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A Qualitative Analysis of the Impact of the Reform of the College of Science Undergraduate Core Curriculum at State University

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A QUALITATIVE ANALYSIS OF THE IMPACT OF THE REFORM OF THE COLLEGE OF SCIENCE UNDERGRADUATE CORE CURRICULUM AT STATE UNIVERSITY

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I would like to dedicate this thesis to all the students who had a love of science and discovery and attempted to persist through self-doubt, anxiety, and emotional distress. Many of these students left the field of science and it is not only their loss but science's as well. Who knows what might have been achieved if they had received support, mentoring, and compassion.

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I would like to acknowledge Professor Gerald Krockover. If there ever was a person that the Yiddish word mensch could apply to it would be Professor Krockover. Mensch roughly translates as a person of honor, integrity, and good will. Thank you for your extraordinary patience and faith!

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TABLE OF CONTENTS

Page

Page

Page

LIST OF TABLES

ABSTRACT

Ballotti, D., Ph.D., Purdue University, December 2014, A Qualitative Analysis of the Impact of the Reform of the College of Science Undergraduate Core Curriculum at State University. Major Professor: Gerald Krockover.

The Dean of the College of Science at State University, a large public Midwestern research university, in a memo to the faculty and staff initiated what he called a "review" of the undergraduate science core curriculum. He formed a task force that was to investigate on three issues; a reassessment of the undergraduate core curriculum, the recruitment and retention of qualified undergraduate students with an emphasis on diversity, and strategies that would address these issues. The age of the curriculum, 40 years since the last significant change, was an important factor in the review of the curriculum. This qualitative study seeks to understand how a group of four administrators and five faculty, all from the College of Science, participated in the task force, perceived the old curriculum, and perceived the changes made and the resulting new curriculum. They were also asked to rank both the prior and new curricula. As part of an ongoing theme in higher education they were also asked if they thought the changes made to the curriculum qualified as reform and why or why not. This resulted in a discussion of what a reform might look like at State University and ultimately a definition of reform.

CHAPTER 1 INTRODUCTION

In a memo to the College of Science Department Heads dated August 15, 2003, the Dean of the College of Science listed a number of reasons for initiating a task force to review undergraduate education in the College of Science. The dean noted that the College of Science was formed as a separate unit forty years ago but in that time the broader requirements of graduation had not changed very much. Although the quality of incoming students had improved dramatically over that period based on SAT scores and high school rank, retention in the College of Science had dropped to approximately 30%.

The dean identified four issues to focus upon: 1) A reassessment of the goals of undergraduate education in the College of Science, 2) Exploring ways to produce graduates who are technically skilled and broadly educated to become scientifically competent leaders, 3) Creating ways to recruit and retain qualified undergraduate students for a diverse population and 4) Developing strategies that address these issues.

In addition to these four issues the dean posed a number of questions for consideration including; increasing retention in the College of Science, attracting a higher caliber of student to the College of Science, addressing different levels of preparedness, using different teaching methods to address different learning styles, accounting for gender and ethnic differences, modifying the current curriculum to address entry into emerging fields, identifying the causes of high failure rates in certain courses, developing orientation courses or procedures that are best suited for beginning students in the

College of Science, deciding whether beginning students should be taught from a common college core science curriculum or individual department cores, the role advising plays, the role of faculty in advising, providing more research opportunities for undergraduate students, the role of co-curricular and study abroad opportunities to provide science students with international experiences, and on time graduation.

A National Perspective

On June 13, 2011, in a speech at Cree, Inc. in Durham, North Carolina, President Obama (Obama, 2011) called for U.S. Universities to graduate an additional 10,000 engineers per year. On April 19, 2012, the Commission on Pathways Through Graduate School and Into Careers (Council of Graduate Schools and Educational Testing Services, 2012) released a report outlining the need to increase the number of Science, Mathematics and Engineering (SME) students in graduate schools and the career paths available to them. This fourteen member commission is made up of industry leaders, university presidents, graduate deans and provosts. They report that between 2010 and 2020 that there will be 2.6 million new and replacement jobs requiring advanced degrees and over half those jobs will be in SME fields. Undergraduate degrees in SME make up the pipeline to graduate degrees in SME. If students are choosing not to enter into SME fields or switching out after beginning college in SME fields then there will be many fewer students to pursue SME graduate degrees.

In January of 2012 the President's Council of Advisors on Science and Technology (PCAST, 2012) issued a report urging that students interested in SME fields not drop out or switch fields. One suggestion was to train SME faculty to become better teachers. The report also called for a national program to improve the mathematics skills of all entering college students and for institutions to provide more and different ways for students to earn SME degrees than the traditional four to five years at one school.

The previous suggestions are economic arguments for increasing the number of graduates from SME fields and they are valid arguments, but are not the only arguments. Another argument on a more personal level addresses the issues of human capital and the needs of society. In their interviews of 355 undergraduate students Seymour and Hewitt (1997) discuss many cases, often of women, of students who had an initial passion for science. Many of these students chose to leave science not because of grades, as conventional wisdom would have it, but because they felt unappreciated, unsupported and unwanted. This loss of human capital is unacceptable especially when many of these students had an initial passion for science. So, aside from the economic arguments being made for focusing on abating the attrition from SME fields, a more pervasive, and persuasive, argument may be the putative fact that science itself is driving many capable students, including many women and underrepresented minorities (URM), away because they do not fit the narrow definition of what a scientist is.

Attrition From Science Curricula Nationally

Although the Dean stated that retention in the College of Science was only 30% (70% attrition) in 2003 the data from other universities across the United States is not much better. Dean Smith also alluded to the fact that he wanted to increase the number of qualified recruits to the College of Science, which included increasing the number of qualified women and ethnic minorities as well.

A number of important studies in the past 25 years have illustrated the great need for science literacy and education. Beginning with the 1983 publication of *A Nation at Risk:*

The Imperative For Educational Reform by the National Commission on Excellence in Education and the Third International Mathematics and Science Study (TIMSS) the United States was considered to be behind the rest of the industrialized countries in science education and that this had become a national threat.

Over the past twenty years research has quantified the issues facing students and institutions in science, mathematics and engineering (SME) fields (Astin, 1985; Hilton and Lee, 1988; Green, 1989a, 1989b; Astin and Astin, 1993; Strenta et al., 1994; Seymour and Hewitt, 1997). The overarching issue is whether or not there will be a sufficient number of students entering into and graduating from SME majors to sustain the U.S. leadership in the sciences and engineering and to populate future science and engineering jobs (Hilton and Lee, 1988; Astin and Astin, 1993). There are also strong implications concerning future K-12 science teachers since they would come from the same cohorts of students in the sciences (Hilton and Lee, 1988; Astin and Astin, 1993; Strenta et al., 1994). Finally the number of women and underrepresented minorities (URM) in the science pipeline, although never high, are declining (Strenta et al., 1994; Seymour and Hewitt, 1997).

Broadly defined there are really two primary issues facing SME fields; attrition from SME fields before matriculation to college and attrition from SME fields after matriculation to college. Beginning in the 1980's the Higher Education Research Institute (HERI) at UCLA identified decreasing numbers of freshmen entering and remaining in SME fields (Green, 1989a, 1989b; Astin and Astin, 1993). The Higher Education Research Institute conducts its annual compilation of higher education from the Cooperative Institutional Research Program (CIRP, 2014) data based on three surveys of college students; entering college freshmen, after completion of the first year of college and graduating seniors.

Hilton and Lee (1988) examined a cohort of over 20,000 high school sophomores in 1980, two years later as high school seniors in 1982, and two years after that in 1984. Approximately 20% of high school sophomores indicated an intention to major in a SME field and by their senior year only 18% indicated an intention to major in a SME and only 14% actually did begin college in a SME major.

Using CIRP data, Green (1989a, 1989b) reports a twenty year decline in interest of entering freshmen in science. This data collected between 1966 and 1988 describes a significant drop in interest in science as a major. Green (1989a) reports a drop in interest in science as a major from 11.5% in 1966 to 5.8% in 1988. For the individual sciences interest in mathematics dropped from 4.6% to 0.6% and in physical science from 3.3% to 1.5%. Even more sharply, interest in engineering and computer science dropped from 12.0% in 1982 to 8.6% in 1988. Alarmingly, interest in science and mathematics teaching dropped from 22% in 1966 to 9% in 1988.

Not only are students losing interest in the sciences and mathematics, those who enter SME fields are leaving in significant numbers. Using CIRP data Astin and Astin (1993) report that students who entered SME majors as freshmen dropped out of those fields at a rate of 40% by the time they were seniors. For biological sciences the attrition rate was 50%, for engineering 40%, for health sciences 53%, and for physical sciences 20%. Engineering fields as a whole lost 53% of its beginners and health professions lost 51%.

Strenta et al. (1994) examined a cohort of 5,320 students (57% male and 43% female) entering highly selective universities in the fall of 1988. These were high achieving students with a combined math/verbal SAT average of 1,310 and a high school rank in the 98^{th} percentile. Forty three percent (N=2276) of this original cohort entered science fields in college, 35% were women and 49% were men. From these beginning students 40% left SME fields (52% women and 34% men).

Seymour and Hewitt (1997) examined CIRP data beginning with the 1987 cohort through 1991 (N=810,794; 73.7% men and 26.3% women). They found that overall 44.1% of SME beginners (biology, physical sciences, engineering, mathematics /statistics, mathematics only, and agriculture) switched to a non-SME major. The highest rate of switching was 63% for mathematics and the lowest rate was for engineering at 38%. From this population 41.2% of the men and 52.4% of women switched to a non-SME field.

From the known data approximately 40% of students are leaving SME fields during the first two years of their college career. Women are leaving SME fields at a higher percentage than men (52% and 38%, respectively), even though women are a far smaller cohort than men initially.

Reasons Given for Leaving SME Fields

Although there are few studies on the attrition of high school students from SME fields (Strenta et al., 1994) before they matriculate to college, there are two theories about why beginning college students in SME fields leave those fields before graduating. One seems to be an acceptance among SME faculty that losing SME students is a natural process, that some students do not have the cognitive ability to do the demanding work required in these fields (Strenta et al., 1994; Seymour and Hewitt, 1997). Another idea put forward by Hall and Sandler (1982) is coined the “chilly climate” theory. Initially

Hall and Sandler (1982) used the "chilly climate" thesis to describe institutional environments, or climates, both inside and outside the institution, that were unfavorable towards women. This focused on how women were treated in the classroom, laboratory, advising and informal exchanges with faculty. In addition, students reported large classes, a high degree of competition, poor teaching and an unresponsive faculty as factors in a "chilly climate." All these factors resulted in women coming to believe that they were second class citizens compared to male students. At issue, women were not being taken seriously for their intellectual abilities.

However, both women and men are leaving the sciences, as well as underrepresented minority students, so the "chilly climate" thesis was extended to include men and underrepresented minorities. Hall and Sandler (1982) posited that a "chilly climate" affected men in subtle ways. If faculty considered women second class then male students might develop similar attitudes towards women which made peer interactions difficult. In addition, if such limited stereotypes about women persisted then what other stereotypes might exist that hampered men in subtle ways too? The same can be said about underrepresented minorities as well. Ultimately there is a serious loss of human capital.

The "chilly climate" thesis is not accepted by all researchers however. Strenta et al. (1994) did not find evidence of a "chilly climate" in their study. Using regression analysis they did not find a significant difference between men and women in their perception of institutional climate. However, Seymour and Hewitt (1997) did find significant evidence of a "chilly climate" especially for women. In their qualitative study of 355 college students Seymour and Hewitt (1997) found that reasons given for switching from a SME field included; poor teaching by SME faculty (90%), feeling overwhelmed by the pace and load of curriculum demands (45%), inadequate advising or help with academic problems (75%) and morale undermined by competitive SME culture (28%).

A Bigger Picture

While the issue of attrition from science curricula, including science education, in higher education is serious it is couched within a larger perspective. This is perhaps best exemplified by the Editor-in-Chief of Science, Bruce Alberts, in an editorial he authored titled "Trivializing Science Education" in the January 20, 2012 issue of Science. Dr. Alberts questions the wisdom of placing too much rigor on the details of science as opposed to stepping back to see the wonder and beauty of what science discovers especially at younger ages. His argument is central to the questions this study seeks to address. In part Dr. Alberts says:

> "When we teach children about the aspects of science that the vast majority of them cannot grasp, then we have wasted valuable educational resources and produced nothing of lasting value. Perhaps less obvious, but to me at least as important, is the fact that we take all the enjoyment out of science when we do so."
>
> "Unfortunately, most students today are taught about DNA at such an early age that they are forced to merely memorize the fact that 'DNA is the material from which genes are made,' a chore that brings no enjoyment or understanding whatsoever. I fear that the joy of discovery has been eliminated by their earlier memorization of boring DNA facts. We have spoiled a beautiful story for them, by teaching it at the wrong time."
>
> "The preference of 'rigor' in science education can also interfere with the teaching of science at the college level. For example, in an introductory biology class, students are often required to learn the names of the ten enzymes that oxidize sugars in a process called glycolysis. But an obsession with such details can obscure any real understanding of the central issue, leaving students with the impression that science is impossibly dull, causing many to shift to a different major."

So, in addition to the "chilly climate" theory Dr. Alberts adds the perspective of the use of rigor and timing in science education as barriers to educating more scientists.

The Bayer Foundation surveyed more than 400 science chairs from the top 200 research universities (Mervis, 2011) on their attitudes towards women and URM's. Eighty four percent of these science chairs said that including women and URM's in SME fields was important to their institutions. However, 46% (a plurality) said that so-called weed-out courses hurt diversity driving many of these students out of SME fields, while 29% said that the current process is an efficient way to identify future scientists. Disappointingly, 57% of these science chairs said that they see no need to change their introductory courses to retain more SME students, including women and URM's. In this article David Seybert, professor of chemistry and dean of the Bayer School of Natural and Environmental Sciences, believes that "a combination of tutoring, faculty mentorship, summer research experiences and internships will be a winning formula for producing a more diverse SME workforce."

Research Questions

The College of Science through the dean's leadership, responded to his 2003 memo by developing a new curriculum which debuted in the fall of 2007. This was the first significant curricular change in over forty years. In addition to the curricular changes the College of Science also outlined specific learning outcomes in six areas including;

1. Demonstrated depth in major.
2. Ability to think and function as a scientist.
3. Ability to communicate well, both orally and in writing.
4. Ability to collaborate as part of a team.

5. Ability to function in a multidisciplinary setting.
6. Demonstrated breadth of knowledge and cultural appreciation.

The above learning outcomes were new for the College of Science and were integrated into the new curriculum. For each of the learning outcomes a set of courses were identified that would satisfy each learning outcome. Many of these courses were newly developed in the individual science departments at the University whereas, other approved courses were already established.

This study seeks to understand the results of these changes five years after they were initiated. Although current quantitative data will be analyzed, this study is more directly concerned with the effects, five years later, that these changes had on the science community at this university. This includes science faculty and university and science administrators. This study will use a qualitative approach guided by the theoretical framework of constructivism using the Fourth Generation Evaluation method developed by Guba and Lincoln (1989).

It is interesting to note that the word reform does not appear anywhere in the dean's initiating memo. Why? The word reform can be pejorative in many ways. From Webster's Encyclopedic Unabridged Dictionary of the English Language (reform, 2014) reform is defined as; 1) the improvement or amendment of what is wrong, corrupt, unsatisfactory, etc., 2) to change to a better state, form, etc., improve by alteration, substitution, abolition, etc. Maybe more illuminating is a short history of the use of the word reform from the book Keywords by Raymond Williams (1983). Williams describes the difficulty in distinguishing between two latent senses of the word reform; 1) to restore to an original form or 2) to make into a new form. The former definition was tied to the idea of restoring to an earlier and less corrupt form and the later definition was tied to the idea of changing something for the better. Williams goes on to explain that reform in its most general sense carries the implication of amending an existing state of affairs in the light of known or existing principles. This use of the word can move towards restoration as well as towards innovation.

The word innovation also warrants some scrutiny. Again from Webster's Dictionary innovation is defined as: 1) Something new or different introduced, 2) Introduction of new things or methods. Arthur Levine (1980) examined innovation in higher education in "Why Innovation Fails: The Institutionalization and Termination of Innovation in Higher Education." His model of why and how innovation succeeds or fails hinges on two components, compatibility and profitability. He defines compatibility as the degree of congruence of the values, norms and goals between the innovation and the host institution and profitability as the degree to which the innovation satisfies the organizational, group and personal needs of the host institution. If the innovation is seen as either incompatible or unprofitable then the innovation will likely fail and be terminated.

Obviously there is a direct connection between the words reform, especially the second Webster's definition and William's connotation, and innovation in the sense that Levine discusses. The distinction between words is important because in assessing what the College of Science has accomplished in its review of its curriculum and processes what has it actually achieved? Was it a reform or an innovation or something else? Hopefully this analysis will answer these questions.

The primary questions that this study will seek to answer are:

1. What does the College of Science faculty think about the “reform” and the current science curriculum?
2. What does a sample of College of Science administrators think about the current science curriculum?
3. Was the dean’s intention a “reform” or something else? Based on his reply, was it successful?

Benefits to be Gained by the Individual and/or Society

The evidence is compelling that fewer high school students are choosing to enter into SME fields when they matriculate to college. Further, the evidence is even more compelling that many students who begin in a SME field leave after the first or second year. As the United States has become more scientifically sophisticated the scientific literacy of most Americans has not kept pace with these advancements (NRC, 1996; AAAS, 1989). As society becomes more complex with the associated problems also becoming more complex, the role of science and technology in addressing these problems is becoming greatly expanded. The ability of the average American to think analytically about events and processes needs to be developed in order to meet the demands of society.

The potential benefits to be gained from this study are great and they would be relevant to many entities including the College of Science at the University, individual students at the University and also to the larger science community nationally. This study hopes to identify what worked in the changes made to the College of Science’s learning outcomes and curriculum changes and also what has not worked. In the case of what has not worked, the hope is to identify different approaches that might be successful in order to address the issue of the loss of human capital in the sciences, especially among women and URM's.

About the Investigator

The author and investigator of this study has a long history and experience in science, engineering and education. My father had a degree in civil engineering and was a professional engineer his entire working career. He had a profound influence on my decision to enter aeronautical engineering as freshmen but my own profound lack of knowledge of college and various majors also had a significant role as well. My initial experiences in the aeronautical engineering department were sobering. It was 1972 and I was the only non-military student in my aeronautical classes. Many of the aeronautical faculty were former military officers as well. It was clear that I did not fit in and I felt completely unsupported. I feel that contributed to my poor performance and eventual exit from aeronautical engineering. After drifting for a year at the university I gained admittance to the civil engineering department and graduated from that department.

I then worked for four years as a field geotechnical engineer after which I left the engineering field because of personality conflicts with the profession. I then returned to the university and earned my Master of Science degree in geophysics. After completing my M.S. I spent some time doing geologic field work and research notably at the Rosenstiel School of Marine and Atmospheric Science and the Ocean Drilling Program, working for the U.S. Geologic Survey in Alaska and as the director of the High Pressure Seismic Laboratory.

I then decided that I had tired of research and began the process of certification to teach secondary science. I completed the entire program except for student teaching because I had become involved with a TRiO Student Support Services Program. TRiO is a set of federally funded programs that assist low-income and first-generation students succeed in college. I worked in this TRiO program for the next 18 years the last 12 years as the director. In the process I successfully wrote four grants for a total of $6.5M. The TRiO program was a true epiphany for me because I had not been aware of the issues related to being a low-income or first-generation student in higher education or K-12 for that matter. In addition, for the first 14 years I was in the TRiO program I also taught math and physics at a local junior college.

The TRiO experience taught me the great discrepancies in education, especially higher education, for low-income students. I become a vocal advocate for these students eventually becoming president of the state chapter of TRiO programs and advocating for them in Washington D.C. Further, my TRiO experience also taught me the power of tutoring, mentoring and how to make learning enjoyable and not a chore. But this experience also showed me how unfair the educational system is for lower income families and how universities quietly work to discriminate against these students.

I believe I am ideally suited to conduct this study because I have real world experiences in engineering, science, research, teaching, administration, curriculum development, and a well developed understanding and compassion for those who struggle against an unfair system. These are also my biases. In conducting this qualitative study I want the reader to understand that I have a significant background in science and education and to be aware that I believe the “system” is biased for all but the most accomplished students. I intend to be as rational and unbiased as I can, to work from a position of clarity, to be ethical and honest and to protect the confidentiality of those whom I work with on this dissertation.

CHAPTER 2 REVIEW OF THE RESEARCH LITERATURE

A Historical Perspective

Early higher education in America. Modern education consists of two worlds, K-12 and higher education, with different mores and values, yet symbiotically linked. One is dependent on the other to educate K-12 teachers who in turn will teach the next generation of students including scientists. The first recognized college was Harvard, founded in 1636 (Rudolph, 1962). It's classical curriculum was taken directly from the great British universities of the period most notably Cambridge and consisted of Latin, Greek, Hebrew, logic, rhetoric, natural philosophy (physics), moral philosophy (ethics), mental philosophy (metaphysics), history, mathematics, botany and divinity. This curriculum was designed to produce the next generation of gentlemen and public servants and until the mid eighteenth century all American colleges followed a close approximation of this curriculum. It is interesting to note that although physics, botany and mathematics were in the curriculum they were not featured subjects and were included as a social nod to the Renaissance. The only degree offered was a Bachelor of Arts in classical education.

By the early eighteenth century Yale added a series of science subjects brought back from England with the direct help of the likes of Isaac Newton and other of the Royal Society members. These subjects, which became known as the "new learning," included; plane and spherical geometry, algebra, astronomy and of course Newtonian physics.

Harvard offered the first course in experimental physics in 1760. Not to be confused with modern day physics, during this period at Yale, the physics course included a section on angels and were “defined as spirits, not made of one of the elements, but of rare medium, endowed with reason and will, and ministers of God, having always existed from the beginning, of least materiality but of many forms (Rudolph, 1977).”

The first college science professor in America, established at William and Mary in 1711, was a professor of natural philosophy and mathematics. Harvard hired its first science professor in 1728. Both of these first science professors were removed because of intemperance. By 1788 all eight of the nascent American colleges had science professorships. Also, at this time, the sciences were being divided into separate disciplines with physics being distinct from natural philosophy and including; chemistry, geography and natural history. At the same time a set of sciences began to be offered at colleges offering medical degrees and included; botany, anatomy and physiology. A general theme being posed by this “new learning” was that science was “the business of the mind is to discover things hitherto unknown (Rudolph, 1977).”

The first colleges to recognize science as worthy of its own degree were Harvard and Yale in 1847. Yale added engineering to its curriculum in 1852. In 1847 Harvard established the Lawrence Scientific School with a donation from Abbott Lawrence and in 1860 Yale established the Sheffield Scientific School. Harvard invented the Bachelor of Science degree in 1852 and Yale created the Bachelor of Philosophy degree in 1853 for its science graduates. Frederick Rudolph in his excellent book “Curriculum: A History of the American Course of Study Since 1636” (1977) makes the salient point that American universities had the unique ability to reform themselves according to the needs of society.

When the Industrial Revolution hit full stride in the nineteenth century American society demanded that its universities shift from granting gentlemen's degrees and begin producing something of practical value, thus the scientific schools were invented and American universities began to take the lead in scientific discoveries into the twentieth century.

Early primary and secondary education in America. Early in the history of the thirteen colonies primary (elementary) education followed the English model of educating children through family, church and community (Rudolph, 1962). Frederick Rudolph's other excellent book "The American College and University: A History" (1962) examines how New England adopted a system of public education with the colonies requiring each town to set up a primary school. The Boston Latin School was the first publicly funded school in 1635. However, outside of New England and particularly in rural areas there was no formal education system through the mid nineteenth century. Until free public education was more generally available private academies provided secondary education in much of the country. These schools primarily were a way for the more wealthy to send their children, mostly boys, to school for basic skills but fulfilled a secondary function as college preparatory.

However, matriculation from these "common" schools to the colleges was not great and many of the students were not well prepared for college level work. One solution to this problem was that the colleges developed their own preparatory departments within the college. By 1870 all but five states had instituted some form of college centered preparatory school intended to feed their colleges. The five states that did not develop these college centered preparatory schools were all in New England where the private academy was still strong. One exception to this trend was the University of Michigan. In 1870 the University of Michigan began certifying certain Michigan secondary schools and admitting their graduates to the University. This was the first occurrence of a university separating itself from its preparatory commitment. This also encouraged the development of the true university and encouraged the state to take ownership of the primary and secondary schools.

In 1892 the National Education Association (NEA) (National Education Association, 1893 and Sheppard and Robbins, 2003) formed a committee of ten persons called the Committee of Ten (CoT). The agenda of the CoT was to determine a common curriculum that would be taught in all high schools to provide uniform preparation for college. The CoT formed nine subcommittees and three of them focused on the sciences; physical science (physics, chemistry, and astronomy), natural history (botany, zoology, and physiology), and geography (physical geography, geology, and meteorology). In their subsequent report the CoT outlined a high school curriculum including the order of courses to take and the amount of time devoted to each subject.

Another committee formed by the National Education Association in 1896 was the Committee on College Entrance Requirements (CCER). The CCER's subsequent report (National Education Association, 1899) had a lasting effect on college admittance to this day. They determined that 16 units of study were necessary for admittance to college; four in languages, two in math, one in history, one in science, and six electives. These units eventually became known as Carnegie Units. The CCER assumed that the six electives would be taken up by science courses. However, because the CoT had recommended only one year of chemistry and physics in the third and fourth years of high school these two subjects became electives and not required.

This also had another, unintended, effect. Since the only science requirement was for one year of science it codified individual science courses into one year blocks instead of being taught over a number of years, which is unique to U.S. science education. Another exacerbating problem at the time was a paucity of qualified science teachers.

Elkana (1970) notes that from the early twentieth century that science education was largely in the inductivist/realist/objectivist philosophical school. Science education, whether as an entity is aware of itself or not, had evolved through a number of different philosophic underpinnings. However, all that changed when the Soviet Union put Sputnik into orbit in 1959.

After Sputnik science education changed and embraced the empiricism/rationalism/positivism school of thought (Matthews, 2004; Turner and Sullenger, 1999). This was reflected in the post-sputnik era of government funding through the National Science Foundation (NSF). Turner and Sullenger (1999) argue that this was a period of elitist and authoritarian practice. The classroom was to be given over to scientists with the goal of making the classroom a model of an actual scientific laboratory. Empiricism ruled and it focused attention on the recruitment of future scientists. Rigorous curricula were organized around scientific knowledge and practice and technology was largely ignored. However, by the mid-1970’s the results were not as promising as first thought and NSF began to withdraw from pedagogy.

The Importance of Educational Reform in the Pre-Sputnik Era

The brief discussion above of the early educational structure and the changes it went through illustrate how the system has changed but also, importantly, the use of reform. In his two books on the history of the American University and its curriculum, Frederick Rudolph constantly evoked the word reform to describe the efforts of early college presidents in making and changing these early colleges and later universities. Arthur Levine in his 1980 book "Why Innovation Fails: The Institutionalization and Termination of Innovation in Higher Education" also evokes the word reform constantly.

In these books both authors describe many situations where the reformer, usually a new college president, confronts the establishment of the college in trying to effect the changes he wants. The first main change was reforming the college curriculum from the British influenced classics model to the nineteenth century German model which focused on science. These early reforms were not successful initially and it took 100 years for American universities to fully embrace science in the curriculum. In this sense reform was simply whether the change was able to take effect and whether or not it was embraced over time.

However, the pedagogy of science was not questioned in these early reforms. In understanding the current situation in higher education's relationship to science it is important to know where we started and how it developed the way it did. The significant reforms in science and how, and why, it is taught happened after Sputnik was launched. For science and science education this was truly a watershed event.

Post-Sputnik Science and Science Education

Pre-Sputnik science education was inductivist/realist/objectivist (Elkana, 1970). This meant that students mostly read books and memorized vocabulary. There was little to no experimentation. This view of science education persisted from the late nineteenth century, as the Sheffield and Lawrence Schools of Science were being developed, up to Sputnik in 1957.

The launching of Sputnik changed everything for American science and science education. When President John Kennedy set the goal of putting a man on the moon by the end of the 1960's the American science and science education communities went into overdrive. The science classroom was to mimic actual scientific laboratories (Turner and Sullenger, 1999). For example, through the 1950's and into the late 1960's the standard college introductory physics course consisted of a course syllabus, textbook, a collection of standard problems, and a set of prescribed laboratory experiments (McDermott, 1991).

Although there had been a paradigm shift to an empiricism/rationalism/positivism framework much of the actual curriculum remained in the read and memorize era. In fact this is a hallmark of reform efforts; reform becomes a reaction to a crisis, which remains largely rhetorical, with little actual change (Levine, 1980). When Sputnik was launched in 1957 the educational system of America was called into question which was blamed for putatively losing the space race at the time (McCormick, 2004). A line from Tobias (1992) sums up the next phase of science education reform, "Americans have become obsessed with science education reform."

In 1958 congress passed the National Defense Education Act which created the U. S. Department of Education. Congress also tripled the budget of the National Science

Foundation (NSF) and charged it to focus on education in science, mathematics and engineering at all levels of education. Curricular reforms were initiated that focused on structure and the process of science (DeBoer, 1991). At the elementary level NSF funded a number of projects including; the Elementary Science Study (ESS), Science - A Process Approach (SAPA), and the Science Curriculum Improvement Study (SCIS) (Shamos, 1995). These programs focused on materials and activities often neglecting the teacher in the learning process (Bybee, 1993).

At the secondary level NSF also funded curricular reform through a number of projects including; the Physical Science Study Committee (PSSC), Biological Sciences Curriculum Study (BSCS), and the Chemical Bond Approach (CBA). Teacher education was also funded through teacher training institutes to build up the content knowledge of secondary teachers. These efforts ignored two important factors; science education faculties were not consulted in the formation of these new curricula and how science affected students in their day to day experiences (DeBoer, 1991). Although many of these projects used inquiry as their basic process and K-12 students were being actively engaged they were ultimately a failure. A large part of the reason of this failure was that the curricula were developed without input from the teachers who would implement them and almost no involvement from science educators (Duschl, 1990).

What did change in higher education in the period between Sputnik and the mid-1980's was that the faculty became more concerned with the star student and very much less concerned with the B and C students. The problem with this approach was that, "although they were elegant and well thought out, they were great as resources for graduate students and even faculty, but were wholly inappropriate for undergraduate courses" (Arons, 1993). Arons (1993) was saying that university faculties were more concerned with the one percent of students in their classes who they saw as highly motivated star students rather than students who were less successful initially. It is also important to note that in these groups of beginning college physics majors were the future K-12 teachers, many who did not persist in the major.

By the early 1980's the "space race" had been won and many considered the crisis in science education to be over (McCormick, 2004). The classroom had been reformed to reflect how a science laboratory functioned with a focus on content knowledge (Shamos, 1995). With the crisis averted interest in science education decreased and funding for reform came to a halt in 1981 when NSF's education funding was severely cut by the Reagan administration where the focus had become tax relief and defense spending.

The Next Crisis – A Nation At Risk

In 1981 the Secretary of Education, T. H. Bell, created the National Commission on Excellence in Education (NCEE) to examine the quality of education in the United States. In this often quoted paragraph from the report Secretary Bell sums up the problem (NCEE, 1983);

> "If an unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might as well have viewed it as an act of war. As it stands, we have allowed this to happen ourselves. We have even squandered the gains in student achievement made in the wake of the Sputnik challenge. Moreover, we have dismantled essential support systems which had made those gains possible. We have, in effect, been committing an act of unthinking, unilateral educational disarmament."

The report notes the poor performance of U.S. students on standardized tests compared to foreign students, having scored last on seven of the nineteen tests, the literacy rate of U.S. students, a seventeen year decline on SAT scores, an absence of "higher order" thinking skills, and a decline in science achievement scores. The report's findings were grouped into four areas; content, expectations, time and teaching. With relevance to science and science education those findings included:

Content	Secondary curricula had become homogenized and diluted to the point that they no longer had a central purpose.
	Too many remedial mathematics courses.
Expectations	Foreign students were spending up to three times the amount of time on mathematics, biology, physics, chemistry, and geography. For those countries these courses were required of all students.
	Thirty five states required only one year of mathematics and 36 states required only one year of science.
	Too few teachers and scholars were involved in writing textbooks or designing curricula.
Time	Too many non-academic courses counted for equivalent credit as did mathematics, biology, chemistry and physics.
	The teaching of study skills was haphazard.
Teaching	Too many teachers came from the bottom quarter of high school and college students.
	Too much effort was being made in methods courses as opposed to content courses, especially in science.
	There was a severe shortage of qualified mathematics and science teachers.
	Many of the new teachers were not qualified to teach mathematics or science.

However, scientists and professionals did not recognize that they were also responsible for educating the very science teachers who would teach the next generation of scientists (McCormick, 2004; NSF, 1996).

In the middle 1980's the National Science Board (NSB) commissioned what became the Neal Report (Undergraduate Science, Mathematics, and Engineering Education, NSB, 1986). Using this report NSF established the Directorate for Undergraduate Education

(DUE). The DUE has funded many programs including undergraduate research and developing curricula.

Science for All Americans

A number of significant events took place starting in the late 1980's that could only be called reform. The American Association for the Advancement of Science (AAAS) introduced Project 2061: Science For All Americans (AAAS, 1989). Project 2061 had as its primary goal that all Americans would be scientifically literate by the year 2061 (the year Haley's comet returns). The length of time recognized both the 75 year period and that a sustained effort would be necessary for success. Science for All Americans was published in 1989 which laid out the benefits of science literacy. Science for All Americans also addressed science education and called for; knowing student's prior knowledge and being able to practice and apply science in the real world.

"Teaching of science should be consistent with the nature of inquiry and include;"

1. Start with a question.
2. Engage students actively.
3. Concentrate on the collection and use of evidence.
4. Provide historical perspectives.
5. Insist on clear expression.
6. Use a team approach.
7. Do not separate knowing from finding out.
8. Deemphasize the memorization of technical vocabulary.

(AAAS, 1990)

Project 2061 also urged college and university presidents to make science literacy a priority on their campuses. It also paid special attention to pre-service science and mathematics teachers and their preparation.

Following SFA Project 2061 published Benchmarks for Science Literacy in 1993. In 1996 the National Research Council (NRC) published the National Science Education Standards (NSES). The NSES not only addressed science standards for grade levels K-12, but it also addressed the role that colleges and universities play in the preparation of K-12 teachers, particularly in science content and science pedagogy.

Reform in Higher Education Science

The curriculum in higher education is mostly controlled by faculty (McCormick, 2004; Shamos, 1995). Faculty learn of needed changes through their professional organizations, professional development and through funding opportunities that target pedagogy and curriculum (McCormick, 2004). Implementation often happens through individual faculty or small groups of faculty. Because of this methodology, reform in higher education is sporadic and has not been embraced institutionally.

The Society of College Science Teachers (SCST) in a position paper states that introductory science courses are where pre-service teachers learn to love or hate science (Halyard, 1993). Along with NSF and AAAS, SCST recommended sciences courses should be inquiry based, use teaching methods that were research based, focused on critical thinking and problem solving, and team work.

One of the more important works that focused on the needs of undergraduate science student was Seymour and Hewitt's (1997) qualitative study of 350 of science persisters and leavers. Poor teaching practices were listed by both persisters and leavers as the greatest concern and reason for leaving (leavers). Students said that classes were boring and relied on memorization. For leavers, and especially among women, there was a clear lack of support from the faculty and science departments they were in. These points support previous findings from NSF, AAAS, and SCST.

Yet another report from NSF titled, Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering and Technology (NSF, 1996), supported all the other reports. Student focus groups found that introductory science courses were barriers, overly mechanical with little connection to other materials. Repeating a theme from other reports, this NSF report stated:

> "America has produced a significant share of the world's great scientists while its population is virtually illiterate in science."
>
> "All students should have access to supportive, excellent undergraduate education in science, mathematics, engineering, and technology, and all students should learn these subjects by direct experience with the methods and processes of inquiry."

In another study by AAAS, Blueprints for Reform (AAAS, 1998), the issues surrounding undergraduate teaching were again brought into focus. Using their studied methodology of how working scientists go about their profession this study recommended:

1. Concentrate on the core concepts, even at the expense of coverage.
2. Link scientific knowledge to other areas of human endeavor, including between scientific fields.
3. Make teaching student centered and use different learning approaches.

A committee of the National Academy of Sciences (NAS), the Committee on Undergraduate Science Education (CUSE), in their report, Evaluating and Improving Undergraduate Teaching in Science, Technology, Engineering, and Mathematics (NRC, 2002) state:

1. Effective teaching in STEM should be available to all students.
2. Design and evaluation of curricula should be the responsibility of faculty.

3. Scholarship that focuses on teaching and learning should be given the same support and rewards as other types of scholarship.
4. Faculty who teach undergraduates should be supported and mentored throughout their careers.

This last report focused in part on an important barrier to reforming undergraduate science courses. Faculty are rewarded for research, publishing and grant funding but not for teaching (NRC, 2002). One way to improve this situation is to put equal emphasis on pedagogy and to create a reward structure for using effective research based teaching methods. For those faculty who have not been trained in effective teaching methods professional development is one path to achieving this goal.

The professional societies have weighed in on the problems illustrated by A Nation at Risk (NCEE, 1983). These prestigious national organizations, NRC, AAAS, NAS, NSB, SCST, all have come to broadly the same conclusions that K-12 and higher education are not presenting science in a way that takes into account the actual practice of science and how students learn best. The problems have been identified and studied and recommendations have been made. In the K-12 system reform, efforts are at the mercy of public agencies such as the federal government, state government and local school systems. In higher education reform efforts, often funded by federal agencies, are in the hands of individual or small groups of faculty (McCormick, 2004). As AAAS points out in Project 2061 and SFA the reform efforts need to be sustained over a long period of time to achieve their lofty goal of science literacy for all Americans.

Reform Efforts in Higher Education

One federal response to the educational crisis was the National Aeronautics and Space Administration (NASA) initiation of its Opportunities for Visionary Academics

(NOVA). NOVA was a faculty professional development program intended to help faculty develop and implement innovative curricula in science and engineering teaching (Sunal et al., 2004). NOVA's goal was to use a research based pedagogy, guided by the national standards, in undergraduate science courses. The expectation was that this would lead to better educated teachers who would then use the same approach in their own future classrooms. NOVA objectives were to:

1. Disseminate NASA's pre-service education model nationally.
2. Continue to develop NASA's pre-service education model based on the national standards.
3. Sustain the change process through mentoring and collaborating with partner institutions.
4. Create a forum to exchange ideas for change in pre-service education.
5. Research the effectiveness of NASA's education model

NASA's funding of NOVA ended four years ago and most of the NOVA programs eventually ended.

In 2006 NSF funded the National Study of Education in Undergraduate Science (NSEUS). NSEUS was originally funded for a five year period but has continued past that period carried by the enthusiasm of its participants for reforming undergraduate science. The primary goal of NSEUS was to determine the impact of NOVA on the learning and teaching practices of K-6 teachers. However, NSEUS has broadened its original focus to include reforming science teaching in undergraduate courses, deciding what a reformed course looks like, and conducting research on reformed science courses.

Concerning the evaluation of NOVA Sunal et al. (2004) report that faculty participant's responses to a survey of questions indicated that faculty felt they had more confidence teaching and that they and maintained high expectations for their students.

Sunal et al. (2004) also found that continued professional development was the key component in making the model work. They found that a typical reformed classroom used inquiry to help students construct their own knowledge, used hands-on activities, incorporated technology, relied on a team approach, and solved real world problems. NSEUS continues to support research on reforming undergraduate science education and to disseminate best practices through an annual conference, maintaining a research catalog and publishing research findings.

Current Reform Efforts

Promising Practices in Undergraduate Science, Technology, Engineering, and Mathematics Education (NRC, 2011) summarizes two NRC sponsored workshops that focused on reform efforts that are currently being used. Chemistry in Context, sponsored by the American Chemical Society, is a curriculum development project at the University of Wisconsin, Madison. This program's goals are to give students a positive learning experience in chemistry and to promote general chemistry literacy. However, there are no assessment tools in place to judge the value of the program but, based on surveys, the program is successful based on the two goals above (NRC, 2011).

Other science courses presenting change models included; evolutionary ecology at Widener University by asking students about their prior knowledge and open ended questions on examinations; physics at the University of Illinois, Champaign-Urbana by developing a new set of learning goals; and developmental biology at the University of Colorado, Boulder by comparing a standard science class with one that focused on cooperative learning with decreased lecturing and more student participation.

In Reform in Undergraduate Science Teaching for the 21st Century (2004) editors Sunal et al. feature research on reform in science teaching grouped into three areas; Lessons from Research on Reform in Undergraduate Science, Perspectives on Reform in Undergraduate Science, and Innovative Models for Reform in Undergraduate Science.

In the Lessons from Research section topics include; collaboration between science and science education faculty, use of prior knowledge, innovative pedagogy, assessment, and professional development. The Perspectives on Reform section topics include; a large university perspective on reform teaching in geosciences, a small college perspective on reform teaching, and a science education perspective and science perspective on reform in undergraduate teaching. The Innovative Models for reform section topics include reform teaching models in biology, chemistry, physics, geology and engineering.

Henderson et al. (2011) reviewed 191 journal articles published between 1995-2008 that promote reform in instructional practices in undergraduate science, technology, engineering, and mathematics courses. They were able to group these articles into four categories; disseminating curriculum and pedagogy, developing reflective teachers, enacting policy, and developing a shared vision. They also identified three distinct research communities that these journal articles were written by or for. Disciplinary-based STEM education researchers (SER) primarily focused on students learning within their disciplines. Faculty development researchers (FDR) conducted research on faculty development to provide faculty with teaching skills and tools for self improvement. Finally, higher education researchers (HER) studied cultural norms, organizational structures, state and federal efforts, and educational policy.

Although Henderson et al. (2011) reviewed 191 journal articles related to reforming science in higher education they also cited other literature reviews of reforming science in higher education. Since the year 2000 there were 3 additional literature reviews from Amundsen et al. (2005), Kezar, (2001), and Emerson and Mosteller, (2000). The NSEUS organization reaches out to at least another 20-30 researchers, the NRC (2011) described above featured 20 speakers, all of whom illustrated their own attempts at science reform.

There is a plethora of journal articles talking about one form or another of undergraduate science reform. However, from my review of these resources, my estimation is that many (>90%) of these efforts involved individuals or small groups, working in one course, making fairly modest changes. If Sunal et al.'s (2004) criteria for a reformed classroom room were applied to a majority of these efforts, very few would be considered reformed. There was little, if any, departmental or institutional involvement behind these efforts. If so, many people are attempting to intact science reform, but these efforts are scattered with varying degrees of effort and few signs of success. Since science reform has not been embraced by departments or institutions, what is the possibility of successful science reform?

Barriers to Reform in Science

During the two conferences that the NRC commissioned in 2008 (NRC, 2011) on science education, two researchers discussed their views of the barriers to science reform. Dancy (Dancy and Henderson, 2008a) describes her findings about barriers to science reform. In interviews with respected, tenured physics faculty, Dancy reports a high level of frustration of the faculty with science education researchers. The physics faculty felt that they were the targets of criticism of the science education researchers for an unwillingness to change their teaching practices. They wanted to be part of the discussion, not the object of discussion.

Dancy used this example to illustrate what she viewed as the primary barrier to science education reform, which is science education's development and dissemination model. Dancy argued that this model focuses on the individual and not the environment or context. Her example was classrooms where the seats were bolted to the floor. Clearly bolted down seats are not conducive to reformed science and are out of control of the faculty. Dancy felt that environmental issues were more important than faculty issues.

Henderson et al. (2010) studied the literature of the three research stakeholder groups identified earlier in Henderson et al. (2011) and found that there was little correspondence between these groups. Referring back to Dancy's view of the development and dissemination model Henderson urged that science education researchers work more closely with scientists in researching and developing strategies to reform science education. Both Dancy and Henderson saw the development and dissemination model as a major barrier to reform.

However, Wright and Sunal (2004) took a more nuanced view of the barriers to reform in undergraduate science. They noted another area where science education reform has been difficult to enact, K-12 education. The barriers to science education reform in the K-12 environment are related to; 1) the culture at large inhibits change, 2) staff development and ongoing support are lacking, 3) the institution shapes what the instructors can do, 4) based on the perception of the classroom instructors use incremental change rather than major structural changes, and 5) instructors own beliefs about teaching limit their choices (Cuban, 1990).

Based on their study of the NOVA program Wright and Sunal (2004) suggest the following nine barriers to reform of undergraduate science education.

Management barriers. First, management barrier issues are related to classroom use and scheduling, administrative turnover, course adoption policies, institutional support for reform including use of resources and time, use of technology, and leadership. One of the more salient of these issues is “turf wars” between individual faculty and with administration. The time and effort needed to develop and teach reformed science is considerable and there seems to be a general lack of appreciation for those who attempt it, both in terms collegiality and professional credit. Wright and Sunal suggest that teams planning reform include senior faculty who are highly respected by decision makers in order to obtain approval for their efforts.

Coordination barriers. Second, coordination barrier issues are related to shared workload and decision making. Wright and Sunal (2004) discuss the lack of communication between faculty and administrators in education and science departments as the primary culprit. They suggest that lines of communication be purposely opened and pursued.

Leadership barriers. Third, leadership barrier issues are related to often what is viewed as a lack of leadership at higher points of decision making. There has to be a knowledgeable and dedicated person in a leadership position who is able to advocate for effective changes among departmental and/or institutional leadership.

Faculty barriers. Fourth, faculty barrier issues that discourage faculty from instituting changes because of a lack of time and merit consideration are of a major concern. Wright and Sunal note, again, that the lack of professional respect between faculty and administrators in the education and science departments as major barriers. They also claim that a lot of the resistance comes from a lack of understanding or fear. Interestingly, they call for senior faculty to “protect” younger faculty seeking to affect reform.

Student barriers. Fifth, the student barrier is all about fear; fear of science, mathematics, change, technology and faculty. In addition to fear there is also a lack, as in, a lack of student assessment, faculty mentoring, student leadership, student academic preparation in science, and a lack of students needs on the part of faculty and administrators. Wright and Sunal (2004) suggest that students be included in any planning processes concerning teaching in a reformed science classroom to address these fears and deficiencies.

Curriculum barriers. Sixth, curriculum barriers are issues related to congruency between external and internal criteria. Decisions need to be made about what is essential and what is ephemeral. This must be guided by research. This is very similar to Levine’s (1980) view of how innovations succeed or fail based on compatibility and profitability, i.e., congruence of the values, norms and goals between the innovation and the host institution and the degree to which the innovation satisfies the organizational, group and personal needs of the host institution.

Instructional barriers. Seventh, instructional barriers are related to the professional development of discipline science instructors who may not have any pedagogical background. To face this barrier Wright and Sunal suggest that teams be formed of science education and science faculties. This will involve a high degree of collaboration and professional development that needs to be ongoing. Interestingly, this barrier is most similar to comments made by Dancy (Dancy and Henderson, 2008a) and Henderson (Henderson et al., 2010) in their discussion of the development and dissemination model. Wright and Sunal (2004) claim that ultimately this may be the most significant barrier to success.

Budget and resource barriers. Eighth, budget and resource barriers include building or remodeling classrooms suited to teaching reformed science, access to technology, and ongoing budgetary support in the face of changing administrations. Ultimately those who control funding will control whether undergraduate science education reform is institutionalized and successful.

Accreditation and certification barriers. Ninth, accreditation and certification barrier issues are concerned with pre-service teacher education. If science education courses are changed how will that affect state certification requirements, local board of education requirements, and national accreditation requirements?

It is evident that there is a common thread to all these barriers and that is the human being. Reform for undergraduate science programs is not a technology issue or even a money issue. In the final analysis human beings must make decisions on whether or not to support reformed science in higher education. This will require time, research, persistence and leadership with a strong person to person ethic that can appeal to a wide range of personalities.

CHAPTER 3 METHODOLOGY

Theoretical Framework

This study is grounded in the theoretical framework of constructivism. I want to know what the various stakeholders in State University's College of Science's curricular reform efforts think are the strengths and weaknesses of these efforts. Another way of stating this is, that I want to know how these stakeholders have constructed their reality around this issue. Patton (2002) describes a foundational question related to constructivism as, "How have the people in this setting constructed reality?" Patton further asks two other foundational questions relative to constructivism; "What are their reported perceptions, 'truths', explanations, beliefs and world view" and "What are the consequences of their constructions for their behaviors and for those with whom they interact?" Comparing the thesis question to these foundational questions it becomes apparent that constructivism is the best theoretical perspective to utilize when investigating the reform of the science curricula in the College of Science at State University.

Paradigms. In order to better explicate the use of constructivism as the theoretical framework for this study it is prudent to review the use of paradigms and why paradigms are important. A paradigm is a set of beliefs, or world view, which guides how a person or organization conducts their daily business. There are many paradigms in the world, for example, there are economic paradigms, political paradigms, theological paradigms and legal paradigms to name a few. It is important to realize that at some basic level paradigms, as sets of beliefs, cannot be proven or disproven and represent the most fundamental components of each system.

Guba and Lincoln (1989), and also Lincoln and Guba (1985), argue that for the past several hundred years there has been a dominant paradigm in western culture that they call the conventional paradigm. The conventional paradigm can also be called the positivist or the scientific paradigm as well. The constructivist paradigm is also known as the naturalistic, hermeneutic or interpretive paradigm.

To compare and contrast the conventional paradigm with the constructivist paradigm, Guba and Lincoln (1989) use three philosophical inquiries that have long been used to question existence; 1) ontology, questions related to existence, what is the nature of reality; 2) epistemology, the origin and nature of human knowledge, how do we know what we know; and 3) methodology, the rules of conduct of inquiry, how do we go about finding out things.

Ontology. This is the central theme between the conventional and constructivist paradigms. The conventional paradigm posits that there is a single objective reality that operates independently of human beings. It is the job of science to discover the rules that this objective reality operates by so that we will be able to control and direct it (reality). The belief is that these rules operate on a cause/effect basis therefore if the chain of cause/effect rules were known then we could produce desired outcomes. Another label for this position would be realist ontology. The conventional paradigm also believes that truth is defined as a one-to-one correspondence between the observer and the objective reality.

The constructivist paradigm asserts that there are multiple, socially constructed realities. This is essentially a relativist ontology that is not governed by natural laws, at least in the positivist sense. These constructed realities are made by individuals who, using prior knowledge, are trying to make sense out of their experiences. As such these constructions are interactive by nature. Truth becomes problematic in the constructivist paradigm. If positivism defines truth as a one-to-one correspondence between the observer and objective reality and if constructivism rejects the concept of objective reality then what is truth in constructivism?

Guba and Lincoln (1989) define truth as the most sophisticated and informed construction that has gained consensus among those who are most competent. The fact that multiple constructions can be held simultaneously among the most informed is illustrated in many fields from science to economics to theology.

Epistemology. The conventional paradigm believes that there is a separate and independent objective reality so that there must also be an objective stance between the observer and that objective reality. It is imperative that the observer does not interfere with the independent objective reality so as not to introduce distortions or biases. The goal of the observer is to see how the world really operates or what the world is really like. If the observer became involved in the observation, then they would inevitably distort that observation and would not see the true reality.

The epistemological questions answered under the conventional paradigm are determined by the dualism of observer/observed and a values free observation. The observer must make both an objective and value free inquiry. This could also be called an objectivist epistemology.

The constructivist however recognizes multiple constructions none of which represent an objective reality. The question of objectivity does not matter at this point. The constructivist does not and cannot separate the observer from the observed. They are part of an entwined whole. This position brings into question the issue of values. The constructivist enquirer, not recognizing an objective reality, intrinsically becomes part of the observation. It can be no other way. In fact the values of all humans involved become part of the observation. To the constructivist observations are of constructed realities therefore the constructivist's values are part of the observations.

The question of values deserves special attention because of the importance that the conventional paradigm places on objectivity. The constructivist paradigm does not recognize a separation between the observer and the observed therefore, the values of the observer cannot be separated either from the observer or the observed. In fact the values of all parties related to the observation are relevant. This is apparent even under the conventional paradigm where objectivity is the accepted norm. In the conventional paradigm the objective inquirer is asking questions, making observations, and drawing conclusions. Yet, in each of those cases it is impossible for the inquirer to disassociate their own prior experiences and knowledge from asking questions, making observations, or coming to conclusions. Therefore the objective observer is not really value-free.

Conventional versus constructivist methodology. The conventional paradigm assumes a realist ontology and an objectivist epistemology. Using this point of view it would make sense that in order to minimize potential contamination that observations are made covertly. The primary objective of the conventional paradigm is to discover "how things really are" and discovery of causal mechanisms is particularly important. If causal mechanisms can be well understood then the ability to predict and control phenomena greatly increases. In order to achieve this level of objectiveness all observations and experiments must be well controlled.

From the constructivist point of view all events and observers are interactive. Methodology is a very important component of the constructivist paradigm. The constructions of all participants, including the observer, are exposed. As will be described later this process becomes hermeneutic in nature. This is an iterative process in that the constructions of various stakeholders are shared between those stakeholders with new constructions emerging. The goal is to gain consensus between the constructions of the various stakeholders. If consensus is not possible then the main differences are illustrated which leads to a more sophisticated and informed construction.

The failure of positivism. Paradigms are very powerful constructions. They dominate how societies organize themselves and provide the framework for norms. Therefore there is a need to expand on the reasons to replace the conventional paradigm (positivism) and constructivism provides the correct context as that replacement. Guba and Lincoln (1989) and Lincoln and Guba (1985) describe positivism as the dominant paradigm or world view. It has been used almost exclusively by science as its modus operandi. Positivism has also become adopted by western society as the best way to conduct business. Therefore it strongly affects and informs cultural norms including legal and political standards. Resistance to change will be great so it is prudent to discuss some of positivisms larger flaws. Following is a brief discussion of the evidence that calls the positivist view into question.

Positivism and ontology. Positivist ontology posits a single independent objective reality that can be called a realist ontology. Yet physics provides a number of examples that call into question this assumption. At one end of the spectrum is determinism as evidenced by Isaac Newton's postulate that given the position and speed of a planetary object that one could predict its location at any time in the future. At the other end of the spectrum is quantum mechanics that defines the position of a given particle as a probability. One of the fathers of quantum mechanics, Werner Heisenberg (1930), developed the uncertainty principle that states that the more that is known about one property of a particle, the less is known about another property. Specifically, the more accurately the position of an electron is known, the less accurately can the momentum of that particle be determined. This is the result of the observation that simply observing a particle changes the way it behaves.

Another example from physics that does not support positivism is the behavior of light. Thomas Young (Young, 2014), a British scientist, developed his famous double-slit experiment in 1803 which has been replicated by every physics student since Young first reported his findings. Young's experiment showed that light could be thought of as a sinusoidal wave with the interaction of multiple waves producing specific interference patterns. Then in 1905, Albert Einstein described the photo-electric effect of light (Darling, 2014). The photo-electric effect describes light as particles (quanta) with specific levels of energy. So, is light a wave or a particle? Niels Bohr introduced the idea of complementarity to describe the dual nature of light and this idea became codified by Werner Heisenberg as the Copenhagen Interpretation in his textbook, *The Physical Principles of the Quantum Theory*, published in 1930. Both complementarity and the

Copenhagen Interpretation agree to define light as having two separate properties, wave and particle. For the discussion here it is important to note that both of these properties cannot be observed simultaneously. One or the other property can be observed depending on how you observe it.

It is also important to note the role of the observer when discussing complementarity because it is the observer who choses how to observe the light and that choice determines which view of light, wave or particle, the observer sees. How can there be a single independent objective reality when two different, but valid, observations of light are made?

Positivism and epistemology. The relationship between the observer and observed has radically changed over the past 3,000 years. Aristotle believed that the observer should remain passive to the observed so as to "see" the world as it really is without the interference of people. Approximately 2,000 years after Aristotle, Galileo Galilei may have been the first scientist to use the positivist paradigm by becoming actively involved in his observations. Galileo's observations of the swinging chandeliers in the Pisa Cathedral led him to conduct experiments that led to his discovery of isochronism in pendulums. Galileo was no longer a completely passive observer like Aristotle but needed to control certain aspects of his experiment in order to observe the properties of the pendulum. In positivism it is necessary for the observer to intervene in the observation to control potential sources of contamination. However, once the controls are in place the observer removes him/herself again in order to see the "real" world. Lincoln and Guba (1985) counter the "observer at a distance" with the following three points.

1. The phenomena of reactivity. Reactivity can be controlled to some degree in physical and life sciences but with human subjects it is almost impossible to avoid. In fact given the nature of human interaction reactivity is expected and becomes part of the observation.
2. The phenomena of indeterminacy. Using the previous example of the duality of light, indeterminacy can be seen in human interactions as well. What you see in light, particle or wave, depends on how you look at it. If you approach human interaction with a specific theory or set of questions then may likely miss a significant part of the whole. Outcomes are indeterminate.
3. The phenomena of interactivity. The interaction between observer and observed cannot, should not, be ignored. And if there are more than two participants then the range of interactivity increases and the outcomes become even more indeterminate.

Positivism and values. The phenomenon of interactivity brings into the discussion the issue of values. Positivists believe that observations can be made values-free. Using the points made so far constructivists believe it is impossible to make a values-free observation. This is especially so when using human interaction. Even under the positivist paradigm values are used all the time. Values are involved when the investigator decides what will be observed. In fact all the choices the investigator makes are value-laden. The choice of what theory to use is a matter of values. Values select the dominant paradigm directing the choice of theory.

Generalizing. One of the pursuits of science is to discover truths, in a positivist sense, which means a one-to-one correspondence between the observer and the single independent objective reality. In science the more fundamental and universal these truths are the better, they are called laws. The belief is that there are causal mechanisms that explain how objective reality "works." Another way of stating this is that science seeks to generalize its discoveries. Positivists believe that objectivity allows observations and theories built from them to be applied broadly, thus generalizing. But if there is no objective reality and objectivity itself is not possible then can generalizations be valid? If the universe was completely deterministic and causal mechanism well defined then generalizations would have meaning. But, as it is argued here, the universe seems to have multiple constructed realities and is completely subjective and generalizations become time and context bound.

Guba and Lincoln (1985) further discuss the time dependency of generalizations. Their claim is that generalizations decay over time. However, given a steady-state assumption, often made in science, generalizations can seem to be time independent. But scientific paradigms shift (Kuhn, 1996) and even neutrons have been discovered to decay over time. More importantly for this discussion social systems can change rapidly so that the time dependency of generalizations become muted.

Causality is still a resonant construction for the positivist as well. However, Travers (1980) asserts that causality in science has been replaced by the construction of functional relationships and offers the following comment:

> Functional relationships imply that variables are related in a necessary and invariant way. Thus the radii of the orbits of the planets, their periodicities and their masses are related functionally. Only a pre-Newtonian would say that the gravitational pull of the sun causes the planets to stay in orbit.

Guba and Lincoln (1989) add their own discourse on causality by noting the following subjective aspects of causality:

- Correlation does not imply causality, that is, recurrent regularity does not itself support a causal presumption unless and until some human supplies a logical reason to account for the connection.
- Human judgment is required to determine when a condition is necessary and sufficient to be taken as a cause and to know that no other causes are present that might account for the presumed effect.
- Human judgment is required to judge when a law is applicable and when and if the initial specified conditions are present and adequate to support a causal imputation.
- Causal imputations are usually made with a specific human purpose in mind.
- Cook and Campbell (1979) suggest that "The concept of causality is closely linked to intentions and purposes. Most causal inferences are about attributes of the world that are particularly relevant to an active, intrusive, willful organism."

Lincoln and Guba (1989) define their own view of causality similar to Travers definition calling it "mutual simultaneous shaping." This construction asserts:

- All elements in a situation are in mutual and continual interaction.
- Each element is activated in its own way by virtue of its particular configuration of all the other elements, potential shapers, that is assumed at that time and in that place.

- Judgments about which of the potential shapers may most plausibly be implicated in explaining and/or managing whatever it is the investigator wishes to explain or manage is a matter both of the circumstances that exist and of the investigator's purpose.
- The peculiar web or pattern of circumstances that characterizes a given situation may never occur in just that way again, so that explanation and management actions are in a real sense unique and cannot be understood as implying either predictability or control.
- Explanations are the best "here and now" accounts that represent a "photographic slice of life" of a dynamic process that, in the next instant, might present a very different aspect.

Mutual simultaneous shaping together with multiple constructed realities forms the basis of the constructivist paradigm and produces a more sophisticated and informed view than the conventional paradigm.

Fourth Generation Evaluation

Guba and Lincoln's (1989) evocative text, Fourth Generation Evaluation, refers to three previous generations of evaluation and describes their approach to conducting a fourth generation of evaluation using what they term *responsive constructivist evaluation.* Responsive refers to a negotiation between the evaluator and all the stakeholders in order to come to a consensus about the issue(s) at hand. If no consensus is possible then the differences clearly illuminate the issue(s) and those can be used for future study.

Their use of constructivist refers to a methodology which can also be called interpretive or hermeneutic. It is a way to focus a study and allows specific themes to emerge. First generation evaluation refers to collecting data and identifying variables. Second generation evaluation refers to identifying objectives and the degree of congruence between the evaluand and those objectives. Third generation evaluation refers to the use of various models (theory-laden) that focus the study in specific ways. Because those models (theory-laden) focus on specific questions, variables or objectives they can often miss pertinent information that is not considered because the focus is elsewhere.

Fourth generation evaluation takes third generation evaluation a step further by specifically trying to identify issues that might have been missed. Guba and Lincoln (1989) define this as the *claims*, *concerns* and *issues* about the evaluand that have been identified by the different stakeholder groups. A claim is a stakeholder assertion that is favorable towards the evaluand. In other words, that the evaluand is effective. A concern is a stakeholder assertion that is unfavorable towards the evaluand. In other words, the evaluand is not effective. Finally, an issue is anything that can reasonably be disagreed with. Fourth generation evaluation uses the claims, concerns and issues that emerge from each stakeholder group as a way to focus the evaluand as broadly as possible.

Fourth generation evaluation recognizes multiple constructions which gives validity to all the stakeholder's perceptions. This is an empowering realization that reality has multiple constructions (and rejects the idea of a single independent objective reality) and is a great benefit when trying to understand how different stakeholders perceive (construct) their world. No single construction is right or wrong, true or false, and consensus, or lack of, becomes the preferred view of reality.

Fourth generation rejects the observer-observed duality and replaces it with an interactionalist model. Guba and Lincoln (1989) assert that it is the very interaction between the observer and the observed that creates the “truth” or constructed reality. Using multiple stakeholders the goal is to gain a consensus on the most informed and sophisticated construction. In this way all views are valued.

Building on the constructivist view of ontology and epistemology, fourth generation evaluation methodology rejects the predict and control nature of the positivist. A hermeneutic/dialectic approach best describes the constructivist methodology. If responsive constructivist evaluation is to be effective then a questioning dialog must be established between as many of the stakeholders as possible.

Standards of Quality

Guba and Lincoln (1989) define three ways to determine the “quality of goodness” of a fourth generation evaluation; trustworthiness criteria, the nature of the hermeneutic process and authenticity criteria.

Trustworthiness criteria. The trustworthiness criteria are a parallel set of standards to the conventional paradigm’s internal validity, external validity, reliability and objectivity criteria. The trustworthiness criteria parallel to the conventional paradigm’s criteria are; credibility, transferability, dependability and confirmability.

Credibility. In the positivist view internal validity verifies the causal link between an outcome and a controlled variable. If there is a correlation between the outcome variable and the control variable then cause is implied, however if there is no correlation then there is no implied cause. Causal relationships are used to establish “truth” but as described earlier causal relationships are tentative at best and can be probabilistic.

Guba and Lincoln (1989) propose using credibility to replace internal reliability. Credibility is a one-to-one relationship between the constructed realities of the stakeholders and the reconstructed realities presented by the evaluator ascribed to those stakeholders. They suggest the following ways to determine the validity of credibility.

1. *Prolonged engagement* that allows the evaluator time and context to become familiar with the stakeholders and their views.
2. *Persistent observation* that allows the evaluator to identify the relevant issues of the stakeholders.
3. *Peer debriefing* is a process of the evaluator talking with a peer. The purpose is to discuss the study being conducted with a peer not involved in the study. This allows the peer to identify or clarify issues that the evaluator may have missed. The peer also allows the evaluator the ability to examine his/her own values and how they affect the study.
4. *Negative case analysis* considers all emerging themes from a study and either accepts or rejects them. This is similar to the case where all hypotheses are considered, or rejected, until the most appropriate one emerges.
5. *Progressive subjectivity* is a process that allows the evaluator to make sure that his or her own constructions do not take precedence over the constructions of stakeholders. The evaluator records his or her own constructions prior to working with any stakeholder(s). Then using the peer debriefer described previously the evaluator can verify that his or her own constructions do not gain precedence.
6. *Member checks* are the best way to verify that the emerging themes are consistent with the constructions of the stakeholders. The best way to verify that the

> constructions the evaluator is collecting is to go back to the stakeholders from whom they were originally obtained and to ask them if the evaluator's reconstructions are accurate. This is an ongoing process that can continue through the study from beginning to end.

Transferability. In the positivist's view external validity describes the degree to which the findings of a study are generalizable to other contexts. This often means that both the study and the generalizing contexts are randomly selected from the same population. However, as discussed previously the constructivist paradigm does not recognize generalizability due to the nonexistence of a single independent objective reality and an observer/observed dualism. Guba and Lincoln (1989) replace the idea of generalizability with transferability. The degree of transferability can be established by the similarity between the study context and any other contexts that used for comparison.

Generalizability in the conventional paradigm is absolute depending on random sampling but transferability is context sensitive. The driving condition for using transferability is the degree of overlap or similarity between contexts. The way to establish the degree of overlap is the use of thick description. Lincoln and Guba (1985) state that there is no agreed upon definition of what a thick description is exactly. However, they also state that transferability depends on the receiving context and not on the sending context, as opposed to the positivist view which reverses those roles. With that in mind a thick description must provide enough detail that the receiving context is able to identify significant overlap between contexts.

A thick description must provide as much detail of the study context in terms of location, time, physical setting, participants and culture. Also, all working hypotheses must be available which adds to the thick description. The evaluator of the study context does not make the transferability decision but provides as much detail so that the receiving context can make a judge of the relevance and applicability.

Dependability. Dependability is the parallel construction to the conventional paradigm's reliability. Reliability is meant to determine the stability of the study over time. Following the general theme of fourth generation methodology what is important are emerging themes. Often the best way to understand emerging themes is to follow them where they lead you. However, in the conventional paradigm changing the design of a study or changing hypotheses often run afoul of reliability and could render the study unreliable.

Fourth generation methodology seeks emergent themes and therefore needs to be able to shift its design and develop new hypotheses. In fact Guba and Lincoln (1989) describe more sophisticated and maturing construction as signs of a successful study. The key to dependability is to be able to clearly follow the path of the emerging themes and understand why and how changes in design and hypotheses were made. They suggest the use of what they call an inquiry audit which is similar to a fiscal audit. The first part of an inquiry audit establishes that there is a process, that it can be followed and that it is documented. The second part of the audit verifies that the data collected can be confirmed. This second part of an inquiry audit is actually the next step in Guba and Lincoln's (1989) fourth trustworthiness criteria called confirmability.

Confirmability. Confirmability is the constructivist's parallel to the conventional paradigm's criterion of objectivity. As has been discussed previously objectivity is not a desired, or possible, construct in fourth generation evaluation. To supplant objectivity the construct of confirmability is concerned with verifying that the data and interpretations are fixed in the contexts in which they were collected and not in the mind of the evaluator. Guba and Lincoln (1989) point out that while objectivity is secured through its methodology in the conventional paradigm, confirmability is secured through the data itself using fourth generation evaluation. This means that the data can be traced back to its sources and that the interpretation of the data is both implicit and explicit in the context of those sources.

This tracking is best achieved as part of the inquiry audit discussed previously. The two parts of an inquiry audit are the dependability audit and confirmability audit. Whereas the dependability audit is concerned with process, its quality and appropriateness, the confirmability audit is concerned that the data can be traced back to its original sources and that the interpretations can be confirmed. The audit is achieved through the use of a "thick" description.

The Hermeneutic Process

The second step in assuring a good evaluation is the hermeneutic process itself. If done correctly it is a self-checking process that corrects errors as they become apparent. Data is collected and analyzed immediately. It is then fed back to its source for elucidation and correction if warranted. The process is also open to be viewed by any concerned parties. This way there are no secrets and false fronts are difficult to maintain. The openness of the process also equally shares information among all stakeholders, which could be used to gain power and pervert the evaluation.

One important point to consider are the constructions of the evaluator and how they affect the evaluation. Guba and Lincoln's (1989) assertion is that under the constructivist paradigm that the evaluator's constructions are as valid as any other stakeholder's in the study. Of course the evaluator's constructions must undergo the same scrutiny that all the other stakeholder's constructions are open to. That means that the evaluator's constructions must be public and receive no preferred treatment or influence.

Authenticity Criteria

The third, and final, assurance of the goodness of a study are the authenticity criteria. Guba and Lincoln (1989) explain that the first check of goodness were the parallel criteria to the conventional paradigm's internal validity, external validity, reliability and objectivity. The second check of goodness is the hermeneutic process. These are important checks of the goodness but are not enough to assure goodness. The first check is parallel to the positivist's criteria and is concerned with methodology. Although methodology is the main criteria of goodness for the positivist it is only one among others for the constructivist. The second check is implicit by nature and does not satisfy a need for explicit data. To address these limitations in goodness Lincoln and Guba (1986a) introduced the construct of the authenticity criteria which are developed uniquely from the basic assumptions of constructivism. The authenticity criteria are fairness, ontological authenticity, educative authenticity, catalytic authenticity and tactical authenticity.

Fairness. Fairness is the degree to which all stakeholders' constructions are recorded and presented. Since stakeholder's constructions are value-laden each one must be presented in an open and honest manner. In fact there will be multiple constructions, from multiple stakeholders using different value systems. The role of the evaluator is to solicit all constructions, and their underlying value systems, and identify the ways they are in conflict. The evaluator must also communicate these conflicts to all of the stakeholders as well.

The first step in achieving fairness is part of the audit mentioned earlier. All constructions within stakeholder groups must identify the claims, concerns and issues particularly where there is conflict. These should be recorded as part of the audit. The second step in fairness an open negotiation of recommendations and subsequent actions. All constructions must be honored especially where there is clear conflict. The same information must be available to all stakeholder groups and positions of power need to be equalized. Negotiations should be carried out under the following conditions.

1. They must be open and in full view of all participants.
2. Negotiations should be carried out by equally skilled participants. In the case where on group may not have the necessary skill it can be the role of the evaluators to assist the less skilled in the negotiations. This may be an advocacy role for the evaluator but is allowable under the constructivist agenda by empowering the disenfranchised.
3. All stakeholders must be allowed equivalent positions of power.
4. All stakeholders must have equivalent access to the same information.
5. Negotiations must be around relevant matters.
6. Negotiations must be carried out in accordance with the rules that all the stakeholders conceived and agreed upon.

Ontological authenticity. Ontological authenticity refers to how each stakeholder's construction becomes more informed and therefore more sophisticated. In the reiterative process of fourth generation evaluation information from other stakeholders can enhance an individual stakeholder's constructions. As individual stakeholders become more aware of other's views they may see their own views in different contexts thus enhancing and possibly changing their constructions.

Ontological authenticity can be verified first through statements that stakeholders make. If various stakeholders attest to a broader view or deeper understanding of the issue(s) being studied then there is evidence of ontological authenticity. Second, the audit trail should be able to demonstrate over time whether stakeholders have changed or improved their constructions.

Educative authenticity. Educative authenticity refers to how individual stakeholder's understandings of the constructions of stakeholders outside their own stakeholder group are enhanced. It is important that individual stakeholders have an appreciation of the constructions of stakeholders outside their own group and how these constructions are based in value systems different from their own.

Educative authenticity can be demonstrated by testimonials of individual stakeholders on how well they comprehended and understood the constructions of stakeholders outside their own group. This does not imply that these stakeholders agree with those constructions, only that they are aware of them. And again, the audit should record these variables as they occur.

Catalytic authenticity. Catalytic authenticity is a call to action. As all stakeholders constructions become more informed and sophisticated there is a natural call for some kind of action or decision making. Catalytic authenticity can be verified through 1) testimony of stakeholders on their desire to carry out actions and their willingness to act on it, 2) resolutions from negotiations between stakeholder groups that action is necessary and since this is a negotiation it is more likely to be carried out, and 3) a built in follow up to the evaluation study which can assess what action were carried out.

Tactical authenticity. One of the core premises of fourth generation evaluation is the empowerment of disenfranchised stakeholders. Thus tactical authenticity is the degree to which power has been disseminated among the different stakeholder groups allowing them to act on equal footing, more or less. One important empowerment is the degree to which less powerful stakeholder groups are allowed to have input and shape the evaluation.

Tactical authenticity can be demonstrated by 1) testimony from selected stakeholders as to their empowerment, 2) follow up after the study as to who participated and to what degree, and finally 3) judgment from the participants as to whether the entire process was empowering.

The Hermeneutic Dialectic Process

The primary purpose in using the constructivist approach is to present the agreements and conflicts between the multiple constructions of different stakeholder groups. Although agreements between stakeholder groups may seem like the preferred goal it is actually the conflicts that are more illuminating. The preferred process of collecting, and then analyzing and presenting, the various constructions is the hermeneutic dialectic process. It is hermeneutic because the goal is to interpret and it is dialectic because it establishes a dialog that seeks to contrast divergent views.

In Guba and Lincoln's Fourth Generation Evaluation (1989) the goal is to form a consensus, where possible, between all stakeholders and the evaluator. It is not meant to justify one's own constructions or to criticize other's constructions. When consensus is not possible the goal of the hermeneutic dialectic process exposes the conflicts between stakeholders which hopefully can lead to informed and sophisticated negotiations. It is about connections that allows mutual exploration.

Guba and Lincoln (1989) set out the following conditions for a successful hermeneutic dialectic process:

1. A commitment from all parties to ethics and integrity. There will be no deception, lying, misleading or concealing.
2. All participants must have a minimal competence to communicate. They must be able to offer their own constructions and make meaningful criticisms of other's constructions.
3. There must be a willingness from all participants to share power.
4. All participants must have a willingness to change if there is a pervasive argument. So called "true believers" cannot or will not negotiate and therefore would invalidate this process.
5. All participants must have a willingness to reexamine their own values.
6. Finally there must be a commitment of time and energy.

The first step. The hermeneutic dialectic process is begun by selecting an initial respondent. The reason for selecting this initial respondent can be for any salient rationale. It could be because that person is in a very specialized position or has power or a prominent point of view. This is a type of sampling that Patton (2002) calls purposive. I will discuss sampling in more detail a little later in this chapter. This initial respondent is asked in a very open-ended interview to describe his/her constructions about the issue being evaluated. Of concern are the claims, concerns and issues as the respondent see them. Earlier in the chapter a claim was defined as a favorable assertion about the issue being studied (evaluand), whereas a concern was an unfavorable assertion about the evaluand and an issue was anything that could reasonably be argued about the evaluand. The respondent will also be asked what he/she liked and disliked about the evaluand.

After this discussion reaches fruition the respondent will be asked to nominate a second respondent from the same stakeholder group. The first respondent will be asked to nominate someone with a point of view that differs from his/hers about the evaluand.

The data from the first interview will be analyzed as soon as possible after that interview and before the second interview takes place. The method of analysis, Lincoln and Guba's (1985) constant comparative method, will be discussed later in this chapter. The second respondent will be treated the same as the first however, at the end of the second interview the results of the analysis from the first interview will be introduced. The second respondent will then have an opportunity to reply to the first respondent's constructions. This is the beginning of building the joint construction that will represent this stakeholder group. At the end the second respondent will be asked to nominate a third respondent, again with differing views.

This process is repeated until no new information is gained or it becomes clear that there is a conflict within that stakeholder group. Guba and Lincoln (1989) claim that conflict within a stakeholder group is likely due to differing value systems.

The style of the interview and the questions asked change as the process continues. At first as much information as possible is solicited in order to build an understanding and a joint construction. However, as the more respondents are interviewed and specific themes begin to emerge the choice of succeeding respondents and specific questions change from open-ended to a focus on those emerging themes. At the beginning respondents are chosen for their wide range of knowledge but as the joint construction begins to take shape and important themes begin to emerge respondents are chosen for their specific knowledge about the emerging themes. Likewise, the initial questions are open-ended to solicit the widest range of information possible but as themes begin to emerge questioning becomes more specific to focus on those themes.

When the evaluator decides that enough data has been collected from a particular stakeholder group, representing a hermeneutic circle, a second round of questioning may take place. The intention is to inform the early respondents with information from the later ones and seek potentially new or modified constructions. During the second round of questioning constructions from other stakeholder groups can be introduced. The goal is to produce ever more informed and sophisticated constructions leading to a final joint construction.

As joint constructions begin to emerge other information may be added to the evaluation. Relevant documents and observations can add new insights particularly when observations confirm or deny any previous constructions. Finally the construction of the evaluator is added. To the positivist this may seem like embracing bias however for the constructivist it is just another piece in a puzzle. The evaluator may be the most informed person in the evaluation because he/she has heard all the constructions. The important aspects of including the evaluator's construction is that it receive no special status and that it is critiqued by the other stakeholders.

The resulting collection of interviews, documents, observations and the evaluator's constructions make up a completed hermeneutic circle. This is also the thick description mentioned earlier and it makes u p what is called a case study.

Sample selection. There are four interacting elements that make up the hermeneutic dialectic, the first of which is sample selection. Patton (2002) describes purposive sampling as information-rich. Information-rich cases are those that we can learn a great deal about the issue being studied from specific samples. Quantitative sampling relies on randomness and statistical representation to provide for generalizing conclusions. However, the constructivist view, and this study as well, is that much can be learned from solitary information rich sources. Patton describes 16 types of purposive sampling, all with the objective of obtaining as much information from individual sources as possible. The type of purposive sampling for this study is maximum variation sampling. Maximum variation sampling provides the widest range of information possible. Patton (2002) states the following about maximum variation sampling:

> "The strategy for maximum variation sampling is to capture and describe the central themes that cut across a great deal of variation. For small samples, a great deal of heterogeneity can be a problem because individual cases are so different from each other. The maximum variation sampling strategy turns that apparent weakness into a strength by applying the following logic: Any common patterns that emerge from great variation are of particular interest and value in capturing the core experiences and central, shared dimensions of a setting or phenomenon."

Lincoln and Guba (1985) describe maximum variation sampling as having two important characteristics. The first is that the samples are selected serially. Each subsequent respondent is only selected after the analysis from the previous respondent is completed. This allows for information to be shared which, hopefully, gleans more sophisticated constructions as the process continues. Second, the process is contingent in that subsequent respondents can be chosen to reflect the needs of the evaluation. Early on respondents are chosen for their differences from each other. But as the study continues respondents might be chosen to focus on any particular themes that are emerging.

Patton's (2002) point of view largely agrees with this commenting:

> "Thus, when selecting a small sample with great diversity, the data collection and analysis will yield two kinds of findings: 1) high quality, detailed descriptions of each case, which are useful for documenting uniqueness, and 2) important shared patterns that cut across cases and derive their significance of having emerged out of heterogeneity. In other words, a theme song emerged from al the scattered noise."

The second step is the interaction, already discussed, of respondent, analysis, next respondent, analysis, etc. However, at this point relevant documents, even quantitative data, can enter the circle. At each step new information can be used to enrich the interviewing process. In this way the evaluator is asking, "tell me what I need to know and then answer it."

The third element in the hermeneutic circle is the grounding of the emerging constructions of the respondents. As more respondents are brought into the circle and additional information, such as quantitative data, is included, the analysis continues. The information becomes more informed and sophisticated as each subsequent respondent adds their constructions and reacts to the constructions of respondents before them. A joint construction will begin to emerge or, if there are disagreeing respondents, more than one joint construction emerges. This process is designed to be iterative so that the emerging joint construction(s) is grounded in all the individual constructions that have lead up to this point.

The emerging joint construction must fit; it must be able to account for the data collected thus far. It must also work; it provides a level of knowledge that is acceptable to the respondents. It must have relevance; it affectively deals with the core issues of the study. And it must be modifiable; it is open to change with new information.

The fourth element is the emergent design. As stated above at first the constructivist does not know what they don't know but as the study advances and particular themes begin to emerge the evaluator is able to focus the study in ways that are more directed. The focus is not on a correspondence between the findings of the study and reality (positivism) but on consensus between the multiple constructions of the stakeholders (constructivist). If consensus is possible then a joint construction emerges, if consensus is not possible then the process makes clear what the differences are and sets the stage for further negotiation. This is the most informed and sophisticated understanding of the study.

What finally emerges from the entire process is the joint construction. It is more of a process then a final product. It represents the constructions of all the stakeholders, who have been purposefully chosen, and the inquirer. These constructions have been informed and challenged, subjected to new information and restated. It is the most informed and sophisticated construction(s) possible. It is reported in a case report which represents the "thick" description used earlier and allows the reader to clearly see the context(s) and vicariously experience it.

Operational Guidelines

So far I have outlined the theoretical framework, constructivism, and the model of Fourth Generation Evaluation that I will use in conducting my study. I have also discussed how the quality of a Fourth Generation evaluation is determined. Now I will outline the step-by-step procedure I will follow. First there are a few things to keep in mind that explain why I feel that constructivism, in particular Fourth Generation Evaluation, is the most worthwhile to use in this study.

After understanding and accepting the ontological and epistemological positions of constructivism, i.e., that there is not a single objective reality, that learning happens through experience (constructed realities) and that subjectivity (relative objectivity) is our only experience, the next most important component of constructivism, at least for me, is that it seeks to be fair and to empower the powerless. It is fair in the sense that in soliciting the claims, concerns and issues (CC&I) of all stakeholders it produces, if possible, joint, shared, and collaborative constructions that honor all participating parties. In this way the process empowers the powerless while honoring the power-rich. Not only does this process embrace the reality of what is, it is also democratic in its execution. The following are the twelve steps that Guba and Lincoln (1989) outline in Fourth Generation Evaluation with some modification to suit this particular study.

Initiating a contract. These are the guidelines for setting up a formal, and legal, contract with those who commission the study, often called the client. In this case the client is my dissertation committee. Part of this contract is to identify the entity to be studied (the evaluand), in this case the evaluand is the set of reforms that the College of Science at State University enacted in 2007.

Next, is to define a purpose for the study. Guba and Lincoln (1989) describe four different types of purposes based on a 2x2 matrix of summative, formative, merit, and worth. The present analysis is a summative worth study. A summative worth study is one in which a body of decision makers, charged with enacting the evaluand for actual use in context, assess the value of that evaluand.

Next, is a statement of agreement to follow the "Conditions for a Productive Hermeneutic Dialog." These were discussed earlier and include integrity, a willingness to share power, a willingness to change your position if warranted by new information, and a willingness to reconsider values if appropriate.

A statement of intent must be made and honored. This is a notification from the evaluator that he/she will be seeking out various stakeholders and solicit their CC&I's. As for this study I have identified four primary stakeholder groups; current and former State University administrators, current and former faculty, current and former undergraduate students, and current and former graduate teaching assistants. It is my intent to seek out various members of each of these groups as respondents in their respective hermeneutic circles.

Next, a statement from the evaluator to guarantee confidentiality and anonymity of information sources is made. Anonymity is a difficult choice to make when working with a hermeneutic circle. Hermeneutic circles honor openness and shun any form of covertness. However, it may be necessary at times to grant anonymity if they wish to remain anonymous.

Finally, the method of reporting described. As stated earlier the final product of the hermeneutic process is a case report. Case reports are utilized for their so-called "thick" description. A "thick" description should give the reader the vicarious experience of being in the contextual framework of the study itself at least in a metaphorical sense.

Organizing. Organizing is the logistics of the study. Who will conduct the interviews, especially when a team is used to conduct the study? In this case I will be working by myself however, the point of how will the interviewer(s) be trained is still salient. Guba and Lincoln (1989) suggest there are two primary ways to prepare interviewers. One is to gain direct experience by putting oneself in as many new situations as possible. The other is to purposefully seek out training with a practiced interviewer. I will argue that while I am not an experienced interviewer that I do have broad and varied experiences with human beings. I have over 20 years of experience as a classroom teacher; I have worked in a variety of fields including; construction worker, engineer, scientist, lecturer, grant writer, program director, and university administrator. I have taught mathematics and physics as well as critical thinking, problem solving and mentoring. By my own admission I am a practiced observer and possess very good people skills. I understand my own biases. Most importantly I understand the nature of constructivism, I accept, and embrace it. I believe, with a little direct experience, that I will be an excellent interviewer.

Gaining entry. Gaining entry is concerned with starting the actual interview(s) which often means getting by or appeasing any gatekeepers. This is not necessarily a negative statement about gatekeepers, but it does recognize that they are an opportunity for negotiation. Gaining entry also includes obtaining consent. Constructivist inquiry demands the highest form of ethics and obtaining written consent is an absolute necessity.

The next component of gaining entry is establishing trust. Trust is absolutely necessary in order to gain the type of information that this study needs. Trust is necessary if the respondent is to be forthcoming and honest. Trust does not suddenly appear but it must be developed on a person to person basis. It is also fragile in the sense that trust could be easily lost. The constructivist needs to be diligent in developing and maintaining trust with all of the respondents.

The last issue related to gaining entry is becoming familiar with any cultural idioms that are evident. If the final joint construction is to be as accurate as possible the context must be well defined and described. Contexts always involve cultures of various types. Cultures can include social political forms. In fact cultural norms involving values are as important as any other form of cultural norms. These cultural idioms can be made evident through the "thick" description used to define case studies.

Guba and Lincoln suggest one way to understand these cultural idioms is to do advance ethnography, i.e., actually live in the context you are studying. Another way they suggest is to let an understanding of culture come through the work done in the hermeneutic circles. I plan on utilizing both of these approaches. As a scientist and educator I have actually lived in this context as well as in the State University community. In addition, I plan on approaching culture explicitly in the hermeneutic circles I develop.

Identifying stakeholders. Two of the main operational points of Fourth Generation Evaluation are empowerment, not disempowerment, and educative. Guba and Lincoln (1989) define three types of stakeholders; agents, those who will use, produce or implement the evaluand; beneficiaries, those who profit from the evaluand; and victims, those who might be harmed by the evaluand. Particular stakeholders can, potentially, fall into more than one group. I have identified four stakeholder groups in this study; undergraduate students, graduate science teaching assistants, science faculty and administrators. Further, the undergraduate students can be divided into two subgroups; science majors and former science majors with the caveat that both groups participated in the reformed science curricula.

An additional caveat to Fourth Generation Evaluation is that in the pursuit of information it is possible that a new stakeholder group may emerge. In this case it is imperative that a new hermeneutic circle be invoked to solicit the CC&I of the new group and incorporated into the emerging joint construction.

Developing within stakeholder group joint constructions. This step involves developing the hermeneutic circles. An immediate decision that needs to be made is; who will be the first respondent in this circle. The answer is that it doesn't matter. The objective of the hermeneutic circle is to gather the widest range of constructions as possible. This has to be done on purpose and either representative or typical respondents are not sought out on purpose. As described earlier the first respondent is asked at the end of the interview to nominate someone else from their stakeholder group who has as different views of the evaluand from them as possible. Each respondent's CC&I's are evaluated before interviewing the next respondent. As the particular circle grows represented by numerous constructions the CC&I's of the group hopefully begin to coalesce around a few salient issues. At this point specific respondents can be sought who are able to address these specific issues directly. In this way the circle goes from a wide range of respondents initially to more specific and detailed respondents at the end.

The analysis of the previous respondent's replies to the interview is completed before the next interview and is used in the subsequent interview. In this way the within stakeholder group's joint construction evolves and develops. Those used to a positivist approach may claim that the process of interview-analysis-next interview may add bias. This position is completely rejected in constructivism because the positivist assumes objectivity. But as argued earlier objectivity is not possible leaving only multiple constructions which hopefully lead to a shared joint construction.

When do you stop adding new respondents to a particular circle? Either when no new information is added or consensus is reached or when it is clear that consensus cannot be reached. In the latter case it might be necessary to several differing constructions from within the same stakeholder group. At this point it is important to bring together, in some fashion, all the respondents to perform what was described earlier as a member, or credibility, check. This allows early respondents the ability to check their constructions against later respondent's constructions. In this way everyone has the ability to affirm their own constructions against the emerging joint construction. The end product is a mutually agreed upon joint construction which includes any unresolved CC&I's.

Testing and enlarging joint stakeholder constructions. As the joint constructions begin to emerge through the hermeneutic circles other sources of information can be brought into the process and used to inform respondents. The sources of this information can be from; document and records, observations, professional literature, other stakeholder circles, and the investigator's own constructions. There are always records, data, or artifacts around any potential evaluand. In the case of this study I will want to examine enrollment records in the College of Science before and after the reform effort. Other related records could include GPA's, retention within the College of Science, etc. Other important types of records might include minutes taken from various meetings that preceded the reforms and any quantitative evaluations took place after the reforms. Part of this study will be to discover what documents are available to peruse related to the reform effort.

Observations made by the inquirer during the hermeneutic process can be important sources of additional information. As discussed earlier understanding cultural norms is important for a number of reasons while interviewing respondents. In order to allow respondents to be comfortable and discuss their constructions of the evaluand without ambiguity knowing and understanding the culture can be of immense help. Context is also important for the constructivist inquirer to be aware of. Observing contextual situations can help support, or not, the constructions that emerge from the interviews.

The use of the professional literature to inform a study can be problematic for the constructivist inquirer. In a sense the professional literature forms a generalization of the topic you are studying. One of the unique aspects of Fourth Generation Evaluation is that it does not seek to generalize but rather seeks to form a shared joint construction of the people in that specific context. However, the professional literature can and should be used, but with care. Information from the literature can be introduced into any of the hermeneutic circles by prefacing comments like, "The research literature suggests…" or "It is sometimes claimed that…" In this way a respondent can consider the statement without the onus of it being absolute.

Information from one hermeneutic circle can be very informative when introduced into another hermeneutic circle. The goal within individual circles is to come to a shared joint construction but there might be very different constructions between circles. This can be particularly apparent when comparing the CC&I's of different circles. Ultimately, and ideally, a single shared joint construction between all circles might emerge. More likely is that there will be significant differences in the various CC&I's of the different circles but this is an acceptable end as well. Differing CC&I's can form the basis for further study or negotiation or both.

Finally, the inquirer's own construction of the evaluand is included. The positivist would claim that including the inquirer's construction incorporates bias into the study. However, the constructivist can claim that since there is no objective reality and that all points of view have value that the inquirer's construction has a much value as any other. In fact, the inquirer may be the most informed person of all because he/she has been involved in all the circles and has heard all the viewpoints. The important aspect is that the inquirer's construction not be given more weight than any other construction and that it is open to the same level of critique that all the other constructions have been subjected to.

When all the steps so far elucidated have been completed to the satisfaction of the inquirer the hermeneutic circles are essentially completed.

Sorting out resolved claims, concerns, and issues. This step refers to the process of organizing the resolved CC&I in each stakeholder group. It is also the simplest of all the steps in the Fourth Generation process. It should be expected that most of the CC&I's become resolved during steps 4 and 5 due to information sharing and communication. In these cases it is important to identify the resolved CC&I's and put them aside to be referenced in writing the final case study report.

Prioritizing unresolved issues. If there are no unresolved CC&I's at the end of step 5 then the entire process is complete and the final case study report can be written. However, it is very unlikely that ALL CC&I's will be resolved so that steps must be taken to deal with the unresolved issues. The goal is to order or prioritize the unresolved CC&I's from low to high. This can be achieved by forming another hermeneutic circle using selected stakeholders from all the stakeholder groups. It will be up to this group to prioritize the unresolved CC&I's.

Guba and Lincoln (1989) suggest three groupings of these unresolved CC&I's. First are those unresolved CC&I's that have the potential of being resolved with a little information and work. Second are those unresolved CC&I's that can be compromised on while leaving a satisfactory level of dissatisfaction. Third are those unresolved CC&I's that rest on closely held value positions. These are the most difficult to resolve and may have to be left unresolved as part of the final report.

Collecting information/achieving sophistication. The next three steps in the Fourth Generation process involve resolving the unresolved CC&I's from the previous step. As stated above if these unresolved issues are based on strong value positions some work will be needed to bring some level of resolution. One way to resolve unresolved CC&I's is to bring more information into the circle. The sources of this information have been discussed in previous steps and might include previous studies, professional literature, and available documents and data. What is sought through this process is a reconstruction that "fits" with the new information.

If new information cannot bring resolution then the unresolved CC&I's may be based on intransient value position. This condition relates to what Guba and Lincoln call a greater sophistication of the shared joint construction. At the beginning the hermeneutic process described earlier an agreement was asked for from all participants that they would be open to reconsidering their previous constructions if new persuasive information was obtained. This is included value positions. Value positions may be the most difficult part in the process to affect and in the end Guba and Lincoln suggest that a plea to an American democratic ideal be used. They suggest introducing the idea of value relativism might relax value intransience. If the only alternative to value relativism is value absolutism, which is not held as a cultural value in the American system, then it is possible that those intransient positions might open up. This is the idea behind increasing the sophistication of the shared joint constructions.

Preparing the agenda for negotiation. The next two steps relate the process of resolving unresolved CC&I's between stakeholder groups in an attempt to achieve a shared joint construction of the evaluand between all stakeholder groups. It is most similar to the conventional process of drawing conclusion and making recommendations. In the case of the present study it may not be possible to achieve a shared joint construction between all stakeholder groups. There may be too large of a power differential between the administrator and faculty stakeholders, as two separate groups, and graduate and undergraduate students. What I hope to show at this point is the differing constructions of these groups, not that a shared joint construction between them is possible.

However, for the sake of completeness the steps Guba and Lincoln (1989) suggest for preparing an agenda for negotiation include the following.

1. Define each unresolved CC&I carefully. Then discuss it with enough clarity so that everyone understands it.
2. Clearly elucidate all competing constructions, again making sure everyone is at the same level of understanding.

3. Provide everyone with the same level of information so that all parties are working from the same knowledge base. The goal is engagement not confrontation.
4. If any of the stakeholder groups are less sophisticated than others the evaluator must take a lead role in increasing the level of sophistication of those groups. This could involve role playing, training, simulation, etc. The goal here is to maintain a reasonable balance of power between groups.
5. Test the negotiation agenda with members of all the stakeholder groups and refine if necessary.

Carrying out the negotiation. This is the actual negotiation step between all the stakeholder groups to try to come to a shared joint construction over the evaluand. The negotiation takes the form of a hermeneutic circle with representatives from each stakeholder group. Each participant must represent all the stakeholders from their individual group. After completing steps 7-9 each prioritized unresolved CC&I should be introduced starting with the highest prioritized item. The negotiation continues, in good faith, until a condition of least constructions is reached. How long should the negotiation continue, how few constructions are enough? Those are decisions left to the evaluator. One important function of the evaluator at this point is to carefully and continuously delineate the differences between competing constructions. Truly unresolvable issues can be included in the final case report as a context for future study.

Reporting. Conventionally, the final report would directly answer the thesis questions posed at the beginning of the study and provide for conclusions and recommendations. However, the constructivist is not as concerned with “facts” as how the individuals framed their experiences. Various terms can be used to describe these experiences; “walking in their shoes” or “vicarious experience” or “living in their skins” are just a few. The final report must demonstrate how the participants make sense of the evaluand and why. The best way to achieve this goal is the case report. I will take up the specifics of what make up a good case report later in this section

Recycling. The final step in Fourth Generation Evaluation is recycling. The point Guba and Lincoln make is that evaluation is never finished. Recycling refers to returning to the study at some future time to assess new information or take up any unresolved CC&I’s. It is an ongoing process.

Processing the Data

As discussed earlier the data analysis will begin immediately after the first interview with the results being used in the next interview. This is called the constant comparison method (Guba and Lincoln, 1981; Glaser and Strauss, 1967). In its original form (Glaser and Strauss, 1967) the constant comparison method was used to derive grounding theory however, for the constructivist developing theory is not a primary concern at this point so this method is used to process data in real time and theory (grounded) will become apparent at or near the end of the study. Guba and Lincoln (1981) describe four steps in using the constant comparison method to process data, as opposed to developing theory.

Comparing categories. The first step is to identify specific categories from incidents from the data that are distinct and concise. This is not an arbitrary or well defined process. They may be names of things, definitive terms or semantic relationships. Guba and Lincoln (1981) suggest at first to use what “feels right” or “looks right.” They also assert that the constructivist should draw on their tacit knowledge in deciding on the initial categories based on incidents. The process is self-correcting in that categories can be divided into multiple categories or can be redefined later as the process develops. At the same time some type of coding system should be devised to keep respondents, categories, locations, etc, clear so that the investigator can keep the data organized. The "first rule" is to then compare incidents from previously collected data with the current incidents and place similar incidents into the same categories.

Whereas there need not be absolute reasons for in assigning specific incidents to specific categories it is important to begin the comparison process immediately. As more incidents are recorded and the breadth and range of categories builds the precise definition of each category will become more apparent. As the categories develop further the theory behind each category should begin to emerge. This is the idea behind the constant comparison method. Glaser and Strauss (1967) claim that as this happens that two types of categories will develop. One type of category will be the constructions of the investigator and the other will be the emerging constructions of the respondents. They also claim that the constructions of the respondents will be descriptive while those of the investigator will be explanatory.

After an initial rush of developing categories the investigator may find him/herself in conflict over precise definitions of categories. It is at this point that the "second rule" of the constant comparison method should be employed. The investigator should take as much time as needed to write down their ideas on the process and initial results thus far. This is meant to be a way to become clear and understand the categories you have so far and to redefine them as needed. This is called knowing the properties of each category which leads to writing the "rules" for each category. Once a rule for a specific category has been established it becomes an easier task to assign subsequent incidents to that category.

Integrating categories. The process of assigning incidents into categories and developing the rules for each category allows the joint constructions to emerge. As data collection and processing continue simultaneously the goal is to make the process more rule oriented. In the beginning categories were developed by a "feels right" or "looks right" methodology using tact knowledge. The process of constant comparison of incidents into categories and writing subsequent rule writing is dynamic. After a while the properties of each rule will become apparent and future categorization becomes rule dominated. Using the properties of the rules categories can be better defined with some categories becoming redefined, divided, integrated or eliminated. As the whole process continues with constant refinement the properties of each rule begin to take on more and more of an explanatory role. Ultimately each rule, along with its explanatory properties, begins to indentify the particular constructions that the investigator seeks.

Delimiting the construction. The process of simply collecting data all at once and then trying to analyze it after collection would be an overwhelming task. But by using the constant comparison method the data can be delimited. As incidents are fit into categories using the properties of each rule additional incidents begin to fill out each category. Occasionally a subcategory may become necessary but as more data is collected fewer changes to the categories will be needed. Thus the process becomes self-limiting and less overwhelming. At this point the categories begin to become saturated and there is no point in adding further data. This is one way of knowing that the process is coming to fruition.

At the end of this process the joint construction(s) sought at the beginning will emerge grounded in the data collected from the respondents.

Unitizing. The concept of "incidents" used above was not well defined. Guba and Lincoln (1981) elaborate a process of "unitizing" the data meant to give more definition to what an incident is. A unit is the smallest piece of data that is used to define a category. Guba and Lincoln (1981) define a unit as follows:

> "First, it should be heuristic, that is, aimed at some understanding or some action that the inquirer need to have or to take. Unless it is heuristic it is useless, however intrinsically interesting. Second, it must be the smallest piece of information about something that can stand by itself, that is, it must be interpretable in the absence of any additional information other than a broad understanding of the context in which the inquiry is carried out. Such a unit may be a simple sentence or as much as a paragraph."

These units can come from observations, interviews, documents, or any other data collected. The newly discovered unit should be written on one side of an index card and coded in some consistent manner on the other side of the card. The process of unitizing and writing index cards should be done carefully which will reduce effort and errors later.

Categorizing. The next step after unitizing, defining what an incident is, is to form categories and define their properties. At the end the set of categories that emerge represent the construction of the data as is at best possible. It is important to remember that the constant comparison method is the paradigm; the following steps represent the process of developing categories.

1. From the stack of cards from the unitizing step select one more or less at random. This is the first card of the first category.
2. Select a second card, if it "looks like" the first card then add it to that pile, if not than start a second category.

3. Continue the process of selecting a card and adding it to a category pile that it "looks like" or start a new category pile. Continue on in this fashion.
4. At a point a selected card may not fit into any of the category piles so far started but it may not seem like a new category either. These cards should start a miscellaneous pile and should not be discarded. After 6-8 cards have accumulated in each category pile the investigator should analyze each pile and start the category property writing task. This will eventually lead to the rule for each category.
5. These provisional rules for each category should be written on another index card and placed on top of the category it represents. Each provisional rule should also be given a title that succinctly defines the category. Then peruse each card within that category to make sure each one "fits" the provisional rule. Some cards may be forced into the miscellaneous pile or the provisional rule may be reviewed and revised. Care should be taken that all the cards meet the provisional rule.
6. The process continues with steps 2-5 but instead of using a "looks like" feeling to include new cards in a category the provisional rule should be used to make these assignments. Again, if there are cards that don't fit the rule they may be put into a miscellaneous pile to be dealt with later or possibly the rule itself needs to be revised.
7. When all the cards have been assigned to categories the miscellaneous pile should be examined. Some of them may "fit" into one of the emerging categories. Others may define a whole new category. Some may be important but don't seem to "fit" into any of the established categories and don't seem to define a new

category. Lastly some may be irrelevant and can be discarded. An excess of 5-7% of cards that don't "fit" or seem irrelevant could indicate a problem with the overall category set.

Next the entire set of categories needs to be checked for consistency and potential overlap. If there are any ambiguous cards they should be examined for a double meaning. It may be necessary to divide such cards and define a new category. The best way to proceed is to make sure that each category is well defined and clear. The card set should be homogeneous internally and heterogeneous externally.

Finally, the entire category set should be examined for relationships between categories. It may be determined that particular categories could be combined and others divided. A few categories may be well defined but incomplete in terms of a critical mass of cards. This could mean that the category is present but not well established enough for inclusion.

8. Categories with incomplete data can be reexamined for additional data. Three methods for reexamination are:

Extension. Known data is used as a starting point or guide for additional questions or by looking for additional information in documents.

Bridging. Some data within an incomplete category may seem disconnected but that is only because the relationships are not well understood. A concerted effort can be made to discover the relationships between the data by further inquiry.

Surfacing. As the process continues the investigator will naturally become more familiar with the evaluand and may be able to identify potentially missing information.

At this point the investigator may be able to seek out the missing information in a fashion similar to hypothesis testing.

9. At some point the investigator will have to decide when to stop the data collection and analysis. This can be decided through predetermined rules that would include; an exhaustion of sources, saturation of categories, emergence of regularities and/or overextension.
10. At the end of the process the emergent constructions should be apparent. Other than a final review of the entire data set and emergent categories a major check of validity should be made. The trustworthiness (discussed earlier in this section) should be verified by performing a member check. The end product is a reconstruction of the original respondent's constructions so a primary method would be to present the reconstruction to the original respondents. If this is done in a careful and precise manner and the respondents react favorably to the reconstructions then you can be satisfied that it was a job well done.

Case Studies

The term case study can refer to either a process of analysis or the product of analysis, or both (Patton, 2002). In the present context case study will refer to a way of presenting the data rather than an analysis of that data. The unit of analysis is individuals which will allow for, ultimately, the analysis of programs or in this instance the evaluand or the reforms within the College of Science at State University. Case study data includes all the information about each case including interviews from the hermeneutic circles, observations, documents and as much contextual information that can be collected. This is the definition of the "thick" description discussed earlier.

The reason a case study is the best choice to report the findings of this study is that it satisfies one of the primary goals of the fourth generation evaluation (Guba and Lincoln, 1981). That is to increase the level of understanding of the reader of the state of the reforms enacted by the College of Science at State University to its undergraduate curriculum. As Guba and Lincoln (1981) point out;

> The case report allows the reader to build on his or her own tacit knowledge in ways that foster empathy and assess intentionality, because they enable the reader to achieve personal understandings in the form of "naturalistic generalizations," and because they enable detailed probing of an instance in question rather than mere surface description of a multitude of cases.

A case study should read like a good descriptive novel, rich with detail and observations that define the "thick description" mentioned earlier (Guba and Lincoln, 1981; Patton 2002). It should give the reader the vicarious feeling of "being there." The following points offer an explanatory justification for the case report.

1. The case study is good at reporting the respondent's reconstructions as opposed to the a priori constructions of a positivist researcher.
2. The case study allows the reader to use their tacit knowledge as they would normally experience the world.
3. The case study allows the reader to observe the interplay between the investigator and respondent. This not only lets the reader see how the story develops but also to judge what bias the investigator introduces.
4. The case study allows a check of internal consistency. As more issues are brought up between the investigator and respondent, more opportunities are provided to check that the internal "facts" are consistent.

5. The case study provides the best opportunity for the “thick” description sought after. This assists in the transferability from one situation to another. As discussed earlier transferability, the constructivist’s generalization, is only useful when both the sending and receiving contexts are well understood.
6. The case study provides the best example for reconstructions which are based in a grounded context.

What is in a Case Study Report?

For inquiry case study reports Guba and Lincoln (1981) suggest writing two separate reports; one for the case study and an addendum detailing the methodology used. The case study itself should contain, at a minimum, five sections reported on over three different time periods. The first item in the case study report is a detailed explanation of the question or purpose of the study. In this case the evaluand is the science curricular reforms enacted by the College of Science at State University.

The second item is a thorough description of the setting and context in which the study took place. This is the first part of the “thick” description. The third item, and second part of the “thick” description, is again a thorough description of all the transactions that occurred in the context described above that were observed during the study.

The fourth item in a case study report is, again, a thorough discussion of all the saliencies, or important elements, relevant to the evaluand that were studies in depth. Last is a discussion of the outcomes or what was learned from the study. It is important to realize that these are not generalizations but rather working hypotheses.

There are three timing phases are periods where the five sections above should be evaluated. In the preplanning phase the expectations and assumptions should be examined during the initial stages of the study. How was the study question formed? What was the anticipated context like? What might be learned? What respondents would be involved? What methods will be used? What might be learned? Many of these questions have already been dealt with in the first three chapters of this dissertation.

Next, when the actual study is about to start the five sections should be assessed again. At this point answers to many of the original questions posed above will most likely have changed. Reexamining these sections will document those changes and better prepare the investigator for the work that is about to begin.

Finally, as part of an ongoing program of trustworthiness the five sections should be periodically reassessed. Potential new problems may crop up and the original question may need to be revised. The investigator will become more sophisticated as the study progresses which will allow the investigator to refine or expand the study. Member checks can be preformed along the way too which helps with the trustworthiness as well.

Factors to be Aware of When Writing a Case Study Report

1. The writing needs to be informal and engaging. It is the job of the writer to portray the constructions of the respondents as accurately as possible. The writing needs to be detailed enough to give the reader the vicarious feeling of "being there."
2. The writer should not be interpretive or evaluative. It is important that the writer portray the constructions of the respondents accurately without portraying his or her own reconstructions.

3. There will likely be a lot of data so at first the investigator should include as much of that data as possible in order to avoid missing something significant, at least in the initial draft. As the writing progresses and the writer becomes more sophisticated in his or her understanding then in subsequent drafts certain data may be deemed irrelevant and can be discarded.
4. Confidentiality must be honored at all times. This can be a difficult task particularly when some respondents are local to the setting that writer is in. Realize that in some cases a determined reader may be able to ascertain identities and/or locations.
5. An audit trail must be carefully maintained. This is a major component of trustworthiness and it should be kept in a fashion that an auditor can easily follow.
6. A firm date should be set at which time no additional data can be added. As member checks occur new data may insist on being added but this could continue indefinitely. The writer must decide ahead of time when to cut off adding new data and not make additional revisions.

Steps in Case Study Report Writing

The first three steps are organizational in nature which will help with the actual writing but also for future reference and auditing tasks as well. The first step is to index all of the data that has been collected. This step most likely was completed in the previous section on analyzing the data. However, at this step indexing the data allows the investigator quick and easy access to the raw data when needed for referencing. And as stated earlier it is important for trustworthiness and potential auditing.

The second step in organizing is to prepare a provisional outline. The outline goes along with indexing the data. It makes sure that all the relevant data gets included in the case study report and helps direct the actual writing. It may become necessary later to rewrite the outline in order to streamline the report but initially it will organize all the data. The third organizational step is to cross reference the indexed data to the provisional outline. This helps connect all the relevant data to the outline and, therefore, to the written report.

Now the actual writing can begin and should follow the provisional outline as closely as possible. The point Guba and Lincoln (1981) emphasize is that the writer should not allow the task of writing to weigh the writer down resulting in mundane or even boring work. They often refer to the work of a novelist telling an exciting story. The writing should paint a story of what it was like to be in the context of the respondents dealing with the issues at hand. The writing should be vibrant and vicarious giving the reader the sense of "being there." The balance is in telling as accurate a story as possible without adding your own interpretation or evaluation. It must be the constructions of the respondents only.

Another task for the writer, mentioned earlier, is to create an audit trail. Every "fact" mentioned must be indexed to the actual data from which it was taken. Guba and Lincoln (1981) suggest that a separate index be maintained that lists each factual data used in the report be linked to the source of that data in a sequential manner. A coding system needs to be developed to make this process manageable.

Another issue that must be dealt with is how to manage the official literature on the topic. On one hand a constructivist study of this type is concerned with allowing the theories and hypotheses to emerge and be grounded in the data. With that in mind introducing salient points from the literature might disrupt any emerging theory. On the other hand information from the literature could have the effect of disconnecting the current study from other similar studies. This could impede the transferability to future situations by not understanding the various contexts. The idea is to have a global understanding of the literature to a point that would assist in knowing what to include or exclude in the current study without overly biasing the current study.

Also mentioned earlier is the issue of confidentiality. The writer is obliged to honor the identity of respondents who requested anonymity. In terms of confidentiality and anonymity there are two audiences, internal and external. The internal audience is local readers of the study who may have familiarity with some of the respondents. Despite every well intended attempt to protect the identity of respondents a well-connected or persistent local reader may be able to identify a respondent. This may be particularly true if local readers are called to be part of a member check. In this case one possible solution is to have those member checkers sign confidentiality forms themselves.

Finishing the Report

After the first draft is completed several important steps need to be addressed before the final version is produced. The draft should be reviewed by those familiar with the study and the following points addressed.

1. Is the draft an accurate representation of the context and respondents who participated in the study?
2. Is the draft factually accurate?
3. Are there any obvious omissions?
4. Has the investigator’s constructions been depicted as the respondent’s constructions?
5. Has confidentiality been protected?

6. Have any potentially provocative issues not directly related to the study been emphasized?

Two additional reviews can be made. One by persons not directly connected to the study but who have expertise in the content of the study. In the case of the present study that could be faculty who have experience with undergraduate science curricula. Another review can be made by experienced persons who would review the study from an organizational point of view. A question they might address is whether a person unfamiliar with the subject of the study but sophisticated in other ways be able to understand the report easily. After all these reviews have been completed the writer can produce the final case study report.

CHAPTER 4 CASE STUDIES AND FINDINGS

The Setting

The setting for this study was a large land-grant research university in the Midwest with an undergraduate student population of approximately 30,000. It will be referred to as State University henceforward. It is incorporated within the city limits of a medium sized city situated across a river next to its sister city (combined population approximately 89,000) set in a rural part of the state. Although agriculture is the primary industry there are a significant number of industrial operations in the area.

On August 15, 2003 the Dean of the College of Science initiated a college wide task force to study the College of Science's core curriculum in the hopes of addressing a number of issues within the College that had been causing stress for the College both within and outside the College. The results of this task force were implemented at the beginning of the Fall, 2007, academic year. This study seeks to determine how, after 11 years, the administrators, faculty, and other concerned stakeholders viewed these efforts.

The University

The University has 11 separate Colleges including: Agriculture, Education, Engineering, Health and Human Sciences, Liberal Arts, Management, Pharmacy, Science, Technology, Veterinary Medicine, and an interdisciplinary Honors College. In addition, there is also a Graduate School.

There are three dates of interest for this study. First, during the Fall of 2003, when the Dean of Science initiated a task force to study the undergraduate science curriculum; second, the Fall of 2007, when the results of that study were implemented, and third, the Fall of 2012, which was the most recent academic year studied. Table 4-1 lists student enrollments at the University for those three dates.

Table 4-1: Comparison of Enrollments in 2003, 2007, 2012 (College of Science, COS)

	Fall 2003		Fall 2007		Fall 2012	
	University	COS	University	COS	University	COS
Undergraduate	29,051	2,804	29,688	2,740	30,147	3,456
Graduate	4,927	982	4,953	1,012	8,163	1,114
Professional	889	NA	908	NA	946	NA
Total	34,867	3,786	35,549	3,752	39,256	4,570

In order to compare the performance of the College of Science to the other Colleges Table 4-2 lists the results of the six-year graduation rates for the 2007 cohort of students who had originally enrolled in the given College (Original College) and those students who transferred into the given College (Transfer) after their freshman year. The Total column is the sum of the Original College and Transfer columns. Table 4-2 is ordered by the Total column, highest to lowest.

Table 4-2: Comparison of Six-Year Graduation Rates of the 2007 Cohort of the Nine Colleges

College	2007 Cohort Six-Year Graduation Rates		
	Original College	Transfer	Total
Health and Human Science	69.4%	9.7%	79.1%
Education	54.4%	20.7%	75.1%
Engineering	56.1%	18.9%	75.0%
Management	53.1%	20.4%	73.5%
Agriculture	57.2%	15.3%	72.5%
Technology	57.1%	15.0%	72.1%
Pharmacy	25.3%	44.9%	70.2%
Liberal Arts	43.9%	20.2%	64.1%
Science	31.4%	30.4%	61.9%

Ad indicated in Table 4-2, the College of Science is in last place in terms of six-year graduation rates for students who started in the College of Science and the total of original college and transfer students. However, considering the six-year graduation rates of those students who originally enrolled in their specific College only, the College of Science is second to last after Pharmacy.

The College of Science

The College of Science has seven departments: biology; chemistry; computer science; earth, atmospheric, and planetary sciences; physics; mathematics; and statistics.

The Dean's August 15, 2003 memo states that the overall retention rate in the College of Science was 30%. Table 4-3 lists retention rates in the College of Science for the three periods under consideration. The values listed for Fall 2012 are for the first year retention of the Fall 2012 freshman class only.

Table 4-3: Comparison of Retention Rates in the College of Science

Retention Rate	Fall 2003	Fall 2007	Fall 2012
Science	30%	31.4%	71.2%*

* First Year Retention Rate

Curricular Review

The Dean of the College of Science in the August 15, 2003 memo to department heads also stated that:

> “The quality of incoming students into Science has increased dramatically over the past ten years, using traditional means of measurement like SAT’s and high school rank. However, the number of students who persist from the freshman year to graduation in Science remains very low. A lot of energy is devoted to new students each year, both in and out of the classroom. New approaches to undergraduate education could allow precious resources to be used more effectively by increasing the number of students who chose to persist to a degree in Science.”

The Dean went further by charging a newly formed task force to address the following four issues:

- “A reassessment of the goals of undergraduate education in the College of Science with a focus on the core elements important for all majors in the College of Science (such as general education and laboratory science). This reassessment must account for the academic and vocational goals of our student body and our partners outside the University.”
- “Explore ways to produce graduates who are technically skilled and broadly educated to meet the needs of tomorrow’s world for scientifically competent leaders.”

- “Explore ways to improve recruitment and retention of qualified undergraduate students in Science, with attention to providing access to a science education for a diverse population.”
- “Development of strategies to address these issues.”

Additionally he noted the following “questions for consideration.”

- “Only 30% of entering freshmen are retained in the College of Science. How do we increase the retention of students?”
- “How do we attract high caliber students to attend the College of Science?”
- “How can we account for the differences in how students learn based on ethnicity and gender?”
- “How can the curriculum be modified to better position students for entry into emerging fields?”
- “We need to address the causes of high D/F/W grades in specific courses.”
- “Are the orientation courses doing what we think they should be doing?”
- “What is the role of academic advising in science?”
- “How can we create more research opportunities for undergraduate students?”
- “Should co-curricular experiences be developed?”
- “How can study abroad be integrated into the curriculum without causing a delay in graduation?”

The Dean’s Retreat

The initial reaction to the August 15, 2003 memo was tepid. After the original memo went out and the initial UTF was formed comprising members of the Dean’s staff and representatives of the departments it lagged for a little over a year due to a sort of inertia that blocked their progress. Ralph explains why:

> "Well we, I mean we actually I would say had a miss that first year. We spent one year with the task force and then we had to restart basically after that year. Um, the reason is because I realized that a task force was really just a set of individuals and they weren't tasked as they, perhaps to the extent they should have been that they would represent departments. They were a set of individuals primarily. And you can't get the entire sense of the school at the time, now a college, from just that set of individuals. And so as much as they did interesting work, they came up with interesting ideas after a year, it became clear that if we were going to do something as major as changing the curriculum when changing the name of a course could be a life or death decision, there was just no way that was going to work. So we restarted and instead actually got every single faculty member involved."

The Dean then scheduled a retreat a year later on September 2, 2004 to reboot the review of the curriculum. From the minutes of the retreat the Dean opened with a review by saying:

> "We need to figure out the best education for our students. Students are not going into traditional fields based on our curriculum. We need to base our curriculum on what the demands of the students are for the jobs available."

Drawing from the minutes of this retreat the Dean opened with a few cursory comments and then went into a short Powerpoint slide show. The Dean's presentation primarily discussed the economics and employment outlook for people with science degrees. Although the details of this information might be interesting he did not address the attrition issue in science either nationally or at State University. Primarily his presentation was concerned about the state of the economy for science graduates and how State University could better prepare its students for such an economy.

As the conversation continued a key talking point was what should the expected outcomes of a science degree at State University be? The conversation then centered mostly on; logistics, what should the outcomes be, how to achieve them, and institutional data. About half way through the discussion one participant asked if the focus was on retention or the curriculum. The answer was both but that the curriculum was more important. The respondent went on to say that retention was a byproduct of the curriculum. However, later in the meeting concerns were raised about how changing the curriculum may not affect retention.

It is difficult to prioritize the Dean's concerns based on his memos. Retention was mentioned several times but he also noted how the quality of the incoming freshmen had significantly increased based upon high school GPA's, SAT scores, and high school rank. He suggested that new approaches to education might be used to increase retention.

Besides exploring new ways to teach the Dean included in his student centered agenda: attracting high caliber students, the learning differences of ethnicities and genders, preparing students better for new fields, addressing high D/F/W grades in certain science courses, orientation courses, research opportunities, co-curricular experiences, and study abroad programs.

A primary question asked at this retreat was what are the expected outcomes of an undergraduate science education? A significant amount of time and effort went into answering this question. During the course of the retreat the participants selected the following as expected outcomes of an undergraduate science education:

- Demonstrated logical thinking; able to analyze information based on data and solve problems.
- Understand the value of lifelong learning, especially in technology.
- Demonstrated ability to work both as an individual and as part of a team.
- Demonstrated flexibility and creativity.

- Participated in a research experience.
- Demonstrated good oral and written communication; ability to make a 15-30 minute presentation.
- Understands and appreciates science in a world environment.
- Demonstrated fluency in information technology.
- Competitive for direct employment.
- Technically prepared for graduate school in the sciences.
- Demonstrated appreciation for other disciplines and is a multidisciplinary thinker.
- Demonstrated ability to apply knowledge to practical situations.
- Received a broad general education, integrated with the science curriculum.
- Demonstrated leadership.
- Had a capstone experience.
- Demonstrated an appreciation for diverse experiences, thoughts, and backgrounds.
- Demonstrated an understanding of a foreign language and multicultural experiences; participate in a study abroad program.
- Participated in a service learning project.
- Demonstrated ability to teach others.
- Demonstrated understanding of the ethical issues related to science.
- Demonstrated depth in major curriculum
- Exposure to the economic value of a science education.

The results of the curricular review were piloted in the Fall of 2006 and implemented College wide in the Fall of 2007. The review of the curriculum resulted in the identification of six desired outcomes and the curricular changes needed to meet those outcomes. The identified outcomes were:

1. Demonstrated depth in major
2. Ability to think and function as a scientist
3. Ability to communicate well, both orally and in writing
4. Ability to collaborate as part of a team
5. Ability to function in a multidisciplinary setting
6. Demonstrated breadth of knowledge and cultural appreciation

Along with these desired outcomes was a new set of core requirements designed to meet those outcomes. These new core requirements included:

- Composition and presentation: 5-10 semester hour credits
- Teambuilding and collaboration: 1-3 semester hour credits
- Language and culture: 9-12 semester hour credits
- General education: 9 semester hour credits
- Great issues: 2-3 semester hour credits
- Multidisciplinary experience: 3-9 semester hour credits
- Laboratory science: 6-10 semester hour credits
- Mathematics: 6-10 semester hour credits
- Statistics: 3 semester hour credits
- Computing: 3-4 semester hour credits

A list of approved courses was included under each core requirement. And a number of new courses were introduced to meet the new core requirements. Specific changes that took place included;

- The Teambuilding area requirement was split into a developmental component and an experiential component.
- Language and culture allowed for a substitution of a cultural experience for language competency.
- Science departments were allowed to develop their own great issues courses.
- Students could participate in a pre-approved research project, internship, or entrepreneurship program that used multidisciplinary teams. Or, the student could complete an additional major or minor in a different discipline.
- Statistics was required in the core for the first time.

Data Collection

In order to answer the thesis questions of what were the perceptions of administrators and faculty about the processes and outcomes of the review of the College of Science core curriculum, a set of open ended questions was reviewed and approved by the University Institutional Review Board (IRB). The responses to these questions are the primary data that came from structured but informal and open-ended interviews with nine participants who had specific knowledge of the review of the College of Science's core curriculum. The interviews were guided by 13 questions approved by the IRB which were:

1. What national trends in undergraduate science education were considered in developing the undergraduate College of Science core?

2. What problems in undergraduate science courses did you observe that caused you to consider making changes in the College of Science core curriculum?
3. What elements were considered in setting up the task force?
4. How was the College of Science task force formed?
5. What changes did you want to make before the task force was formed?
6. What changes did the College of Science make in the undergraduate core?
7. What do you consider to be successful attributes of these changes?
8. What do you consider to be unsuccessful attributes of these changes?
9. Are there any changes that you wanted, but did not get accepted?
10. On a scale of 1-5, how would you rate the success of the College of Science core prior to 2007, with 1 being completely unsuccessful and 5 exceeding your expectations?
11. On a scale of 1-5, how would you rate the success of the College of Science changes to the undergraduate core after 2007, with 1 being completely unsuccessful and 5 exceeding your expectations?
12. How do you define reform in light of the College of Science undergraduate core curriculum?
13. Do you consider the changes made to the College of Science undergraduate core curriculum to be reform? Justify your answer. If your answer is no, what changes need to be made in the College of Science undergraduate core curriculum for you to consider it to be a reformed core curriculum?

The Participants

The participants for this case study were purposefully selected (Patton, 2002). Purposeful selection offers the greatest opportunity to learn specific information from those who might know it best (Stake, 1994). All of the interviews took place on campus with the exception of one which was conducted at the new location of one of the respondents at another large research university in the Midwest. All names used are pseudonyms.

Mary is a faculty member in the biology department and was very involved in the reform effort from the beginning. Although she is tenured faculty in the College of Science she had been working in the administration of the College of Science at the time of the curricular review. She was responsible for promoting and organizing the review and was involved from the very beginning.

William is also a tenured faculty member in the College of Science, but he was not a member of the College of Science administration. Although he was not part of the initial push of the review, he was involved early on and was responsible for involving his department in pilot testing the new curriculum.

Josh is also a tenured faculty member in the College of Science but was not a member of the College of Science administration. Josh was involved from an early part of the review and like William was responsible for involving his department in pilot testing the new curriculum.

Tom was in the administration of the College of Science and was responsible for organizing the review along with Mary. He was not a tenured faculty member.

Ralph was the Dean of Science at the time of the review and was responsible for initiating all of the changes along with appointing Mary and Tom to organize the faculty to get their input and help. Since the implementation of the new curriculum, Ralph has relocated to another university.

Dan is tenured faculty with a dual appointment between the College of Science and the College of Education. He came into the process late and left for another position before the new curriculum was implemented.

Joan is an academic advisor in the same department as Josh. She was very familiar with the old curriculum and therefore knew many of its strengths and weaknesses, at least from the student's point of view. As an academic advisor she would be responsible for implementing the new curriculum with the students.

Betsy was also an academic advisor in a different department from Joan. Like Joan she knew the strengths and weaknesses of the old curriculum and would be responsible for implementing the new curriculum. She was also in the department that offered the greatest resistance to changing the curriculum.

Sam was tenured faculty in the College of Science and was involved with the review process from the beginning. He had held a number of positions in his department and was very familiar with the old curriculum and had been an advocate for change for many years.

Organizing the Data

As described in the Methodology chapter, the constant comparison method (Guba and Lincoln, 1981; Glaser and Strauss, 1967) was utilized to organize and analyze the data. After each interview was completed it was transcribed and categories were developed. A category is any small piece of information, called an incident, that is distinct and concise. Guba and Lincoln (1981) suggest using anything that “feels right” or “looks right.” Incidents developed from the first interview were selected into categories and incidents from subsequent interviews were added to these categories and new categories were developed as needed when novel incidents were identified. This is a self-correcting process. At the end similar categories may be combined and others eliminated as needed. At this point a consensus should emerge that represents the beliefs of the participants.

Categories. From the initial selection of incidences 44 relevant categories developed and coded. Table 4-4 is the initial list of categories and their coding’s.

Table 4-4: Initial list of categories and coding from the analysis of interviews

Attrition (A)	Outcomes (O)
Careers (CR)	Presenting (P)
Changes Made (CM)	Ratings Post (RP)
Changes Not Accepted (CAN)	Ratings Prior (RP)
Changes Wanted/Needed (CN)	Reasons For Reform (RFR)
Communication (C)	Reform (RM)
Computer Science (CS)	Resistance (R)
Core Curriculum (CC)	Retention (RT)
Critical Thinking (CT)	Students (S)
Curriculum (CR)	Study Abroad (SA)
Faculty (F)	Successes (SS)
Faculty Arguments for Reform (FAR)	Successful Attributes (SA)
Faculty as Teachers (FAT)	Task Force (TF)
Global/International (GI)	Task Force Members (TFM)
Great Issues (GIS)	Teamwork (TW)
Groups (G)	Undergraduate Science Core (USC)
Language Requirement (LR)	Undergraduate Science Courses (UGS)
Large Lecture Classes (LLC)	Undergraduate Science Education (USE)
Miscellaneous (M)	Unknown Successes (US)
Multicultural (MC)	Unsuccessful Changes (UC)
Multidisciplinary (MD)	Women in Science (WS)
National Trends (NT)	Writing Skills (WS)

After a process of reviewing the categories and comparing the incidents within each category a number of categories were combined and others eliminated due to a lack of relevance. Table 4-5 lists the remaining categories from which the case studies report were developed.

Table 4-5: Final list of categories and codling's used to develop the case studies report

Changes to the Core (Cc)	Multidisciplinary (M)
Communication and Presenting (CP)	Ranking (R)
Critical Thinking (CT)	Reform (Rm)
Curriculum (C)	Resistance (Rs)
Faculty (F)	Science Education Trends (ST)
Great Issues (GI)	Task Force (TF)
Language and Culture (LC)	Teamwork (TW)

Case Studies Report

In his initial statement to the College of Science Department Heads (Memo, August 15, 2003) the Dean of the College of Science noted:

> "That the world of science had changed much in the forty years since the College of Science was formed as a separate unit."

> His primary concern was that:

> "Our mission for undergraduate education remains to provide core competencies in the sciences. However, it is important to provide an education that prepares students for their future as scientists, educators, industrialists, entrepreneurs, government leaders, and informed citizens."

Undergraduate task force. As mentioned earlier the Dean of the College of Science at State University presented his vision of the review of the College of Science's core curriculum in his August 13, 2003 memo to the faculty. In that memo he also stated that he was forming a task force to study and make recommendations as follows:

- A reassessment of the goals of undergraduate education in the College of Science with a focus on the core elements important for all majors in the College of Science (such as general education and laboratory science). This reassessment must account for the academic and vocational goals of our student body and our partners outside the University.
- Explore ways to produce graduates who are technically skilled and broadly educated to meet the needs of tomorrow's world for scientifically competent leaders.
- Explore ways to improve recruitment and retention of qualified undergraduate students in science, with attention to providing access to a science education for a diverse population.
- Development of strategies to meet these issues.

How was the Undergraduate Task Force (UTF) formed, who was involved, and how were decisions made? Mary states that the review was a Dean's directive:

> "Yes, it was a Dean directive. But he knew many of us were interested in moving in that direction, but it was his directive. But he was the one who said this was going to happen. He convened the department heads and said this was going to happen."

Josh had the same impression as Mary:

> "The Dean was in discussion with obviously the Associate Deans. He was largely driving this sort of the vision for how the process would work. Um, he had a style for doing things that was one very much of driving things, but driving a process rather than saying you had to have this outcome. But his decisions about the process sort of encouraged certain things to happen."

Although it was the Dean's decision to initiate the process and form the Undergraduate Task Force (UTF) the Dean quickly gave the organization and the selling of the review of the curriculum to the Associate Dean for Education. Ralph explains:

> "Yeah. The Associate Dean for Education led the efforts. She oversaw the, um, task force and then there, uh, the new task force that resulted from that that kind of worked with the departments to get a hold of their input. Ah, she did a great job."

From this point the Dean, in his regular meetings with department heads, gave them a directive to appoint a faculty member, preferably the undergraduate committee chair in each department, to the UTF. In addition to this person the evolving UTF also asked each department head to appoint up to three tenured faculty members who were favorable to education to the UTF. Tom supports this point of view:

> "We, we wanted, we wanted as broad a representation from the faculty as we could get. We asked the departments heads to select, we wanted the undergraduate committee chairs from each department on the committee. And then we asked that the other faculty members, and I don't remember, even now I think it's like three from each department, if I remember right. We wanted, um, we wanted faculty members that would be open to undergraduate education ideas. Whether they had much practice in that themselves or not didn't seem to be as important. And we were looking for, I'm trying to remember, we had a few assistant professors but we wanted tenured professors as much as we could get it because we knew they weren't going to be rewarded for this work."

Joan remembers that the appeal to be on the UTF was even broader than just faculty:

> "Yes, they wanted all the departments represented, they wanted faculty, they wanted academic advisors, um, they wanted, um a good representation of people who were working with undergraduates, things like that."

After the original August 15, 2003 memo went out and the initial UTF was formed comprising members of the Dean's staff and representatives of the departments it lagged for a little over a year due to a sort of inertia that blocked their progress. Ralph explains why:

> "Well we, I mean we actually I would say had a miss that first year. We spent one year with the task force and then we had to restart basically after that year. Um, the reason is because I realized that a task force was really just a set of individuals and they weren't tasked as they, perhaps to the extent they should have been that they would represent departments. They were a set of individuals primarily. And you can't get the entire sense of the school at the time, now a college, from just that set of individuals. And so as much as they did interesting work, they came up with interesting ideas after a year, it became clear that if we were going to do something as major as changing the curriculum when changing the name of a course could be a life or death decision, there was just no way that was going to work. So we restarted and instead actually got every single faculty member involved."

The Dean felt that without the entire College faculty participating that the process was stalled, so he reconvened the UTF for the entire College on September 2, 2004 at a College wide retreat. The Dean felt that this effort produced better results based on a College vote. Ralph emphasizes this point:

> "We asked every department to convene multiple faculty meetings and just discuss what are the key outcomes or goals that our curriculum should achieve? And if we hadn't done that I think what would happen is that every faculty member would be skeptical, skeptical that oh you know I don't really agree with this or that. The fact that they came out of the units themselves gave a lot of credibility to the whole effort and allowed it to go forward. People understood that we really sought their input and if they disagreed with one of the outcomes it was because the reason we went forward with what we did was because we had this overwhelming majority saying these are the important things. And it was approved something like 58% to, um, 42, or 60-40, something like that. So pretty good record."

Although Tom stated that the UTF wanted a broad representation on the task force there was a problem in achieving that goal. Josh explains:

> "Because what tends to happen in, in some of our departments because of the fact that the departments, not all of them, many of them are overrepresented in males, especially at the more senior levels who tend not to choose struggling assistant professors to stick in. So even though we've been hiring in a more diverse way if you look at the mid and later career people, especially at that stage, um, many of them were more traditional, have more traditional views. So those opinions tended to be overrepresented on the task force."

So the UTF was predominately made of senior male faculty that held more traditional views. In addition to being male dominated there were other problems in forming the

UTF. There was significant resistance to being involved in the process to any degree by a couple of the departments. Mary explained that a couple of departments preferred to make their own decisions.

> "Math didn't buy-in. Um, CS was on the fence, I'm never sure that they bought-in. They were interested, but and this is a difficult, this is one of the difficulties, is they kept defining everything in terms of CS and CS students."

And:

> "And there were several departments that weren't going to go there. They were trying to take things they already had in place and, and, really sort of push and shove them into meeting a requirement."

Mary also felt that a number of individual faculty were highly resistant because they felt matters of education were outside their areas of interest:

> "It was very difficult to get several of the faculty to move out of their discipline."

Or was not relevant to their academic area:

> "There were also fights, and we do these town halls. We make sure we wouldn't debate people, we just write what they had to say. Because, and they get up and talk about all this fluff we were adding. I mean it was just rough."

Although the mathematics and computer science departments were resistant to efforts to reform the science core curriculum they did voice reasons why. In particular the mathematics department view was that mathematicians did not typically work in teams or across disciplines, two of the eventual core revisions. Josh encapsulates their views:

> "So the vision of a mathematics researcher that we all sort of vaguely, the misconception we have in our minds but probably not too far, is the individual sitting in a room with a pencil, you know, doing proofs. And that's not how math is done. That encapsulates the push that came from that department, say what's this teamwork thing, we don't need teamwork, this multidisciplinary won't produce the best mathematician, we don't want to, they don't need to spend their time learning how to do stuff with other people."

Sam was more succinct in his assessment of how the Mathematics Department was different from the rest of the College of Science:

> "The problem is math, computer science out of which, which grew out of math historically and when my kids call sadistics. The basic ground rules of what they want for their students is fundamentally different from what physics, chemistry, the biological sciences and earth atmospheric and planetary sciences believe."

Betsy also viewed the mathematics department as an obstacle to the curriculum review but explained it as the nature of practicing mathematics:

> "Yeah, it's the personalities of the people who major in math. Um, and to some extent probably that is a discipline that is more solo, you know, than anything and so it's not like a regular lab science where you're definitely, you're working in the lab and you've got people around you that you're working with."

However, at least one participant thought the mathematics department got an unfair reputation. Tom, who had been a mathematics major, reasoned that the mathematics department had a lot of math education students but no math education faculty, said:

> "And I probably thought they were less a problem than others thought. The biggest problem with math was they had half or more of the science education students in science and they had no education faculty. So, uh, that was one of the reasons they were I think perceived as being more difficult to work with. Because they didn't understand, they didn't have somebody to go back to in their department that would advocate the education speak."

Josh reiterated this point of the mathematics department and why the department made the decisions it did:

> "My personal opinion is that the math faculty weren't thinking about what all of their students need to do, they were thinking about the subset who were going to become graduate students like them."

But those who wanted change prevailed, Mary stated:

> "The other thing, then in retrospect I learned, right after we did that and got that, I learned a lot about politics and I learned a lot about strategies. And it was, it was a faculty vote, one faculty, one vote. The entire faculty not just the task force. The task force had votes in between to see how we're going to put it all together and whether it all had to stand together or how we were going to have the whole college

> vote. We were going to have the vote on single things or all together. Those of us who wanted it all together prevailed."

And Josh reiterated that view that in the all College vote that the dissenters did not have enough votes to sway the end result:

> "They lost (laughs). Again, this was something that it came down to a large open meeting and voting about these things so they were, the dominant feeling from the faculty who bothered to turn up and express opinions about these things was in fact it was important to have multidisciplinary experiences and to do teamwork. So there were minority opinions voiced very strongly because this is a college requirement if you were just one subunit of a department you're not going to win that."

The consensus among the participants in this study agreed on how the curricular review started and proceeded. The Dean of the College of Science initiated the curriculum review process but according to Mary, and others in the College, there had been talk already of starting just such a process. The primary reason given at the beginning was the age of the current curriculum of over 40 years old.

The Dean gave the organization of the review to the Associate Dean for Education. The first UTF was made up of members of the Dean's staff and at least one tenured faculty member chosen by each department head. The initial UTF spent a little over a year studying the issue, collecting data, reviewing literature, collecting comments from alumni and industry leaders, and planning. However, by the end of that first year the Dean felt there was not enough broad support within the College for the revision of the curriculum to be successful. He then reconvened the UTF in September of 2004.

There was debate over the purpose of the review with most objections coming from the mathematics and computer science departments. The primary objection coming from the mathematics department was that they felt several of the emerging goals were not compatible with the profession of mathematics. They felt that teamwork and multidisciplinary work were not traits that a mathematician needed and would waste time in the curriculum. However, it was pointed out that many mathematics students do not go on to be professional mathematicians, over half the undergraduate student body was in mathematics education for example. In the end over half the participants in the College of Science voted to proceed with the curricular review.

Student Focus. Since attrition seemed to be at or near the top of the Dean's concerns it is prudent to look at attrition and at the national trends concerning attrition in science and science education. Were national trends considered important by the participants in this study? Did they have a bearing on the review process? At least one participant did not think so, William stated:

> "What national trends were considered? I don't think I can answer that question. I think I'm much more in tune with the national trends today. I don't recall what the trends were then. I think there was a, the entire motivation, from my perspective, to revise the core that it had been stagnant for forty or fifty years. I don't know we were necessarily led by trends and other programs. I'm sure were but I can't pinpoint what those trends were."

Sam was more blunt in his assertion about reviewing national trends:

> "Nothing, complete and utter absence of consideration."

However, a number of other participants remember the issue of national trends differently. For instance, comments about what industry and alumni were telling the committee what they saw as weaknesses in science graduates. Chief among those were teamwork, communication skills, multidisciplinary experiences, global experiences, and critical thinking skills. Dan summed it up this way:

> "Uh, I'm not sure about national trends as far as other universities were concerned but, um, I do know that one of the driving forces that I kept hearing over and over again was employers were saying, those who employed College of Science graduates were saying that those graduates were coming out inadequately prepared in things

> like teamwork, inadequately prepared in critical thinking, inadequately prepared in a variety of different areas. Um, and so I think that in large part that's what motivated the committee to start looking at things like the composition, the communication types of skills that were there, teambuilding, um, the multidisciplinary experience and so on."

And Josh supported this view:

> "It's been a while but things that I was particularly involved in and interested in were teamwork, um, the rise in importance in interdisciplinary work, um, variously described, um, communications, so the ability of students to not just write, writing is important, but also the ability to give presentations. So all communication. And then, you know, there was a lot of debate going on, as there is still today, about, um, the issue of a foreign language versus generally more global competency issues. So those are the ones that come to mind."

Furthermore Tom sums it up:

> "Um, well there were a couple of things as I recall. Uh, one was, what was, the feedback we were getting from alumni about our graduates, so it wasn't so much, it was education but it was sort of the applied education. What were they able to do and what weren't they able to do. And, um, was there something we could do about it."

The need to improve the basic skills of science graduates was the most common response when participants were asked about trends. More fundamentally those basic skills included communication, verbal and written, how to work in a team environment, critical thinking, and the ability to work with someone outside your discipline.

However, another weakness that was identified was the age of the curriculum. As the Dean stated in his August 15, 2003 memo, the current curriculum was over 40 years old. As William stated previously, the core curriculum had been stagnant for 40 or 50 years.

Tom explains:

> "they hadn't looked at undergraduate education in over 40 years. In 40 years you probably should look at undergraduate education."

William also thought that the point of the revision was to address an old curriculum:

> "I think there was a, the entire motivation, from my perspective, to revise the core that it had been stagnant for forty or fifty years. I don't know we were necessarily led by trends and other programs."

However, on the issue of national trends, especially those cited in the literature, none of the participants mentioned any specific study. Instead many participants did state that they had heard from alumni and industry groups of what the weaknesses in the old curriculum were. Tom summarizes this point of view:

> "Well there were a couple of things as I recall. Uh, one was, what was, the feedback we were getting from alumni about our graduates, so it wasn't so much, it was education but it was sort of the applied education. What were they able to do and what weren't they able to do. And, um, was there something we could do about it."

Dan also supports that point of view:

> "Uh, I'm not sure about national trends as far as other universities were concerned but, um, I do know that one of the driving forces that I kept hearing over and over again was employers were saying, those who employed College of Science graduates were saying State University's graduates were coming out inadequately prepared in things like teamwork, inadequately prepared in critical thinking, inadequately prepared in a variety of different areas."

And Joan adds:

> "The administrators, Deans, and some of the faculty had been getting input from employers that said we want students that can work I teams, will understand the importance of group work. The employers again were telling the University that they need students who could communicate scientific information to various groups. They needed people who had knowledge of other cultures and were aware that we were a global economy, a global world, and not just Midwest or east coast or whatever that happens to be."

The bias of the investigator going into this study was that attrition from science programs nationally had reached significant proportions and that that would be the driving issue behind the revision of the science curricula at State University. Although attrition (or retention) was mentioned by several participants it was usually near the end of their comments and as more of an addendum. Dan was one of the participants that mentioned attrition as an issue but only after being prompted, he stated:

> "Yes, um, I knew for a long time and I think the biology department, although they didn't trumpet this, they acknowledged that they were having problems with, um, attrition for the biology majors. Um, and I know the College of Science as a whole was working on that too. So, yeah, that's a good point. I think that was another driving factor."

Mary admitted that attrition was an issue but that it was difficult to get the administration to recognize it:

> "Yeah, that was part of the problem (attrition). And this is always difficult to get the administration to really understand that at the time, and I don't know how this has changed, at the time we were, um, a feeder school."

Tom gave a more expansive view of attrition by noting the type of students the College of Science was losing:

> "And we were still losing a significant percentage of those students, we were losing a larger percentage of those below the top half. I mean not top half 50 percentile of their high school graduating class, but top half of our class. Um, so we were still losing a significant number of those students, uh, we were losing more students in the low, lower section, but we were still losing a lot in the upper section."

By noting that the loss of students from the College of Science was not limited to what Tom called the "lower half" belies the common belief that the loss of students was a natural process of attrition due to a lack of ability. This point of view was amply investigated in Seymour and Hewitt's book Talking About Leaving.

An additional issue at State University was the admittance process. At the time of this study at State University a student could apply to the College of Science as a vehicle to be admitted into the College of Engineering. After spending a year or two in the College of Science a student could attempt to transfer into the College of Engineering.

This could make it appear that that student had dropped out when in fact he/she had transferred into the College of Engineering. Betsy alludes to this by noting:

> "They figure out where they're going to go so, you've got this, you know, pressure on science to keep their students but yet students aren't picking it necessarily because they want science."

Betsy added to this point of view more succinctly:

> "Yeah, that was part of the problem (attrition). And this is always difficult to get the administration to really understand that at the time, and I don't know how this has changed, at the time we were, um, a feeder school."

However, the University administration has since made it much more difficult for students to be admitted into one college while actually wanting a different one. A number of the participants felt that a more relevant problem was that students were choosing science because of a fundamental misunderstanding, and a lack of experience, of what science is. Tom really understood this issue:

> "And, again, I was fully ready to accept that we should be losing some of them. They didn't really understand from their high school science experience what being a scientist really meant. And we had some work to do to help them understand that. But we were losing too many in that category from my standpoint."

And Betsy amplifies this point:

> "Yeah, I, you know I think it's not necessarily a misconception but it's just not understanding the full scope of what science is. Of what, really get in to upper levels. This stuff they've taken in high schools that's covered in the first semester of chemistry or biology or whatever. And then they're beyond and it gets, and it's really you know it's a whole new ballgame and they're not, I mean. You talk to the biology advisors because that's where we have so much, there's a ton of attrition from the students that start from biology. Because they all think they're going to be premeds, they all think they're going to med school and then they realize how hard it is and shift."

Sam had an additional issue to add to the discussion of attrition versus the general education of undergraduate science students and the age of the curriculum. In his view besides a total lack of consideration of national attrition trends Sam felt that no goals were established, he said:

> "So there was no discussion at the college level of any goals that we had of how this fit into any trends. Of how this fixed any problems other than the perception that we hadn't really looked at our curriculum."

From Sam's view there was not recognition of any actual problems other then the age of the curriculum. And since national trends were not considered there was not an awareness of how to fit goals to trends.

Based on the forgoing discussions the decision to revise the College of Science core curricula started from input from alumni and industry concerning the type and level of skills that graduating students displayed. Secondarily, the age of the curricula also had a significant impact. However, it seems from the discussions of the participants that attrition, whatever the causes, was a tertiary concern. This was a surprise to this investigator who was very familiar with national and local data concerning attrition from science programs.

When attrition was discussed it was often late in the interview and sometimes at the prompting of the investigator. And according to Sam national trends, and therefore attrition, were not considered. The primary point made about attrition at this time was that students did not understand what science was or were improperly placed in the College of Science due to a unique admittance procedure that allowed students to be admitted into one college when they actually wanted another.

Expected outcomes. The UTF broke into six subgroups, each focusing on a ways to achieve each outcome. The subgroups were:

- Demonstrated logical thinking; ability to analyze information based upon data, solve problems, and apply knowledge to practical situations.
- Good written and oral communication skills; ability to make a 15-30 minute presentation and to teach others.
- Demonstrated ability to work as part of a team and provide leadership, including an understanding of the ethical issues related to Science; possible expressions include research experience, a capstone experience, or participation in a service learning experience.
- Multidisciplinary perspective, ability to appreciate more than one discipline or perspective and to bring diverse skills to bear on problems.
- Demonstrated flexibility and creativity.
- A broad general education, integrated within the Science curriculum.

Later another expected outcome was added that became a bit divisive among College of Science faculty:

- Demonstrated appreciation for diverse experience, thoughts, and backgrounds; understanding of foreign language or multicultural experiences, or participation in a study abroad experience, understanding and appreciation of Science in a world environment.

There were six committee members in each subcategory. Each subcategory then divided into two more pieces with each studying a different aspect related to their subcategory. The end result of these committees work became the expected outcomes of an undergraduate education in Science at State University stated earlier. They are:

1. Demonstrated depth in the major

2. Ability to think and function as a scientist
3. Ability to communicate well, both orally and in writing
4. Ability to collaborate as part of a team
5. Ability to function in a multidisciplinary setting
6. Demonstrated breadth of knowledge and cultural appreciation

Each one of these outcomes was to be achieved through either courses already in place or by developing new courses and/or experiences such as study abroad opportunities. Study participants were asked to reflect on what changes were made to the undergraduate science core and how successful or unsuccessful they thought the changes were.

However, many faculty were resistant to changing or even establishing expected outcomes. Mary explained that one way she was able to convince resistant faculty was to connect accreditation with establishing learning outcomes which needed to include ideas such as teambuilding and critical thinking:

> "So to get faculty to think about outcomes, which was all about the accreditation, that's how we started the curriculum work. We talked about what learning outcomes we wanted for the students in the College of Science. So we didn't throw out anything, we said what learning outcomes do we want. Now let's look at what we have them do and where are the gaps? First of all, is what we do, where does what we do fit into these outcomes and second where are the gaps? And that's how we finessed it into things like teambuilding and critical thinking."

Critical Thinking. Although critical thinking is not explicitly mentioned in the expected outcomes it was the single most talked about skill that came up in many different areas of the interviews. Mary brings up critical thinking but as with other's who talked about critical thinking it was in context with other ideas:

> "Critical thinking skills and communication skills because they had been given short shrift in the other core, in the original core curriculum."

And:

> "So, we were concerned about the lack of these other skills, the critical thinking, the ability to work in a group, um, no computer science was in our original core."

Mary also explained how critical thinking and other outcomes like team building were talked about in context of more concrete items like learning outcomes.

> "First of all, is what we do, where does what we do fit into these outcomes and second where are the gaps? And that's how we finessed it into things like teambuilding and critical thinking."

Although the study participants all talked about critical thinking it was often like Mary did, in context of another, more prioritized, outcome. Clearly critical thinking was on their minds but not as a standalone outcome.

Communication, writing and presentation skills. Communication skills in general were a great concern for UTF members. Mary Connected critical thinking skills with communication skills because they had so little focus in the older core curriculum:

> "Critical thinking skills and communication skills because they had been given short shrift in the other core, in the original core curriculum."

However, she also wanted to connect with certain national trends that were informing her that communication was a focus nationally as well:

> "There were also a lot of national trends in terms of communication that we wanted to make sure that science students got those skills."

Josh also felt that communication skills needed to be improved and noted that presentation skills were not in the old core curriculum:

> "We included a change in the communications requirements that, um, involved presentations so that's a change. Um, in terms of communication skills and writing skills students are getting more practice."

Joan, being an academic advisor got to know her students on a more personal level, also reflected the need for better communication and presentation skills:

> "We felt like that, we had a lot of science students who weren't comfortable getting up in front of a group. When they interview they may have to give a presentation, if they were fortunate or unfortunate enough never to have that experience in a classroom, they hadn't had communications since high school, they may not go for a job they need because it was those types of skills they need to develop."

Tom was a little more expansive in his understanding for the need of better communication skills, repeating a common theme with him of becoming a better citizen:

> "Well again I haven't seen it implemented but, uh, I would say, including communication first of all was a big deal. I think that's important just because whether our students were going to be pure physicists or pure chemists the majority of our students are going to work in the world where that purity isn't important. So, so having a mindset to think about that as an undergraduate felt to me that it was going to prepare them better for being a successful citizen in the world no matter, you know they might end up in economics or whatever but they still understand the relationship between these different components. I thought that was important. Be able to communicate about that I thought that was important."

Finally, Betsy connects good communication skills back to critical thinking and life-long learning

> "I hope that the change in the communications and writing, um, you know making that more, cause science students think, you know, why do I have to write, oh heck yeah. You're going to write your entire life. I spend most of my day writing."

The idea of critical thinking appears in many different places throughout the interviews but always in support of another objective. This is illustrated by Mary who related other changes in the core curriculum with critical thinking skills:

> "So, we were concerned about the lack of these other skills, the critical thinking, the ability to work in a group, um, no computer science was in our original core. I think adding stat and CS allows them the physical points of critical thinking. I think that was very important."

The consensus among the study participants seemed to be that better communication skills affects critical thinking and better prepares students for the world of work and being better citizens.

Team building. The idea of team building or teamwork may have been the most divisive of all the expected outcomes. There were many disagreements about the need to teach teamwork. However, among the study participants teambuilding was a primary concern. Mary spoke to this issue:

> "Many of us wanted to, um, do more with groups, um, teamwork, and for me teambuilding."

Josh also reflect3ed how his personal experiences working in a company influenced his view of teamwork especially for students:

> "Part of my personal baggage that I bring to this is that, um, I used to work in a company and as someone who used to recruit undergraduate students to work in a company. Um, you know I've interviewed a lot of students and these are the same things I identified in those. That they were often very good at their discipline but couldn't do anything useful because they didn't know how to work in teams, didn't work with people with other expertise, and their writing skills were pretty poor. So all of these things in my mind started to come together."

And Tom also reflects on what he considered to be a given in the world outside of the university:

> "Teamwork, teamwork, yeah. And again clearly in the world that we're in hardly anything happens with a person in a room by themselves."

Even though among a number of this study's participants the idea of teamwork made a lot of sense there were others on the UTF who felt strongly that it should not be part of the curriculum. Much of the resistance to teamwork came from faculty in specific departments. Josh relates how some departments felt about teamwork:

> "Well so there was a, there are parts of the college where certainly advanced work in that field is not typically done, um, with, and I'm going to put multidiscipline and

> teamwork together because I was involved in both of those and there were similar controversies about it, um, so, and I'll pick math as an example because this was one of the departments that pushed hard against these things."

The mathematics department in particular did not feel that there was a need for teamwork based on how they viewed the world, again Josh relates:

> "So the vision of a mathematics researcher that we all sort of vaguely, the misconception we have in our minds but probably not too far, is the individual sitting in a room with a pencil, you know, doing proofs. And that's not how math is done. That encapsulates the push that came from that department, say what's this teamwork thing, we don't need teamwork, this multidisciplinary won't produce the best mathematician, we don't want to, they don't need to spend their time learning how to do stuff with other people."

The mathematics department felt that teamwork didn't produce the best mathematicians so they were naturally against an idea they thought would take up valuable time and space in the curriculum. However, Tom thought that that same belief was more widespread than just the mathematics department:

> "Well, science faculty doesn't have a long history with teamwork. And, and I would think that it might be difficult to get the faculty to accept that people like us (advisors/educators) could serve a valuable role by fostering a teamwork environment, you know, how to, how to work as a team. So they aren't used to doing it themselves, it doesn't surprise me."

Among many of these same faculty was the belief that doing required laboratory work qualified as teamwork. But many study participants felt that laboratory courses did not really express the essence of what teamwork was. Mary said:

> "The second thing is that certain departments insisted on, they said, well lab is teamwork. It's not unless you do it appropriately"

Joan expressed that some of the concern with teamwork in science laboratories was that no one trained the teaching assistants or students how to work in a team and subsequent many typical problems surfaced:

> "So I don't know, I think the students do need to understand that when you are in a chemistry lab or a physics lab or something like that, there is going to be somebody who doesn't pull their weight, so how do you do that? You're going to have somebody with lots of energy in the beginning but not at the end. Somebody's going to come along at the end and sparkle and shine but they kind of dragged their feet the whole time."

In the end the decision was to support teamwork but it was not a unanimous point of view. Josh talked about how the end vote to include teamwork happened:

> "They lost. Again, this was something that it came down to a large open meeting and voting about these things so they were, the dominant feeling from the faculty who bothered to turn up and express opinions about these things was in fact it was important to have multidisciplinary experiences and to do teamwork. So there were minority opinions voiced very strongly because this is a college requirement if you were just one subunit of a department you're not going to win that."

The majority vote was for implementing some sort of teamwork experience but the question remained how to achieve that goal. It was decided that teambuilding would incorporate two components; instructional and experiential. Josh explains how it worked in the beginning:

> "We implemented a requirement in teamwork that had two pieces. So an initial training program to understand how do teams work, the theory behind it, the practice and philosophy behind it. And then to take a course on an experience that included teamwork. So that was a change that hadn't been explicitly included before."

Initially the instructional or training component was taught by various faculty and/or graduate students including at one point the Dean of the College of Science. Joan relates the difficulty the College had in teaching the instructional component:

> "They had a Dean and a grad student trying to teach it, they had an administrator trying to teach it. It was just all over the place. And some of the things they would have them do in there were not science related. So it was kind of tough."

Joan continued to discuss how difficult the instructional component of teamwork was and whether that component or the whole teamwork outcome might be eliminated:

> "So it's, um, oh you had to have teamwork your freshman year and then they backed off and then they said you have to have the teamwork module within a semester of your teamwork experience. They just didn't know what to do with it. And it was just, it's been exhausting. All these years trying to work with that and it's kind of up for a vote about whether or not they'll keep it."

Josh gave a more comprehensive view of the problems with the teamwork component:

> "Um, the, the teamwork, um, requirement had some challenges associated with it. Didn't have many people who were actually trained to do anything with that. Our faculty are wonderful people but most of us aren't trained in many of these areas. We, we may think they are important and we may sort of know something about but we don't, uh, know that from training. So we have to come up with some ways to train students in teamwork and so that was done with a, you know, small groups, staff, and there was an online process."

Then the instructional component was changed to an on-line class and others began to doubt its effectiveness. Mary comments:

> "Um, it's been, the teamwork has been difficult. Partly because now they've taken away the hands-on first part of it."

And William concurs with this point of view:

> "On line…Yeah, it's not clear how seriously people take the online stuff."

Most of the study participants felt that the teamwork outcome was important but didn't know how to properly deliver it to the students and were clearly frustrated. Betsy explains her point of view:

> "So I think in theory teamwork, um, is a good idea although I don't know that we have ever done that great of a job in implementing it."

And Joan Observed:

> "The teamwork thing, was just, they offered it on Saturdays, football weekends to get people in. The course times conflicted, they tried to offer it three times during the semester."

And Mary adds:

> "Um, it's been, the teamwork has been difficult. Partly because now they've taken away the hands-on first part of it."

It seems that the consensus among the study participants is that teamwork was a necessary skill that science graduates needed to have. However, they did not know how to teach it and the task fell in priority. After initially teaching the instructional component in an in-class format it was changed to an on-line format. There was serious concern among the study participants about the effectiveness of the course being on-line. There is now talk of eliminating the teamwork component entirely. At this time no decision has been made

Multidisciplinary. The multidisciplinary component of the expected outcomes was at least as derisive as the teamwork component. The initial rationale for the multidisciplinary component was to give students broader experiences other than their own fields. Josh explains:

> "Um, students don't write well, um, they don't have a lot of preparation and practice in giving presentations, and many of them hadn't thought carefully about or had much experience in interacting either in teams or in teams that involve people who had expertises was very different from theirs."

In addition, whereas there were problems teaching teamwork, the multidisciplinary component lacked for a better definition. William explains:

> "And then there's this multidisciplinary component which nobody knows, I mean that's the one thing, that's kind of where we gave up because we said this sounds good let's require it. Who the hell knows what it means."

William continued by saying that simply taking one course in a different, but related, field did not really satisfy the intention of the outcome:

> "I guess, I, I don't know how it's being done. I don't know what students are doing to meet it. Ah, I do know. Physics majors will take an astronomy course, whoa! That's not what I, I think we came up short on that one."

Josh echoed some of these same concerns:

> "Um, there were concerns about the multidisciplinary work. People really doing multidisciplinary work, or was it just, you know, window dressing around a course that really wasn't multidisciplinary."

Josh further explained that the multidisciplinary component was also unpopular for similar reasons that the teamwork component was unpopular and with the same departments:

> "Well so there was a, there are parts of the college where certainly advanced work in that field is not typically done, um, with, and I'm going to put multidiscipline and teamwork together because I was involved in both of those and there were similar controversies about it, um, so, and I'll pick math as an example because this was one of the departments that pushed hard against these things."

However, there several study participants who didn't think the multicultural was necessary. They explained that each science department was already multi disciplinary because students took courses from each science department. Joan notes:

> "Yeah, I think the multidisciplinary was, um, was not needed. Not needed, um, everybody was already doing all of this except math. When they changed the program they already made everybody multidisciplinary."

With the exception of the mathematics department, again, Joan reasoned that science students were already multidesciplined. Betsy concurred with this point of view:

> "Well that was one I think that you know kind of sounded good on paper, um, but you know science, maybe not math and statistics so much but most of the sciences are already multidisciplinary and so it was kind of this thing that just was like we're already doing this."

An important additional problem was that there was no well defined way to satisfy the multidisciplinary component. A committee was formed to review the process. Joan commented:

> "When it first started it was this horrible process of trying to prove that you were multidisciplinary. And they have a, um, committee that would approve, if somebody had an experience that was multidisciplinary or not."

Betsy sums up the attitude towards the multidisciplinary component by talking about the difficulty of working with it:

> "I don't think that one was successful. It was too confusing and not well defined as to what it was. I know when I sat down with students and I would have to kind of say, kind of go through my little spiel I would always get to multidisciplinary and I would never have good reasoning for our rational for that."

Although the multidisciplinary component is still required the consensus of the study participants was that it was not successful. The feeling was that it was never well defined, was not developed, and dropped in priority (my view). There was also a large resistance to incorporating the multidisciplinary outcome into the core curriculum. Although this resistance primarily came from two departments there were enough other voices that felt that the science core was already sufficiently multidisciplinary. However, this was because the old core required that students take a broad range of subjects from other science departments. This was not the intent of those who saw a need for a multidisciplinary component. Josh succinctly summarizes this view:

> "Transdisciplinary. And that went nowhere, absolutely nowhere. I would have been happy to make do with interdisciplinary but even that, um, was not well accepted by the larger community because of concerns about what it might mean. People were happy with the idea of multidisciplinary because they thought they could get away with saying OK if I could just put two disciplines in the same course that's multidisciplinary. But I don't have to try and do stuff that we use them together because that would be interdisciplinary and no one knew what transdisciplinary meant. Even though it was the right word for what we were trying to do."

For Josh this was more than using a different word (transdisciplinary). His view was that a group of students all from different departments should work together on a project that required each one of their skills to solve. The multidisciplinary component of the core remains unsettled as the study participants could not come to a consensus.

Language and culture. Under the old core curriculum the language requirement stated that a student must have "proficiency" in another language other than their own. This was to be demonstrated by taking up to four semesters of a language and/or passing an equivalency test(s). Mary reflected that sentiment:

> "In terms of our language requirement, we required language up to, I guess, two hundred and two or four semesters. That the goal of that requirement was to help students have some cultural appreciation outside of their own culture."

However, many of the study participants questioned what was meant by "proficiency" and is it even possible to be proficient after four semesters of a language. Joan's view was:

> "And then, um, they reduce the foreign language because they said really if you are completing the 202 level, you're really not fluent. So, if you go to a foreign country you have to have, or another country to study, your 202 level is probably not high enough."

Adding to the view that proficiency, however it is defined, were admitted biases on the part of the study participants. William expressed his dislike of the language requirement in general:

> "I personally had a prejudice against language requirements. Ah, only because I'm not good at languages and when I was a graduate student, ah, I had, they, they relinquished the language requirement at MIT. And that was a great day in my opinion. So, and, now I have to temper that, I think it's great if a student wants to take foreign language. Ah, and I've taken foreign language. Ah, I took several years of French and I regret I can't speak Spanish."

From this point the discussion shifted from being proficient in a language to being able to understand and appreciate other cultures. The language requirement became combined with having cultural experiences. Josh combined the idea of being proficient in a language with understanding other cultures in order to be able to function in a global environment:

> "So in terms of those particular things what I identified is, um, in terms of the foreign language thing, um, you know you have students who know their 473 words in Spanish or whatever they learned in two years of Spanish but actually didn't know anything about foreign cultures and were not prepared to interact with people in that global environment."

As many of the study participants did Josh combined his personal experiences with his perceived need of students by stressing the importance of global experiences:

> "Um, I do a lot of stuff internationally so I had some personal views about the importance of being able to, to sort of act in a global situation in ways that didn't necessarily mean you had to speak the language."

Tom agreed with Josh's view but more from the point of view that reflected one of the primary objectives of the curricular review, what it meant to be a scientist:

> "So, so there is, I think there is value in learning a foreign language because again it gets you out of your comfort zone, it forces you to think about abstract ways of representing ideas. And that's what science is about. Is to think about abstract things in a different way. And so I was all for keeping some foreign language requirement but I also felt like we needed a cultural experience as well because you know our students were going to be working in the world not in the States."

There was a lot of discussion on the point of what to do with the language requirement. The final decision to fulfill the language and culture requirement was for a student to take three courses in the same foreign language, or take two semesters of a foreign language and then demonstrate a cultural or diversity experience to by taking one or two of a set of approved courses, or an approved study abroad experience. Josh expresses his view of the language and culture requirements:

> "We changed what students have to do to meet what you would call the foreign language requirement. And that was one of the ones that took up a lot of debate in the open meetings. Uh, there were a number of people who felt it was wrong to give students options other than taking language courses. So now there were a number of different ways of satisfying that sort of global competencies requirement."

Tom's views were similar

> "I thought it was a good idea because I'm not sure that the way, I'm not sure the way foreign language is being taught that a fourth course in a language was adding that much to the student's education. I've not traveled extensively but I've been around a little bit and I know that English is used practically everywhere. So that, that doesn't mean we shouldn't have a foreign language requirement because I also know that wherever we went I felt really out of place because I didn't speak the language. But even more importantly I felt like when I've been different places understanding that there is a culture different than ours, that the way they view the world isn't the same way we view the world."

And finally, Betsy's view:

> "Well they, um, the foreign language requirement was reduced, instead of four semesters of a foreign language students could use, um, two or three semesters, I think it was a total of 9 hours, they have two semesters of language, and then another cultural type course. It was a very broad offering, study abroad could be one. Basically any course that had a non-USA type focus. I think in general that the language was successful I think that getting students to think a little more outside of their American focus."

From the point of view of this study's participants it was the consensus that reducing the number of semesters of a foreign language necessary to fulfill the language requirement and including cultural, diversity, and/or study abroad experiences was a positive development. A theme that has been building through this study among the participants is that graduates from the College of Science needed to have more experiences outside the science classroom and more reflective of the world in which they would work. This also included experiences with different cultures and types of people.

Great issues. The idea of the great issues courses generated a lot of discussion. For many of the study participants the idea of great issues connected into several of the expected outcomes including critical thinking, multidisciplinary, cultural awareness, global issues, and becoming a better citizen. Mary relates this point of view:

> "And a key thing that a number of us were talking about for a long time, is the students were being educated with a lot of depth and detail, but they had no

> appreciation of what we call it now, the great issues. Big issues in science. How'd it apply to them?"

> "And, um, so the students were not appreciating global things and that's where the world was going. Students were not understanding the big issues. They need to understand those kind of things."

> "Um, great issues became a requirement! Um, a student had to take one great issues course, and its been great!"

The concern that graduating science students were not aware of the world around them and the effects that had on themselves and the world was very present with many of the study participants. William relates his point of view:

> "There was a lot of discussion about bioengineering with crops, the genetic manipulation of crops. And all the ethical and other scientific concerns about that. Nuclear energy, there's lots of issues surrounding about that. So there were all these, hot topics that were evolving so quickly that, there were no textbooks. You had to rely on, you know, current material."

William also connected great issues to a broader perspective that included the importance of people with different skill sets being able to work together to solve complex problems:

> "I also think that in part that the course was career counseling because it tried to show students, I explicitly made this point whenever I could, that these problems are so complex that, that even though you might think it's a political problem there's a role for a chemist or a computer scientist. Many of these problems require teams of individuals with different skills in order to fully address them."

So, for William the great issues brought together awareness with critical thinking and problem solving. For him this was at the core of what a science education was all about.

> "My approach was to keep it very broad. And others, the courses are equally good, tended to take a single topic. One faculty member focused on oil, you know it went deeper. What I tried to look at was the interconnectedness of the various issues. I think my own feeling it that it was a positive change."

Although William sees a need for the great issues courses, and most of the study participants agreed with this, there were a couple of associated problems. One problem was that, with a few exceptions, there were no great courses at the time the curricular review was being made. Another problem is that the College of Science is required to keep the total number of credit hours under 120 and adding new courses might mean eliminating other courses. Betsy commented

> "You know we didn't have courses for great issues. I thought the great issues were a good idea."

Tom discussed the great issues courses but from a historical point of view. He pointed out that great issue courses were first taught in the 1950's and 1960's and were at the end of the curriculum as a capstone experience. He reminisced about teaching them earlier in the curriculum:

> "Of course the great issues in the 50's and 60's was more of a capstone sort of thing. The other thing that was different was, as I recall, I don't know where it ended up, we talked about getting at least some component of those great issues at the beginning rather than at the end."

Additionally, the University was in the process of developing a common core for all freshmen and sophomores and there was a concern of how the great issues courses might fit in with the University's new common core. Josh discussed this very issue:

> "Ah, great issues is the one that surprised us all but the reason it doesn't fit the foundational core is not because it isn't science, technology in society, it fits that description beautifully, but it's too high a level. And the foundational core courses are meant to be things that first and second year students can get into. The great issues courses were purposefully designed to be courses that after you've taken several years of your major you know something about computer science, biology or whatever it is. And you bring that perspective to the discussions at the great issues. It's meant to be more of a capstone experience where the foundational core is meant to be sort of a beginning experience for students. So it's not the either of them is wrong, you can't count one for the other means that there's sort of an additional burden on our students."

Although Josh supported the great issues courses and felt that they were a positive step in the College of Science he also recognized that they clashed with the University's common core. Resolving this conflict was not going to be easy. Josh felt that the great issues courses would be better taught as a capstone experience but in that case would not qualify to be part of the University's common core. His solution was to teach the great issues courses early in the curriculum but he felt that this would have been a less effective outcome for the students:

> "It may decrease in terms of what we've been trying to do in the college. Now if a student is taking a science and technology in society course as a freshman or sophomore, you know, are they actually getting a lot of the outcome and experience associated with what we're trying to do in the great issues course. It's not that we're going to lose what we were trying to achieve we'll have different things, probably not as effective."

Although the great issues courses became part of the new science core there is still discussion on how well they fit in it. Overall, everyone seemed to agree that the great issues courses were important and needed but could this requirement be fulfilled elsewhere outside the College of Science? This conversation is still continuing.

Summary of perceptions of expected outcomes. The majority of the discussions with the study participants were spent on their perceptions of the six expected outcomes and the mechanisms by which they could be achieved by students. There was consensus among the study participants that critical thinking was something important to focus on also. However, no one mentioned how it could be achieved or how it could be assessed.

There was also consensus that good communication, writing, and presentation skills were needed. There was also a common belief that the core requirements required to demonstrate good communication, writing, and presentation skills were sufficient. Those requirements included completing freshman composition, taking an approved course or action in technical writing, and taking an approved course or action in technical presentation.

There was no consensus concerning teamwork or team building as Mary seemed to prefer calling it. Achieving the teamwork outcome was split into two separate student tasks. The first one was an instructional course on the theory and practice of teamwork while a second student task was to have an authentic teamwork experience. There were difficulties with the first task almost from the beginning. This may have been because there didn't seem to be expertise in the College of Science regarding how to teach teamwork. It may have also been a lack of real desire among the faculty to be involved in teaching teamwork. The instructional component of teamwork was then left to an on-line course and many of the study participants questioned its effectiveness. Several study participants questioned whether the teamwork component would remain as an expected outcome.

The experiential part of the teamwork component was to be fulfilled by an approved course and/or experience by the College of Science. There have been problems with this requirement too. In order to satisfy many of the teamwork and multidisciplinary components a student needed to get approval from the College of Science. There has been confusion about who would provide this approval and what exactly counted as an approved course of action by the student.

The problems with the teamwork component might have its origins in the way it was presented and approved. Although the majority of the faculty who voted for the new expected outcomes voted for teamwork there was a significant disagreement in at least two departments, mathematics and computer science. The feeling in those departments was that their graduates did not need teamwork because the work of a mathematician was primarily done individually. Their feeling was that taking course work on teamwork was a distraction and wasted curricular time. However, it was pointed out that graduates with bachelor's degrees in those majors often didn't end up doing traditional academic mathematics work but rather ended up in positions that required teamwork concepts most notably teaching. But without a true consensus can a comprehensive review of the curriculum (reform?) really be successful? In fact this author can report a confidential discussion with someone requesting anonymity who bitterly disagreed with the whole review process and its outcomes.

Likewise there was broad disagreement on the multidisciplinary expected outcome. There was a consensus among the study participants that the multidisciplinary expected outcome was not successful. The same departments, mathematics and computer science, questioned the need for a multidisciplinary component for their students. However, there was an interesting secondary reason for not supporting the multidisciplinary component. A number of the study participants felt that the College of Science was already providing a genuine multidisciplinary experience. The reasoning was that the science core required courses in almost all other science departments and that that provided the multidisciplinary experience. However, at least one study participant felt that courses in other departments were not enough. There was discussion about a capstone course where teams of students, each from a different department, would work together to solve a real world problem. Currently this expected outcome is achieved by approved coursework, research project, internship, or an entrepreneurship program. An approved minor or second major can also satisfy this component and a degree in secondary science education automatically satisfies this requirement. And, like the teamwork component, there was a distinct feeling among the study participants that the multidisciplinary outcome could be eliminated.

There was a consensus among the study participants that the language and culture expected outcome was successful. However, there was a debate over lowering the number of language credits in favor of some kind of a cultural experience. The prevailing feeling among the study participants was that an extra course in a language was not going to make students fluent but a cultural experience might enable them to work in a global environment better. This outcome could be achieved by specific coursework which included approved courses in culture and/or diversity. A study abroad experience also qualified for this outcome.

The great issues courses were also a debated component of the new undergraduate science core curriculum. However, there was consensus that the great issues courses were important and addressed many of the basic principles that the College endorsed including critical thinking, multidisciplinary, cultural awareness, global issues, and becoming a better citizen. However, there was concern as to how the great issues courses fit into the new undergraduate science core. As originally conceived the great issues courses were to be taught towards the end of the curriculum but they were to be taught near the beginning of the new undergraduate science core. If they were taught near the end of the curriculum as a capstone experience then these courses would not fit into the also new University foundational core which focused on lower level courses. And there was a total credit hour cap to deal with so the great issues courses didn’t really fit at the end without exceeding the cap. An additional problem was that although a few departments were offering great issues courses they were new to the majority of the College and the overall selection was not great. There was some talk about eliminating the great courses because of these problems.

Perceptions of faculty. Although direct questions about science faculty were not asked in this study, a number of responses from the study participants began to paint a limited picture of the science faculty. One important quality of the science faculty was that many did not understand the needs of its students especially those who would not go on to be graduate students. For a number of this study's participants one departmental stood out, Josh explains:

> "My personal opinion is that the math faculty wasn't thinking about what all of their students need to do, they were thinking about the subset who were going to become graduate students like them."

Tom echoed this point of view:

> "And, they're used, they get rewarded, they're used to dealing with PhD students. And all but the very best of our undergraduate students are not going to be PhD students. So there's a whole different mindset about a PhD student versus an undergraduate. And the results you want out of those kind of people. And that was the biggest challenge throughout was to get them to think about undergraduates and not just the science student.

Seemingly the faculty was more focused on graduate students and those undergraduate students who would likely go on to become graduate students. Another faculty/student disconnect for Tom was the faculty's understanding of grades:

> "And we were, what we were finding was if you didn't get an A in the first course you weren't getting through the fourth course in four semesters. And, um, that was a surprise to the faculty. Because they thought, I mean I think they thought that all the A and B students go on and get an A or B in the next course."

In addition to a faculty misunderstanding of grades in sequential courses they did not understand the ramifications of so-called weed out courses either. The faculty may not have understood that their grading in specific courses was actually "weeding" students out of the College. Tom explains:

> "And, so, what I was finding was that the, that the grading scale in those courses was really weeding them out even though they didn't think it was. It was weeding the students out."

The faculty was not thinking about the needs of the undergraduate students. Again, Tom explains that the faculty were only paying attention to certain students, those going on to graduate school.

> "So, I mean I also pointed out, I mean I had my pie charts out that showed what percent of our students that went on to graduate school, went to medical school and all those kind of things. As a part of it to show, well and the medical students were, they actually got some earplay from the faculty as well. The fact that they were going on to a professional program. That carried some weight with them. The ones going out to work didn't carry much weight."

The overall aspect was that faculty were only paying attention to those undergraduate students who they felt would go on the graduate school, and to a lesser extent professional school, while disregarding the needs of the majority of undergraduate students.

Logistics. Besides resistance to the teamwork and multidisciplinary expected outcomes, which were centered in particular departments, there was also a logistics problem related to the size and number of courses currently being offered and required for graduation. There is a political requirement to keep the number of course hours for graduation at 120 credit hours. This led to significant problems with developing new courses because the curriculum was already too crowded. Departments were not willing to give up credit hours, in many cases, in order to achieve larger goals. Tom illustrates this point of view:

> "Well, lowering the number of hours would not have been a bad idea. With the other experiential things being in there. But that wasn't a very high priority."

There was also a desire among study participants to have a more holistic approach to the undergraduate science program. Tom possibly had a more student centered view of this approach because of his high involvement with students in the College of Science. Tom stated:

> "I would have liked, I wanted to see, um, two things that I can think of. One was an introduction to a science way of thinking early on. There was an assumption that students had it and they didn't. So to do something to help them think about things more scientifically. I would have said, I would have expanded some of those core, I, I would have, how to be a scientist. I would have had, I think maybe there's, I think we ended up one course in a great issues kind of thing, I would have had two. I would have had maybe one, maybe one in both. So it would have been things like that more than reducing the hours I think."

Tom felt that science student didn't really understand what science was and how it is practiced. Spending more time helping undergraduate students in the College of Science understand the field of science was not uniquely stated by other study participants. However, William touched on using the great issues courses as a sort of career counseling:

> "I also think that in part that the course was career counseling because it tried to show students, I explicitly made this point whenever I could, that these problems are so complex that, that even though you might think it's a political problem there's a role for a chemist or a computer scientist. Many of these problems require teams of individuals with different skills in order to fully address them."

There was a similar view among those that supported a strong study abroad program and its use, in particular, in satisfying the language and culture requirement. Tom expressed his view that learning a language coupled with a study abroad type experience would broaden (holistic) a student's understanding of the world:

> "So, so there is, I think there is value in learning a foreign language because again it gets you out of your comfort zone, it forces you to think about abstract ways of

representing ideas. And that's what science is about. Is to think about abstract things in a different way. And so I was all for keeping some foreign language requirement but I also felt like we needed a cultural experience as well because you know our students were going to be working in the world not in Indiana."

Another logistical issue that became more apparent after the new core was operational, and talked about earlier, was how to approve a student's proposed course of action in order to satisfy the Language and Culture and Multidisciplinary outcomes. A student could propose a course of action to satisfy one of these outcomes and it was up to a committee to approve it or not. However, the approval process was not clear which resulted in the rules changing often. Betsy talked about this:

"In fact at the time that this was implemented, um, we started a system in the College of Science it was called the exception database. And, um, while certain you know a student would petition you know so we kind of had our current set of rules which shifted as far as implementing the curriculum, it was shifting and changing all the time. Um, and a student would come up with something and we'd work out something and it wouldn't kind of be on the approved list and, um, then you would you know submit something and it would get ruled on."

The final logistical issue was how undergraduate students initially viewed the new core curriculum. In some ways it was more complex than the old curriculum and students recognized that. Betsy stated:

"The old curriculum was easier to understand by the students. And it was easier because it was kind of more of a check box."

And Betsy continued:

"And the new curriculum, part of it because of its implementation and refining and it just, you know, it got so confusing."

Although Betsy felt that the new core curriculum was confusing Sam felt similarly about the old core curriculum:

"It was fairly well recognized by faculty who had been active with the college that we had a curriculum that had flaws in it. You know it was the Chinese restaurant syndrome, choose two from column A and three from column B and people were

> never all that confident. So we had a general perception that our curriculum was too old."

There didn't seem to be a consensus among the study participants when comparing the old to the new curriculum. Some thought the new curriculum was better and others thought the old curriculum was better. Most didn't know how the students viewed it, with the exception of Tom, Joan, and Betsy.

What Is Reform?

One of the core purposes of this study was to determine whether the effort to review the undergraduate science core at State University was a reform. One difficulty with defining this effort as a reform was the word itself and its meaning. As a precursor to determining if the review of the undergraduate science core was a reform the study participants each explained their own view of what a reform would look like.

Many study participants felt that reform meant large scale, major changes. Mary explained what that meant to her:

> "I guess if we threw out (the old science core), if we threw it out and that's one of the things that several of the departments wanted us to throw out. Yes, (throw out) just the core and let the departments run it."

Mary continued by explaining the necessity of a large scale change to qualify as reform:

> "Yep. Or either way. If we took over everything that's… I guess I see reform as big changes, where I see what we did was, um, assessment and evaluation to meet the needs. I don't see that as reform. That doesn't mean I see that as a non-significant change. Some of these were very significant changes. But they're not, they weren't, I guess if we said you don't need math any more, as a scientist you don't need calculus, I would not have survived that. That would have been reform."

William also felt that reform required big changes:

> "I guess to me it would have implied more wide ranging changes rather than tweak here, tweak here, tweak here. Because I think what we did is nothing radical."

Further:

"(Reform requires) Big change."

Speaking to a reform effort at another institution William defined reform by what it is and what it is not:

> "You haven't simply introduced a set of requirements or a single new course. They took topics and integrated them in new ways. That's a reform."

Tom also referred to the necessary large scale of reform:

> "Reform I would have said, in my mind, when you reform something you sort of start over from scratch. You may, you may pull in good the components that are out there. You know if there is a block that's working, why tear it up and start over again? But you put all your blocks out on the table and then you pick up what you need."

Joan added:

> "To me reform is probably something huge. It's big, it's not oh let's tweak it a little, let's add this. Reform is big. So reform would be, um, something that would, um, move mountains as opposed to oh we'll just add this course or something like that."

Dan also supported the idea that reform needed significant and fundamental changes:

> "Well reform is one of those terms that has multiple meanings. When I think of the term reform I think of something that's a pretty fundamental change. I don't think of something that's tinkering. I think of something that's more significant change that is very carefully thought out."

Most of the study participants talked about reform in generalized terms. However, Dan offered a particularly comprehensive idea of what reform might look like:

> "One would be, would have been a broader representation of different stakeholders. From the beginning, throughout the entire process to ensure that perspectives from students, from employers, from faculty, those who are on the campus with student right here were well represented and became part of the consensus making process. That needed to take place"

Two key elements for Dan in defining reform was inclusion and participation of all stakeholders and comprehensive study of what was working and what was not working. Dan also referred to the need to consider long term consequences:

> "The longer term consequences and how they would measure the longer term consequences of the changes they were planning to implement. Both on campus and off campus after the graduates left."

There seems to be a consensus about what makes a reform, at least within certain limits. Reform requires large scale significant change. But it is important to attain input, even consensus, from all stakeholders. It also requires significant study of the current situation in terms of what is worth retaining and why and what changes can be made with an eye to long term consequences. Dan voiced the most detailed view of reform:

> "There was a lot of time, even in the couple of semester I was involved, there was a tremendous amount of time and effort that was devoted to changing the requirements, ah, without any kind of a systematic way of asking the question 'were we successful' 'does this make sense' and again without having representation from the stakeholders and follow up with the students, with the employers, with the faculty, with the advisors and everybody else, without having something in place I don't know how you could have said if it were successful or not."

Reform as a pejorative. Semantics within a community is actually rather important and the word reform was not used in any of the supporting documents or discussions related to the review of the undergraduate science core at State University. Josh related to the use of the word reform:

> "Um, so, so I guess I hadn't noticed that it hadn't been included but may in retrospect it doesn't necessarily surprise me. Because every community uses the words that seem to make sense."

However, in light of the high attrition rate out of the College of Science at State University, as well as at many other universities across the United States, and that at least part of the review agenda was to address this attrition, it may be prudent to ask if this effort was a reform. And if it were not a reform on what scale did it approach reform?

When asked about whether the review of the science core was a reform many of the study participants visibly recoiled from the suggestion. When Mary was asked if the word reform was purposefully avoided she replied succinctly "yes." Mary continued when asked whether the word reform was pejorative she replied:

> "Yes, I do. Especially when you are dealing with faculty. Remember that."

Mary continued with that line of reasoning by explaining that many faculty interpret reform as something that is bad and a result of their action or inaction:

> "That you are telling them they are wrong. You're going to make it better. When you deal with faculty who design something, change to what they've done is a bad thing."

Josh expanded on the idea that the faculty could interpret using the word reform as something they did wrong:

> "Reform I see has sounds like we did something wrong before. Ah, reform school or something. Um, and so the reason it's not used is probably simply because that community didn't intuitively know, it wasn't a good enough word to choose because no one really quite knew what it meant. Um, that people would have suspicions that it would have baggage associated with it or maybe it's one of those education words."

Betsy agreed with the view that reform meant something wrong even bad:

> "When I see, hear the word reform I'm think you're fixing something that is wrong or, or not working or there is just an inherent you know something bad about it."

However, at least one study participant felt that avoiding the word reform was not purposeful, Ralph explains:

> "Ah, I don't, I don't remember that. I used to, um, I used to say when we were starting the process that, um, the curriculum dated back to, ah, I think it was actually around forty years or so and it's always a good practice every forty years or so to look at how you are teaching what you teach and why you teach. And, um, I don't remember a conscious choice of using it or not using it."

Aside from Ralph there did seem to be a general consensus that using the word reform was purposefully avoided. In addition, there was a wide spread belief that the word reform implied that something had been done wrong and there needed to be a remediation of some kind. Further reform also implied blame and there was a certain level of care taken not to imply either wrongness or place blame particularly in reference to faculty.

Was it Reform? Was the effort to review and revise the undergraduate science core curriculum a reform? This was another of the primary questions of this study. In the last section the study participants explained their views of what reform might look like. A definition of reform was developed but now the question is, was this a reform? Mary was somewhat equivocal when she at first said:

> "Those places, those institutions, those people who want our students have different expectations. We need to meet them. I see it more as an updating."

But then followed immediately with:

> "In some cases, um, I see it as a reform in sense of less rigidity, more options. So that's where I see the reform."

Finally Mary said:

> "I see it as a reform as we are talking about outcomes not just a language requirement, a math requirement, what are you trying to get at with that? So that's where I see the reforming."

Mary had a much less well defined definition of reform than other study participants. Earlier Mary voiced the point of view that reform required large scale changes. Here she seems to be saying that reform can be found in many small changes instead of large scale change. Her vacillation may be due to her dual roles as faculty and administrator in that she was trying to satisfy both duties which can have very different points of view. In the end Mary said that she would not call this reform but that many of the small scale changes could be called reform on a lesser scale.

William also had a similar view in that he thought reform required big radical change. When asked if he thought this was a reform he succinctly stated:

"No, I don't think so. I don't think so. I don't think so."

Josh, much like Mary, seemed to equilibrate between reform or not reform. Josh was of the opinion, voiced earlier, that reform implied that somebody had done something wrong. However, he also seemed to think that the current effort was an attempt at reform when he stated:

> "Um, this was an effort at reform. We were changing what was going on in the light of a better understanding of the changing needs of our students. And to me that sounds like a piece of reform."

Tom was more succinct in his explanation of whether this was a reform when he said:

> "Um, I, I would say it was more iterative than a reform. Reform I would have said, in my mind, when you reform something you sort of start over from scratch. You may, you may pull in good the components that are out there. You know if there is a block that's working, why tear it up and start over again? But you put all your blocks out on the table and then you pick up what you need. We didn't do that. We just, iteratively, we tinkered. I felt like we tinkered pretty extensively on some things."

Tom seems to be reflecting on earlier comments that reform required fundamental changes. He used a word that was frequently mentioned, tinkering. The semantic difference between tinkering and reform seems to be matter of scale. Making small changes to items already in place was tinkering whereas large scale changes, even throwing items out and starting over from scratch, defined reform.

Dan, who gave a detailed description of his view of reform earlier, felt that this effort was not up to the level of reform, at least in his own definition:

> "Um, to be perfectly honest I did not think that the change in the COS core requirements fell under that category of reform. I didn't think it was a fundamental change because many of the same kinds of thing reappeared in the new core requirements."

Betsy also felt that this effort was not up to a level of reform:

> "But that's, yeah, but I wouldn't have said it needed reforming, I would say it needed some, some enhancements. Um, but I wouldn't say it needed reform. So I think kind

> of having a general framework is good, um, but I wouldn't say that, you know, we need reform. I probably wouldn't put that word on it."

Although the majority of the study participants felt that the review of the undergraduate science core was not a reform there was not a complete consensus. Joan felt that it was a reform but that was within the context of her definition of reform. Joan stated:

> "Um, yeah probably, um, yes because they really were trying to mold it a little bit to fit what the expectations were today, so it wasn't something where they changed absolutely everything but, um, it was enough of a change in attitude that that could be reforming."

As with other study participants Joan felt that reform was a matter of scale. In her case Joan felt that there were enough small scale changes to qualify as reform for her.

However, Ralph was the sole study participant who really felt this was a reform:

> "Yes, a major reform or really just starting from scratch, a total redesign. It was much more than a tinkering. Tinkering is sort of the process that happened over the preceding forty years."

As the only study participant who felt this was a major reform Ralph tacitly disagreed with the other study participants. He says that this was a total redesign and not tinkering. With the exception of Joan every other study participant felt that this was not a major "starting from scratch" effort and was in fact a "tinkering." However, Ralph remained vigilant stating that:

> "Yes, it's a, it's a new framework, a brand new framework that makes, it was significantly different from the old curriculum and, uh, I think moved the college forward in very significant ways."

With the exceptions of Joan and Ralph all the other study participants believed that the review of the undergraduate science core was not a reform. In fact many used the word tinkering to describe what they felt had happened. The difference in point of view may have to do with each person's personal definition of what reform is and, possibly, what their position or stake was in this effort. In particular, Ralph, as the Dean and initiator of the review, had a high personal stake in its outcome.

Ranking the Success of the Undergraduate Science Core Prior to Revision

Although the majority of study participants did not believe the review of the undergraduate science core was a reform most of them considered the results to have varying degrees of success. Specifically two of the interview questions asked participants to rank the success of the undergraduate science core prior to and after the implementation of the new revised core. The participants were asked to rank the success of the undergraduate science core prior to implementation of the new revised core on a scale of 1-10 with 1 being no success and 10 being total success. This was an arbitrary ranking based on the impressions of each participant. A number of participants refused to give a ranking because they felt they had no basis on which to make a decision.

Mary based her prior ranking on how it addressed the expected outcomes that were developed for the revised core. She replied:

> "So, if we define it as reaching the outcomes that the College of Science faculty said they wanted I'd say three."

William was one of the participants who felt he had no objective measure to give a ranking. However, he did give one based on his personal observations:

> "OK, so first, I have no objective measure, ah, was it successful? You know, we produce some great students. Did we lose students because of something that was in the core or was not in the core? I have no idea. So, I, I say it was probably a four."

Josh was very succinct on this point:

> "Oh, um, I guess I would rate it at you know I mean, this is the obvious answer, it's going to be a four."

Tom particularly did not think the undergraduate science core was very well developed prior to the revision saying:

> "Um, we didn't have that, uh, I was going to say we didn't have that much of a core. We had, a third of our classes were liberal arts type classes. But there was no cohesion to them at all. So I'd maybe give them a 3 or a 4."

Dan admitted that he was not that aware of any problems with the undergraduate science core prior to the revision. However, when he became more aware he related:

> "Um, I guess I didn't at the time I joined the task force and my knowledge of the old core at the time, I probably would have given it a rating of probably like a six or something like that. I didn't, I wasn't aware of really serious problems with it and so that's my rationale of giving it a rating of at least five. Um, but I also knew that there were some relatively small things missing. And again with the idea of having a more well rounded kind of experience for the COS grads. So that's why I'd probably give it that rating."

Joan was one of the participants who felt that the old core was actually successful. She seemed to be considering how the students who successfully negotiated the curriculum and graduated felt. She said:

> "Probably about a seven, I'm sure students left here with a really good education it was just a lot of work. I'm not sure they were getting everything they needed so let's just give it a seven."

Like Joan Betsy felt the old core was successful but she also questioned how to base a decision about her ranking. Joan stated:

> "Oh I don't know, I mean, I think it was successful, I don't know what that really means, whether it's successful, I would say a six or seven."

Both Ralph and Sam declined to give a ranking.

Based on the rankings given for the undergraduate science core prior to the implementation of the new core the study participants gave an average ranking of 4.7 out of 10.

Ranking the Success of the New Undergraduate Science Core

Much like the rankings prior to the implementation of the new core the rankings after the implementation of the new core are also divided. This is best exemplified by Mary's comments about the post implementation core:

> "So I think the new core had the potential of being an eight in terms of that but I think it's probably a six or a seven now simply because, um, of the way it played out. In terms of great issues I think it's a ten. I think there are different component parts that have really done it. I think one of the best things was the great issues."

Many of the study participants made similar statements particularly when discussing the success of the old versus new core and in discussions about whether it was reform or not. Mary felt that particular components such as great issues was very successful while others not so. This is what prompted her new core ranking from an eight to a six point five.

For William, as with his ranking of the prior core, was concerned about how to objectively measure the success of the core, prior or post. However, he did state:

> "Ah, I, I, again no objective measure, maybe a four point two."

Josh was succinct in his post core ranking:

> "A nine in theory, a seven in practice."

However, Josh voiced an important concern regarding the post implementation core. He was concerned that future pressures on the College of Science might force changes that were not intended and as a result decrease the effectiveness of the new core.

> "Well there were some potential changes coming up that might actually make it less than a seven. Um, so as you know we have a new foundational core requirement coming in. And at the same time we have the state, um, mandate/encouragement to reduce to a 120 credits, in cases where a 120 credits where we're more than 120. And so these different pressures coming in and so if the college has a requirement that also meets the foundational core than that's a no brainer and you keep doing that and

everyone's happy. But if the college has a requirement that doesn't meet the foundational core, which means our students are taking more credits and we can no longer, and we're also having to try to squish down to 120 then at some stage something will have to be jettisoned."

Josh was relating how the new foundational core that State University was introducing and a state mandate to keep the total required credit hours for graduation to 120 hours could affect the revised undergraduate science core. The issue is that the College of Science's total required credit hours for graduation, including the new core, were already at the state mandated 120 credit hours. That made it impossible to add any more credit hours required for graduation. If the new State University foundational core demanded that a College of Science course be taken out of the foundational core there would not be room in the science curriculum credit wise and something would have to be dropped. Josh was concerned this would affect the great issues course if State University decided it was not eligible to be in their foundational core. Josh said:

"It may decrease in terms of what we've been trying to do in the college. Now if a student is taking a science and technology in society course as a freshman or sophomore, you know, are they actually getting a lot of the outcome and experience associated with what we're trying to do in the great issues course. It's not that we're going to lose what we were trying to achieve we'll have different things, probably not as effective."

However, Tom felt the new undergraduate science core was a great improvement, if not a true reform:

"Well again, whatever transpired or not, on paper it looked like a seven or eight to me. I thought it had made quite an improvement."

Similar to Tom, Dan felt the new core was a great improvement. Dan previously said that he felt the new core was not reform primarily because of a lack of input from all stakeholders and a comprehensive assessment of what was working well in the old core. However, he saw a great improvement:

> "I probably would have given that closer to a seven or eight. Again because I was pleased to see the specificity that was included in the new version."

Joan also felt the new core was a great improvement but not a reform:

> "I would move it up to an eight. I think it improved it a lot, um, but like I said the multidisciplinary just throws it all off. We have students who don't know what you're going to do when they are already multidisciplinary."

Joan had issues with the multidisciplinary requirement not because of an ideological difference but because she felt it was not well defined which caused students problems. This follows a trend among study participants in that most of them felt the new core was an improvement over the old core but that there were still problems with it. This may have been a trend with the study participants but each had a different reason for nor fully supporting the new core.

Betsy, who left her position after the implementation of the new core, related how confusing the new core was. Initially she ranked the new core at 3-4 but after she left, five years into the new core, she felt it had improved to a six. She said:

> "Well just because it was still, so you know, it was still changing and shifting even at that time. In 2012 when I left and this was five years in we were still working out the kinks. And, um, you know, in the first couple of years I would probably rate it a three or a four. Um, you know, I would say a six when I left."

Again Ralph declined to give a ranking.

Averaging the rankings prior to and after the implementation of the new undergraduate science core gives values of 4.7 and 6.7, respectively. Table 4-6 reports each of the study participants ranking of the undergraduate science core prior to and after implementation of the new core.

Table 4-6: Study Participants Ranking of the Undergraduate Science Pre/Post New Core

Study Participant	Ranking Prior	Ranking Post
Mary	3	6.5
William	4	4.2
Josh	4	7
Tom	3.5	7.5
Ralph	NA	NA
Dan	5	7.5
Joan	7	8
Betsy	6.5	6
Sam	3	3
Average	4.5	6.2

The differences in the rankings per individual are informative. While Betsy was the only person to rank the new science core lower than the old one both William and reflected small improvements. However, William and Betsy may have different reasons for not feeling as good about the new science core compared to the old one. William made the point of saying that he did not feel that he had an objective measure of the curriculum and Betsy felt the new core was more confusing for students because it changing too much.

It is also interesting to note that the old undergraduate science core was not highly ranked by four study participants, below 5 out of 10. Three of them were faculty while the fourth was an administrator responsible for guiding the development of the new core. The highest rankings of the old core came from two academic advisors and one faculty.

There does seem to be a difference in views between advisors and faculty. What could be a possible explanation for this difference? I will attempt to address this difference in the conclusions chapter.

One other notable observation is that while Ralph declined to rank the undergraduate science core, old or new, he did state that he felt the new science core was a reform and was very successful.

What Would Real Reform Look Like?

Part of the last question asked of the study participants was if they did not feel that the new science core was real reform, what changes would have made it reformed. For Mary simply throwing out the old core and starting new would have represented reform, Mary said:

> "I guess if we threw it out, if we threw it out and that's one of the things that several of the departments wanted us to throw it out."

Mary was talking about eliminating the undergraduate science core and letting each department direct their own curricula individually. However, Mary also thought another option would have been for the College of Science to take over and direct the entire curriculum, again Mary said:

> "If we took over everything that's… I guess I see reform as big changes, where I see what we did was, um, assessment and evaluation to meet the needs. I don't see that as reform. That doesn't mean I see that as a non-significant change. Some of these were very significant changes. But they're not, they weren't, I guess if we said you don't need math any more, as a scientist you don't need calculus, I would not have survived that. That would have been reform."

Mary's larger point seems to be that what was accomplished was not reform in her mind because it was not more of an extreme change. Either letting each department direct their own curricula or the College of Science direct all the departments curricula look to be end type situations.

William echoed Mary's view that actual reform needed to include more major change in the curriculum. William stated:

> "I guess to me it would have implied more wide ranging changes rather than tweak here, tweak here, tweak here. Because I think what we did is nothing radical."

For William reform required big change:

> "Big change, require every College of Science student to take physics. MIT does that. Every MIT student takes physics. That would have been reform."

William had a more specific idea of what real reform might look like. He related a reform at another institution in his content area department. For William real reform included changing the curriculum, or at least rearranging it, completely. William related:

> "Oregon State, for example, they changed their upper division courses, ah, by breaking down the barriers between the different topics. What they did is they said let's break down the barriers between the courses. We're going to do, we're going to do topics like waves. Waves in mechanics, waves in E&M (electricity and magnetism), waves in, in quantum mechanics. They called it the paradigms. And to do that, and we looked at this when we were considering changing our curriculum, it required a lot of buy-in from the faculty because different faculty would teach different parts of this course. It was a, it was, it wasn't just a change of topics it was sort of reshuffling the whole deck. That was a reform because it was, it was, radical. It's been very successful there. But to me that's a reform. You haven't simply introduced a set of requirements or a single new course. They took topics and integrated them in new ways. That's a reform."

William uses the word radical to illustrate how he might see real reform. For him it was a new way of looking at the curriculum. Instead of using specific content topics this change used specific themes and studied them across the different content topics. This was an example of real reform for William.

For the remaining study participants who said that this effort was not reform almost all mentioned the idea of big changes that would define real reform. Tom exemplified this idea when he said:

> "Reform I would have said, in my mind, when you reform something you sort of start over from scratch."

Again, this is similar to Mary's idea of real reform. Starting over and developing a new curriculum seemed to define what was meant by making big changes. Tom gave the following as an example of what he meant by starting over:

> "I would have deconstructed our current curriculum into components and evaluated each of those components. I can't, first of all going back to that standard that we wanted to get our curriculum to. But, um, I would have looked and said, I would have gotten away from, well calculus is five credits so it has to be five credits. I would have gotten to what is it we want to accomplish and is it possible to create a course that's calculus and chemistry together?"

He seemed to being saying something similar to William. Instead of looking at individual courses and fitting them together to represent some coherent whole consider what you want the end product to be and combine topics in a way that achieves those end products. His example of combining calculus and chemistry together is intriguing and might represent real reform.

Dan did not elucidate a vision of what a real reform would look like but he did comment on a process that might have led to a real reform. Dan stated:

> "Well reform is one of those terms that has multiple meanings. When I think of the term reform I think of something that's a pretty fundamental change. I don't think of something that's tinkering. I think of something that's more significant change that is very carefully thought out, um, alternative approaches are considered and debated and usually a consensus is developed of all the stakeholders involved. Um, and then careful thought is being put, should be put into how it's going to be implemented and then how it's going to be assessed, the success of the reform. How are we going to measure whether this is actually doing what we intended it to do or not."

Although Dan did not have a specific view of what reform might have looked like, he did not consider the current effort a reform, he did provide a process by which it could have been achieved.

Similar to an earlier section asking whether the current action on the College of Science's curriculum was a reform or not only three study participants offered an idea of what an actual reform might look like. One more study participant offered a process by which an actual reform might be achieved. The remaining participants declined to give a specific idea of what actual reform might be.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

Conclusions

In Fourth Generation Evaluation Guba and Lincoln (1989) named their method Responsive Constructivist Evaluation. It is constructivist because it describes the methodology used based in an inquiry paradigm. They also describe it as interpretive or hermeneutic. These paradigms are an alternative to a scientific paradigm. It is responsive because it seeks out different stakeholder's views and allows the stakeholders to respond to each other's views. Ultimately the goal of Fourth Generation Evaluation is to achieve consensus among all stakeholders. If that is not possible then the goal is to explain why consensus was not possible and to seek alternative ways to gain consensus.

Guba and Lincoln (1989) discuss how to report the results of a qualitative study like this one using a case study. Their endorsement is to tell a story. In order to succinctly tell this story and understand the positions of the College of Science Dean, College of Science faculty and College of Science administrators who were interviewed for this study need to be addressed individually.

How faculty viewed the undergraduate core curriculum prior. There were four exclusively faculty members in the study group; William, Josh, Dan, and Sam. The first research question asked, "What does the College of Science faculty think about the current science curriculum and, secondarily, what do they think about the "reform" of the undergraduate core curriculum?"

The four faculty members in this study ranked the curriculum prior as: William (4), Josh (4), Dan (5), and Sam (3) out of ten. This gives an average of 4.0, which is slightly less than the all participant average of 4.5. Table 5-1 summarizes the rankings of the undergraduate science pre and post new core, grouped by faculty and administrators.

Table 5-1: Rankings of the undergraduate science pre and post core by faculty and administrators

Participant Name	Pre New Core	Post New Core
Faculty		
William	4	4.2
Josh	4	7
Dan	5	7.5
Sam	3	3
Faculty Average	4	5.4
Administrators		
Mary	3	6.5
Tom	3.5	7.5
Joan	7	8
Betsy	6.5	6
Administrator Average	4	7
Overall Average	4.5	6.2

Obviously the four faculty members in this study did not think very highly of the undergraduate science core prior but understanding why they felt this way is a little more difficult. On one hand they all felt that each department was doing well in terms of content in that department. Sam seemed to summarize the faculty views of the core curriculum prior by saying:

> "It was fairly well recognized by faculty who had been active with the college that we had a curriculum that had flaws in it. You know it was the Chinese restaurant syndrome, choose two from column A and three from column B and people were never all that confident. So we had a general perception that our curriculum was too old."

This echoes the view that the core curriculum was unorganized and lacked coherency potentially because of its age. Sam also mentioned an issue that no one else did but it fell outside the curriculum:

> "In the college of science those students never bond. The chemistry majors did not feel that they were the same as the ones who were biology majors and neither of those groups thought they were the same as the physics majors. The division was not created, it was intrinsic from day one on campus. I am chemistry major, I'm not a science major."

According to Sam there never seemed to be a sense among science students of belonging to the College of Science. Was this a problem related to the curriculum or did it develop over a long period of time outside of the curriculum? Sam, nor any of the other faculty participants, never commented on this but if a curriculum lacks coherency within a college then it is certainly possible. This lack of coherency might be related to the Chinese restaurant syndrome Sam mentioned earlier in that students never understood what courses they were taking or why they were taking them.

William talked a lot about the need for a "great issues" course because he felt that students were coming out of their disciplines well-schooled but unaware of how the larger scientific issues fit into society and what challenges they presented. He saw this as a significant weakness in the core curriculum prior.

Josh saw a lack of communication skills, language and/or cultural knowledge, team work, and multidisciplinary skills as significant weaknesses in the core prior. He related that his views were informed by his own experiences when he worked in industry and from comments he had received from industry associates and alumni.

Dan related that he had not recognized any real deficiencies in the core curriculum prior but explained that was primarily due to that fact that he worked mostly with education majors. Echoing other views Dan thought his department was doing a good job of preparing students from a content point of view.

So, among the faculty participants the major weaknesses in the core curriculum prior was its disorganization and lack of coherency; a need for general education skills such as communication, language and culture, team work, and multidisciplinary experiences; a need for what might be defined as science and technology in society; and its old age.

This group agreed on how the task force was formed and that it was a Dean's directive. However, on the questions of national trends and other factors weighing on the need to review/reform the curriculum there was not a consensus among this group. There did not seem to be either a desire or an awareness of what national trends were saying about undergraduate science students nationally. Sam stated that no national trends were considered at all while William did not know whether national trends were considered but wasn't sure. Dan did mention attrition trends but only in the sense of the biology department at State University. Josh focused on the needs of the business community and what they and alumni were telling him about the problems in the curriculum.

What was missing from these faculty members views of the core curriculum prior was the students. There was no mention of how the students viewed the curriculum and what they thought might be wrong with it. This lack of student input is a recurring theme among most of the study participants.

How administrators viewed the undergraduate core curriculum prior. There were also four members in this group; Mary, Tom, Joan, and Betsy. Their ranking of the undergraduate science core prior was; 3, 3.5, 7, and 6.5, respectfully. This gives an average of 5.0 (out of 10) compared to an average of 4.0 for faculty and 4.5 for all participants. The administrator average is a full point higher than the faculty average. But that may be due to the fact that of the four administrators two are actually academic advisors and another was a former academic advisor. Not surprisingly the academic advisors including the former academic advisor were the most knowledgeable of students and made the most direct references to students.

An example of this trend was a comment Tom made concerning attrition:

> "Well it certainly was a consideration for me. I never did get the faculty really excited about retention issues. Um, their perspective is more if they can't cut it they don't deserve to be here."

Tom may be unique among administrators but his view that attrition, or retention, was not a top concern for faculty is reflected in the fact that none of the faculty really discussed attrition. A moderately positive way to state this may be that faculty is much more focused on their individual disciplines rather than the needs of students. Conversely, faculty simply do not know the very students they teach. This repeats an emerging theme that students were not considered as contributors to the curriculum.

Tom's position as a former academic advisor afforded him a nuanced view of students. His view of the weaknesses in the core curriculum prior were issues that faculty were largely unaware of. Tom was able to predict the future success of a student in a given course series by looking at how that student did at the beginning the series. Tom explains:

> "And we were, what we were finding was if you didn't get an A in the first course you weren't getting through the fourth course in four semesters. And, um, that was a surprise to the faculty. Because they thought, I mean I think they thought that all the A and B students go on and get an A or B in the next course."

Tom knew that this was information that faculty were unaware of and saw it as a major weakness in the curriculum, i.e., allowing a student to continue in a particular course series after a poor grade in the first course. This was a predictor of failure.

Another weakness that Tom identified, again from his position as an academic advisor, was how individual courses had grown over the years. Again, Tom:

> "The material in the first course was getting added onto year after year after year because we know about those disciplines. And, so, you know, this course up here, we want to add this course in here, which means this one, you know they just kept adding things in. And there was a significant additional amount of coursework in those early courses. And there hadn't been much compensation to deal with that. So our students weren't necessarily getting that much better to be able to deal with them."

So, over the years individual courses had grown to the point that student were struggling to keep up with the material. This was largely lost on the faculty who weren't paying much attention to how courses changed over the years.

Mary views of the core curriculum prior were very similar to the faculty in this study with one difference, how women were treated in the College of Science. Mary states:

> "And so young women just felt it was for majors but they got blown away because, first of all there were very few of them, and then it was all male, it was all male ideas, and all male way of dealing with subject matter."

Another difficulty with the curriculum prior was some of the typical things mentioned in previous studies like large lecture halls and non-English speaking faculty. These may not be problems in the curriculum but they were problems for students. Again, this reinforces the emerging theme that the experiences of students were not considered in either the old or new core curriculum.

This group of administrators mostly echoed the faculty participants about the weaknesses of the core curriculum prior. There was a need for better general education type skills including communication, language and culture, team work, and to a lesser degree multidisciplinary experiences. An important addition the administrators added was that faculty did not understand the experiences students were having in the College of Science. Specifically, that faculty were much more focused on their own research and not aware of how students were doing in course within and outside of their departments. In addition, the experiences of women students and the problems they faced were almost unrecognized by faculty.

How faculty view the new undergraduate core curriculum. The four faculty participants ranked the new core curriculum; William (4.2), Josh (7), Dan (7.5), and Sam (3). This gives an average of 5.4 compared to the average of 6.2 for all participants. Obviously an improvement over the ranking of the core curriculum prior. The primary focus of this group of faculty in ranking the new core curriculum was how well it addressed the four areas defined by communications, language and culture, teamwork, and multidisciplinary.

William remained consistent in his thinking concerning his ranking of the old core stating that he did not have an objective measure to rank the new core. However, he did think that the great issues course was important and thought maintaining it in the new core was an improvement.

Josh ranked the new core significantly higher than his old core ranking (7 vs. 4). However, he stated that in theory he could have given the new core a 9 but didn't because of his concerns that the College of Science would not be consistent in its implementation of the new core. Specifically he was concerned that because of the 120 credit hour limit imposed by the state that the College might reduce or eliminate some of the changes that he thought might make it a 9. In general, his positive ranking of the new core was due to the changes made in communications, language and culture, team work, and multidisciplinary experiences.

Dan related that he gave the new core a higher ranking because he liked the increased specificity or the new core curriculum.

Finally, Sam did not change his ranking between the old and new core saying that he didn't feel the new core achieved anything.

The faculty, as a group, ranked the new core higher than the old core primarily because of their perception that the new core adequately addressed the weaknesses in the old core of the need for better communications, language and culture, team work, and multidisciplinary experiences.

How administrators view the new undergraduate core curriculum. The four administrator participants ranked the new core; Mary (6.5), Tom (7.5), Joan (8), and Betsy (6), for an average of 7.0. This was the highest ranking of all the groups, pre and post core curriculum.

Mary focused her comments on the four curricular areas of communications, language and culture, team work, and multidisciplinary experiences. She initially felt that the new core had the potential to be an 8 but chose the 6.5 because of how it was implemented. This echoed Josh's feeling that the changes had not worked out as well as he first thought. The problems stem from how team work and multidiscipline were executed. As mentioned earlier no one was sure of how to teach these components or who would teach them. However, Mary was happy with the other components and felt they had improved the curriculum.

Tom felt that the new core was a great improvement. Again, he based his view on his perceived success of the four components that were added to the new core curriculum.

Joan and Betsy, as academic advisors, felt that the new core curriculum was a great improvement as well. Similar to the others they both felt that the added components made a great improvement. However, both Joan and Betsy had reservation about the new core curriculum. Joan did not feel that the multidisciplinary component was well defined and was confusing for the students. Betsy had a slightly different opinion that the entire new curriculum was too confusing for students but gave it a higher ranking because it seemed to address flaws in the old curriculum.

Overall, the administrator group ranked the new curriculum higher that the old curriculum and higher than the faculty group. Primarily they saw the new core curriculum as being simpler to students than the old core curriculum and that the added components really were an improvement. An important difference between the faculty group and the administrator group was the perception and inclusion of students. The faculty group was looking at the new core curriculum from their own individual perspective while the administrator group, who had more direct contact with students, was considering the direct effect it had on students.

What Was the Dean's Intention?

The last research question asks, "Was the dean's intention a "reform" or something else? Based on his reply, was it successful?" To succinctly answer the question of the Dean's intention Ralph stated:

> "Yes, a major reform or really just starting from scratch, a total redesign. It was much more than a tinkering. Tinkering is sort of the process that happened over the preceding forty years."

The Dean believed that this effort was a major reform. When asked how he would define reform Ralph said:

> "Yes, it's a, it's a new framework, a brand new framework that makes, it was significantly different from the old curriculum and, uh, I think moved the college forward in very significant ways."

This was all Ralph said about defining reform. Also based on this statement Ralph believed not only that this effort was reform but that it was also successful.

Was It Reform?

The word reform was not used in any of the defining documents or meetings held to discuss the review of the undergraduate science curriculum at State University. However, when considering that this review ultimately required change it naturally occurred that it might be considered reform. Part of this study was to determine whether this review was actually a reform but it became apparent that reform meant something different to each participant. So the first step in deciding whether this was a reform was to define what reform is in the most general way possible.

The first item that emerged when talking about reform was that it is a pejorative term. At first this was a surprise but then it became apparent that most participants had the perception that reform was a personal reflection. Mary summed up this point of view when she stated:

> "That you are telling them (faculty) they are wrong. You're going to make it better. When you deal with faculty who design something, change to what they've done is a bad thing."

And when asked if she felt faculty felt that way about reform she replied:

> "Yes, I do. Especially when you are dealing with faculty. Remember that."

The word reform and presumably the reformer are interpreted as negative words. This may be a reason that few people are willing to be involved in reform or known as reformers.

The most common replies of the study participants when asked about what reform was meant to them included: "big", "large scale", "big change", "wide ranging change", "starting over from scratch", "something huge", "moving mountains", and "fundamental change." Dan voiced a significant concern about reform stating that it should be inclusive and comprehensive. Inclusive means that ALL stakeholders should be identified and engaged. Comprehensive means that significant study should be made considering trends, national and local, and what is working and not working in the present, and hearing from all the stakeholders. And, importantly, consider the long-term consequences.

All of the study participants, except one, did not believe this effort was a reform. The exception was Ralph who unequivocally believed it was a "major reform." The word reform is not well defined in that its meaning is often interpreted according to the subject of the reform. Looking through the research literature two related issues occur over and over; the reform of the social system and public education reform. So reform is in the eyes of the beholder. Dictionary definitions of reform may be a good place to start. But even here there is a degree of divergence.

From the Oxford Dictionary:

"To make changes in (something, typically a social, political, or economic institution or practice) in order to improve it."

From the Merriam-Webster Dictionary:

1a. To put or change into an improved form or condition.
1b. To amend or improve by change of form or removal of faults or abuses.
2. To put an end to (an evil) by enforcing or introducing a better method or course of action.

From the Free Dictionary:

1. A change for the better; an improvement.
2. Correction of evils, abuses, or errors.
3. Action to improve social or economic conditions without radical or revolutionary change.

From Wikipedia:

"The improvement or amendment of what is wrong, corrupt, unsatisfactory, etc."

Interestingly, the pejorative nature of the word reform is evident from all of these definitions going as far to use the word evil. The idea of change is the next most mentioned concept and then improvement. So, according to the dictionary reform is the changing of some imperfection, wrong, or even evil that results in an improvement.

However, the definition of reform that came from comments of the study participants is somewhat different. This definition of reform is more specific and in ways more global. This definition of reform will be used to evaluate if the effort to revise the undergraduate science core curriculum was actually a reform.

Reform must contain at a minimum the following elements:

- All possible stakeholders must be identified and engaged.
- A comprehensive study must be made including an understanding of what is working and not working in the present. A significant consideration of trends, national and local, along with input from concerned outside parties must be sought.
- A set of carefully determined goals that significantly consider long-term goals.
- Changes implemented, representing the reform, must be significant and address all the concerns and issues in the deepest way possible.
- An assessment plan to evaluate the reform periodically must be in place.
- Input from all the stakeholders must be solicited after implementation.
- An awareness that there will be conflict and a willingness to engage but not yield to it.

The current revision of the undergraduate science core cannot be called a reform based on this definition for the following reasons:

- Too few stakeholders were engaged. Most importantly students were not identified or engaged.
- Industry/business concerns seemed to be the primary voices heard other than faculty themselves. Alumni represent industry because industry is their primary employer.
- National trends, such as the loss of students majoring in science, were not considered in light of the fact that science programs nationally are losing science students in significant numbers.

- The changes that were implemented were surficial. No content area was addressed or issues related to the climate within the College of Science. Climate can be defined as any issues within a college or department not directly related to the curriculum.
- There was no apparent assessment plan to evaluate the success of the curricular revision.
- There was no mention of long-term goals.

Recommendations

In assessing what recommendations to make a consideration of what specific issues the recommendations are meant to address must be understood. The Dean of the College of Science initially said that this was to be a “review of undergraduate education” and he went on to list three “issues” to focus on; 1) a reassessment of the goals of undergraduate education in the College of Science, 2) recruitment and retention of qualified undergraduate students with an emphasis on diverse students, and 3) development of strategies that address these two issues. Were these goals? There was no mention of goals at all, so what were the goals of this “review of undergraduate education?”

Interpreting the comments of the study participants and understanding the outcome(s) of the “review of undergraduate education” the goals seemed to be; 1) aligning the core curriculum with the needs of industry and 2) updating a 40 year old curriculum. If these were the goals then it was successful and recommendations are probably not needed. However, are there other criteria that this “review of undergraduate education” can be evaluated on and thus recommendations be made?

Yes, student attrition (or retention) must be addressed and can be with some basic but fundamental changes (reform?). Achieving this goal would require going back to the first step in the process and identifying and engaging all stakeholders and developing a set of goals. However, this also would require restarting the process over again and it seems unlikely given that this review was implemented in 2007 after a 40 year wait.

A set of recommendations must address what research says about student attrition from college science programs. Chapter 1 discusses some of the reasons why students switch from SME fields. Strenta et al. (1994) and Seymour and Hewitt (1997) discuss how many science faculty think attrition is a natural process based on the assumption that some students don't have the cognitive ability or a dedicated work ethic.

The "chilly climate" theory put forth by Hall and Sandler (1982) but reinforced by Seymour and Hewitt (1997) is used to explain how environments negatively affect students. The "chilly climate" theory suggests that institutional environments, or climates, both inside and outside were unfavorable to students. This included the classroom, laboratory, advising and informal exchanges with faculty. Students reported large classes, a high degree of competition, poor teaching and an unresponsive faculty as additional factors that established a "chilly climate." In addition, students reported feeling overwhelmed by the pace and load of curriculum demands, inadequate advising or help with academic problems, and morale undermined by competitive SME culture.

One other factor driving students away from majoring in science put forth by this researcher is the exclusionary nature of science. Students are actively engaged in science up to around ninth grade where they begin to encounter a culture that demands hard work via memorization and where the is focused on high grades. Students begin to realize that they are not welcomed in science if they are not perceived to be smart and do very well on low-level cognitive tests. This is the beginning of a winnowing process where at each subsequent grade level courses and institutional attitudes become more difficult and less welcoming, respectively. This process continues through high school and college.

Pedagogy. The suggested recommendations divide into two basic areas; pedagogy and climate. In terms of pedagogy teaching strategies and practices must engage students in a better way. Interestingly at State University there is a program designed for faculty to help them improve the delivery and performance of their courses called *Instruction Matters: Purdue Academic Course Transformation (IMPACT).* The mission statement of the IMPACT program is:

> Our mission is to improve student competency and confidence through redesign of foundational courses by using research findings on sound student-centered teaching and learning.

Begun in 2011 the IMPACT program seeks to help faculty teaching large foundational courses, not just in science, to change their courses to a more student centered model using recognized good teaching practices. Two of the guiding documents that IMPACT uses are the Seven Principles for Good Practice in Undergraduate Education (Chickering and Gamson, 1987) and The Guidelines on Learning that Inform Teaching Based on Ken Bain "What the Best College Teachers Do" developed by the faculty of the University of New South Wales (UNSW Australia).

Both documents describe many of the same practices concerning pedagogy, these ideas include:

- Actively engage students in the learning process.
- Encourage student-faculty contact.

- Encourage cooperation among students.
- Use activities that are interesting and challenging but also fun for students.
- Use student reflection about their experiences, challenging current beliefs, and developing new understandings.
- Recognize prior experience and knowledge.
- Relevance to everyday life.
- Encourage discussion between students and between faculty and students.
- Recognize the diversity of student experiences.
- Use multiple teaching strategies.
- Clearly articulate goals, expectations, and all course requirements.
- Encourage student responsibility for their own learning.
- Use cooperative learning (team work).
- Use a variety of assessment strategies.
- Provide meaningful and timely feedback.

The IMPACT program helps faculty redesign their courses to achieve many of the goals listed above. Faculty participants, called faculty fellows, receive mentoring, participate in faculty forums, and are provided support while designing their courses.

Ironically, the suggestions from both documents and adapted by the IMPACT program can be found in almost any secondary science methods course taught at universities including State University (Chiappetta and Koballa, 2010 and Bybee, Powell, and Trowbridge, 2008).

The pedagogical recommendations are:

1. Create an inclusive classroom by asking questions such as to whom are you planning to teach, what are you planning to teach, how are you planning to teach, how will diverse students be addressed, and how will you assess student learning.
2. Make some attempt at getting to know your students. In large classes this may be difficult but using teaching assistants effectively could help.
3. State and be clear and concise with your goals and expectations for earning a specific grade.
4. Use a variety of teaching strategies including; lecture, demonstration, activities, laboratories, group work, hands-on activities, discussion, effective questioning, reading and writing, and reflections.
5. Use different and multiple forms of assessment that reflect both the learning goals and all learning domains.
6. Make the science being taught relevant to everyday life.
7. Encourage discussion and team work.

Climate. In many ways climate is more difficult to address than pedagogy. Climate describes the attitudes and values expressed by the community of science, institutions, colleges, departments, and individuals. It also describes how a student interacts with all those entities. This is both a big picture and small picture issue. In terms of the big picture it is important to recognize that the community of science has been much more exclusionary than inclusionary at least over the past hundred years. Statements like science is only for men, that it is a sink or swim environment, that only smart people need apply, and many other exclusionary terms need to be stopped. But how are these practices reduced or eliminated? Like so many destructive attitudes in society these need to be discussed by the community and publicly censured.

But the problem is that destructive ingrained attitudes are very difficult to simply eliminate. This is about a belief system which is visceral and not based in rational thought. Often it takes generational change to even modify some of these beliefs. A beginning would be to initiate discussions at all levels about what is best for the field of science. Adapting the ideas related to scientific literacy in AAAS' Science for All Americans (1989) and Benchmarks for Science Literacy (1989) might be good places to start. The community of science must recognize that a scientifically literate society is the best way to engage more students into becoming future scientists.

On the smaller picture level colleges and departments can work to create environments that are more accepting of diverse students, diverse practices, and diverse thinking. Mentoring is one way to effectively connect students to faculty and science. Develop practices that are welcoming and engaging. Adopt a philosophy that says anyone who is willing to learn science is welcome and we will support that learning in any way we can.

While the IMPACT program does a lot to address the pedagogical concerns expressed earlier the climate issue is still an obstacle. Science must work to create a more welcoming environment for all students. And, science leadership must put forth the effort to recruit and retain a diverse faculty that challenges the stereotypical scientist as the white man in the white coat with the Einstein hair. (Howard, A. 2014). Building the Bionic Woman. Vol. 346, No. 6206, Science, p. 274). This is work for future study and understanding.

REFERENCES

REFERENCES

Alberts, B. (2012). Trivializing science education. *Science*, Vol. 335 (6066), pp. 263.

American Association for the Advancement of Science (1989). *Project 2061: science for all Americans.* Washington D. C.: A.A.A.S.

American Association for the Advancement of Science (1998). *Blueprints for reform*. Washington D. C.: A.A.A.S.

Amundsen, C., Abrami, P., McAlpine, L., Weston, C., Krbavac, M., Mundy, A., & Wilson, M. (2005). The what and why of faculty development in higher education: A synthesis of the literature. Paper presented at the American Educational Research Association 2005 (April) Annual Meeting, Faculty Teaching, Development and Evaluation SIG.

Arons, A. (1993). Uses of the past: Reflections on United States physics curriculum development 1955 to 1990. Interchange, Vol. 24(1), pp. 105-128.

Astin, A. W. (1985). Involvement: The cornerstone of excellence. Change, Vol. 17(4), pp. 34-39.

Astin, A. W., & Astin, H. S. (1993). *Undergraduate science education: The impact of different college environments on the educational pipeline in the sciences*. Los Angeles, CA: Higher Education Research Institute, UCLA.

Bybee, R. W. (1993). *Reforming science education: Social perspectives and personal reflections*. New York, NY: Teachers College Press.

Bybee, R. W., Powell, J. C., & Trowbridge, L. W. (2008). *Teaching secondary school science: Strategies for developing scientific literacy*. Upper Saddle River, NJ: Pearson Merrill Prentice Hall.

Chiappetta, E. L. & Koballa Jr., T. R. (2010). *Science instruction in the middle and secondary schools.* Boston, MA: Pearson.

CIRP, (2014). Retrieved from http://www.heri.ucla.edu/abtcirp.php.

Cook, T. D. & Campbell, D. T. (1979). *Quasi experimentation: Design and analysis issues for field settings*. Chicago, IL: Rand McNally.

Council of Graduate Schools and Educational Testing Service. (2012). Pathways Through Graduate School and Into Careers. Report from the Commission on Pathways Through Graduate School and Into Careers. Princeton, NJ: Educational Testing Service.

Cuban, L. (1990). Reforming again, again, and again. Educational Researcher, 19(1), pp. 3-13.

Dancy, M. H. & Henderson, C. (2008a). *Barriers and promises in STEM reform*. Washington D. C.: NRC.

Darling, D. (2014). Einstein and the photoelectric effect. Retrieved from http://www.daviddarling.info/encyclopedia/E/Einstein_and_photoelectric_effect.html.

DeBoer, G. (1991). *A history of ideas in science education: Implications for practice*. New York, NY: Teachers College Press.

Duschl, R. A. (1990). *Restructuring science education: The importance of theories and their development*. New York, NY: Teachers College Press.

Elkana, Y. (1970). Science, philosophy of science and science teaching. Educational Philosophy and Theory, Vol. 2(1), Hoboken, NJ: John Wiley and Sons, Inc.

Emerson, J. D., & Mosteller, F. (2000). Development programs for college faculty: Preparing for the twenty-first century. In R. M. Branch & M. A. Fitzgerald (Eds.), Educational media and technology yearbook 2000 (Vol. 25, pp. 26–42). Englewood, CO: Libraries Unlimited, Inc.

Glaser, B. G. & Strauss, A. L. (1967). *The discovery of grounded theory*, Chicago, IL: Aldine.

Green, K. C. (1989a). A profile of undergraduates in the sciences. The American Scientist, 78: pp. 475-480.

Green, K. C. (1989b). Keynote address: A profile of undergraduates in the sciences. In *An Exploration of Nature and Quality of Undergraduate Education in Science, Mathematics, and Engineering, A National Advisory Group, Sigma Xi, The Scientific Research Society.* Racine, WI: Report of the Wingspread Conference.

Guba, E. G. & Lincoln, Y. S. (1981). *Effective evaluation*. San Francisco: Jossey-Bass.

Guba, E. G. & Lincoln, Y. S. (1989). *Fourth generation evaluation*. Newbury Park, CA: Sage Publications, Inc.

Hall, R. M. & Sandler, B. (1982). The classroom climate: A chilly one for women? In *Project on the Status and Education of Women*. Washington, DC: Association of American Colleges.

Halyard, R. A. (1993). Introductory science courses: The SCST position statement. Journal of College Science Teaching, Vol. 23, pp. 29-31.

Henderson, C., Finkelstein, N., & Beach, A. (2010). Beyond dissemination in college science teaching: An introduction to four core change strategies. Journal of College Science Teaching, Vol. 39(5), 18–25.

Henderson, C., Beach, A., & Finkelstein, N. (2011). Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature. The Journal of Research in Science Teaching, Vol. 48(8), pp.952-984.

Heisenberg, W. (1930). The physical principles of quantum theory. Chicago, IL: The University of Chicago Press.

Hilton, T. L. & Lee, V. E. (1988). Student interest and persistence in science: Changes in the educational pipeline in the decade. Journal of Higher Education, Vol. 59: pp. 510-526.

Howard, A. (2014). Building the bionic woman. Science, Vol. 346(6206), pp. 274.

Kezar, A. J. (2001). Understanding and facilitating organizational change in the 21st century: Recent research and conceptualizations. *ASHE-ERIC Higher Education Report*, 28(4), 1–162.

Kuhn, T. S. (1996). *The structure of scientific revolutions*. Chicago, IL: The University of Chicago Press.

Levine, A. (1980). *Why innovation fails: The institutionalization and termination of innovation in higher education*. New York, NY: State University of New York Press.

Lincoln, Y. S. & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage Publications, Inc.

Lincoln, Y. S. & Guba, E. G. (1986a). But is it rigorous? Trustworthiness and authenticity in naturalistic evaluation. In D.D. Williams (Ed.), Naturalistic evaluation. San Francisco, CA:Jossey-Bass.

Matthews, M. R. (2004). Reappraising positivism and education: The arguments of Philipp Fran and Herbert Feigl. Science and Education Vol. 13: pp. 7-39.

McCormick, B. (2004). Science education reform and higher education. In D. W. Sunal, E. L. Wright, and J. B. Day (Eds.), *Reform in Undergraduate Science Teaching for the 21st Century* (pp. 17-32). Greenwich, CT: IAP Information Age Publishing.

McDermott, L. C. (1991). Millikan lecture 1990: What we teach and what is learned-Closing the gap. American Journal of Physics, Vol. 59 (301).

Mervis, J. (2011). Weed out courses hamper diversity. Science, Vol. 334 (6063), pp. 1333.

National Commission on Excellence in Education (1983). A nation at risk: The imperative for educational reform: A report to the Nation and the Secretary of Education, United States Department of Education. Washington D. C.: National Commission on Excellence in Education : Supt. of Docs., U.S. G.P.O. distributor.

National Education Association (1899). Report of committee on college entrance requirements. Ann Arbor, MI: University of Michigan Library.

National Education Association (1893). Report of the committee of ten on secondary school studies. Ann Arbor, MI: University of Michigan Library.

National Research Council (2011). *Promising practices in undergraduate science, technology, engineering, and mathematics education: Summary of two workshops*. Washington D. C.: National Academies Press.

National Research Council (1996). *National science education standards*. Washington D. C.: National Academies Press.

National Research Council (2002). *Evaluating and improving undergraduate teaching in science, technology, engineering, and mathematics*. Washington D. C.: National Academies Press.

National Science Board (1986). *Undergraduate science, mathematics, and engineering education.* Arlington, VA: U.S. Government Press.

National Science Foundation (1996). *Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering and Technology* (NSF 96-139). Arlington, VA: Author.

Obama, B. (2011). Remarks by the President at Cree, Inc., in Durham, North Carolina. Retrieved from http://www.whitehouse.gov/the-press-office/2011/06/13/remarks-president-cree-inc-durham-north-carolina.

PCAST, (2012). Report to the President: Engage to Excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics. Retrieved from http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_2-25-12.pdf.

Patton, M. Q. (2002). *Qualitative research & evaluation methods*. Thousand Oaks, CA: Sage Publications, Inc.

Reform [Def. 1]. (n.d.) In Merriam Webster Online, Retrieved November 17, 2014, from http://www.merriam-webster.com/dictionary/citation.

Rudolph, F. (1962). *The American college and university: A history*. New York, NY: A. Knopf.

Rudolph, F. (1977). *Curriculum: A history of the American undergraduate course of study since 1636*. San Francisco, CA: Jossey-Bass.

Seymour, E. & Hewitt, N. M. (1997). *Talking about leaving – Why undergraduates leave the sciences*. Boulder, CO: Westview Press.

Shamos, M. H. (1995). *The myth of scientific literacy*. New Brunswick, NJ: Rutgers University Press.

Sheppard, K. & Robbins, D. M. (2003). Physics was once first and was once for all. The Physics Teacher, Vol. 41 (420).

Stake, R. E. (1994). Case study: Composition and performance. *Bulletin of the Council for Research in Music Education*, No. 122, Qualitative Methodologies in Music Education Research Conference (Fall, 1994), pp. 31-44.

Strenta, A. C., Elliott, R., Adair, R., Matier, M., & Scott, J. (1994). Choosing and leaving science in highly selective institutions. Research in Higher Education, Vol. 35(5).

Sunal, D. W., Wright, E. L., & Day, J. B. (2004). Reform in undergraduate science teaching for the 21st century. In *Research in Science Education*. Greenwich, CT: IAP Information Age Publishing.

Tobias, S. (1992). *Revitalizing undergraduate science : Why some things work and most don't*. Tucson, AZ: Research Corp.

Travers, R. M. W. (1980). Letter to the editor, *Educational Researcher*, Vol. 10 (32).

Turner, S. & Sullenger, K. (1999). Kuhn in the classroom, Lakatos in the lab: Science educators confront the nature-of-science debate. Science, Technology and Human Values, Vol. 24 (1), pp. 5-30.

Williams, R. (1983). *Keywords: A vocabulary of culture and society*. New York, NY: Oxford University Press.

Wright, E. L. & Sunal, D. W. (2004). Reform in undergraduate science classrooms. In D. W. Sunal, E. L. Wright, and J. B. Day (Eds.), *Reform in Undergraduate Science Teaching for the 21st Century* (pp. 33-52). Greenwich, CT: IAP Information Age Publishing.

Young, T. (2014). Retrieved from http://en.wikipedia.org/wiki/Thomas_Young_(scientist).

APPENDIXES

Appendix A

Below are the annotated transcripts of the interviews of the study participants. Following the procedures of Guba and Lincoln (1989) the first step in analyzing the data (interviews) is to identify what they call incidents. Incidents can be almost any statement from the interviews that seem to address the concerns and/or issues of the study. After identifying a number of incidents they are grouped into categories. Categories are developed as the process continues and initially emerge as to what makes sense. Categories can be added, subtracted, or combined as the process continues according to what makes sense to the investigator.

In the interviews that follow the incidents are highlighted and there are inserted boxes to the left of the incident that indicates the category into which it is grouped. Inside each category box is a number indicating the page from the interview transcript it is taken from and the chronological order of the incident on that page. Below that number is the coding of the category that that incident is placed in. There were 44 initial categories and the coding for each category is listed in Table 4-4. By the end of the process the number categories were reduced to 14 by either by eliminating or combining categories. The categories with each incident are listed in Appendix B. The interview transcripts are listed in the order they were recoded.

Mary's Interview – January 18, 2013

DB Alright, um, it's January 18, 2013 in my first interview with Mary, um, let's get started.

M Perfect

DB OK, so my first question, um, what national trends in undergraduate science education were considered, ah, in developing the undergraduate science core?

M um, we thought about a number of things, um, one is that the trends is that science needed to be more rounded, so we wanted to make sure that we had things about global, international, general education that because as the disciplines, as more and more material, more and more findings are in the disciplines, faculty tend to just put that, keep putting things on, because they feel their discipline is so important, they need to have that taught, so what happens is these other things get moved out. And so we were very conscious of the fact that we didn't want that to happen. There were also a lot of national trends in terms of communication that we wanted to make sure that science students got those skills. Critical thinking skills and communication skills because they had been given short shrift in the other core, in the original core curriculum. Um, and third, the ability to work in groups, the benefit in terms of the thinking process, in terms of the ability to get along with each other, the ability to discuss ideas from different viewpoints is so critical for these science students whether they are going into industry or other professions like law or even into science or med school. This all contributes to them being good scientists, and those were the national trends we were looking at.

DB Um, one of the things that this, kind of a personal note in one of the times I talked to you, you gave me a book, Talking About Leaving, did you consider those kind of things in this process as well?

M We did.

DB So, um, women, was there a special consideration towards women?

M There always is a special consideration towards women because there aren't very many. And so as part of the new curriculum initiative there were secondary goals to that and that was to get the departments talking about their own curricula so that these issues came up. Um, the core curriculum are skills that all faculty or all science students need, um, we wanted to make sure that men and women alike could succeed in them, so that we tried to avoid gender bias. Where we think the issue is about the leaving is in the discipline. Is in the way, um, physiM is taught, where an A is 50%, those kinds of things if you read that why they are leaving, students are leaving because they get in these classes where all of the sudden they feel lost. Although the faculty member is going to curve the results, but if you get

50% you get that sort of oh my god this isn't for me. So, that kind of information, the message, that this isn't for me, particularly if you're a young woman or a person from an underrepresented group we wanted to be very careful that as we were moving through it that they were getting the message that this is for everybody.

DB That included underrepresented minorities as well.

M Right

DB The second question is kind of linked to that. What problems in undergraduate science courses did you observed that caused you consider making changes to the undergraduate science core curriculum?

M One of the, so, in the College of Science all of the faculty develop the core curriculum, so that's what's across all of the students. The departments then, the disciplines, create a curriculum for their particular discipline. And the idea is that the two come together and that's how you get a well educated, um, science student. So, we were concerned about the lack of these other skills, the critical thinking, the ability to work in a group, um, no computer science was in our original core. So, we had students graduating from science in 2009 and 2010 who could, who had never been required, so computer science, so we were looking at deficiencies that we thought all science students should know something, just like we said all students should have math, all students should have some kind of language, I'll get back to that. Students needed to be at least computer literate. So, we asked the computer science department to think about that and design a course, or whatever course, tweak whatever course they had, that would be suitable to all science majors and majors outside. In terms of our language requirement, we required language up to, I guess, two hundred and two or four semesters. That the goal of that requirement was to help students have some cultural appreciation outside of their own culture. Be in a straight language course for four semesters wasn't doing that. Um, that's, um, why we modified the language requirement and made it a language and culture requirement so students could meet it in a number of ways. We al, science students were also not taking advantage of study abroad and we felt that was an important opportunity for students. So, um, we incentivized that and if you took a year-long study abroad, that could serve as your language and culture. As long as you were embedded in another culture, you weren't with your American Purdue friends just hanging out in another country, but you were embedded. We scrutinized that very carefully. Often these students needed to take, go to an English speaking country but we wanted to make, that was OK, but Canada we sort of frowned on a little, it was too much like the good old U S of A. But England and Australia we looked and made sure they were getting a good dose of a culture. So those were sort of the deficiencies we were looking at. And as I said at the same time we were hoping the departments would again look at what they were doing and to see where they were struggling. M we urged, and we continue to urge, more and more about making it more accessible to women, more approachable to women. And we did it, at one point we were having some movement. There was a book published, I can't remember the name, it had Clubhouse in the title. And it was at, I think, Carnige Melon, where they made two entry level courses. Because when you look at the literature, you do all these surveys, typically, I'm generalizing, young women and young men come in to see us with very different M backgrounds. We had one entry level course. And so young women just felt it was for majors but they got blown away because, first of all there were very few of them, and then it was all male, it was all male ideas, and all male way of dealing with subject matter. And they weren't as expert because they hadn't been doing video games, they weren't doing all this other stuff. So this book, this study shows that if you make a class that is more accessible for those that aren't a nerdy, geeky M boys, and you offer that, you will have women and other students in there. But yet as they progress through the major they won't be behind. It gets them to where they need to be. And then there is a level playing field. And those programs that do that have women in them and women graduate, are retained, and graduate. So we were encouraging M. I haven't been watching them for several years now so I don't know what's happened. But that was beginning to happen. So that's one of those secondary goals of looking at the core curriculum is to get those kind of discussions going.

DB From the research I've done other points come up like large lecture hall classes and even some of the climate, if you will, within particular departments, did you talk about that or try to address those issues?

M We tried, we talk about that a lot. The difficulty is, um, in that for example the classes are huge. They, and maybe I shouldn't say this, but they have designed a class for majors which is smaller but is a disaster.

DB How and why?

M It typically is taught by a new faculty, often taught by a non-English speaking faculty, and the students are just like… Often higher level math faculty, higher level faculty in any field, don't understand where the students are. So these are majors, so they're good at math, they want to be mathematicians. They're being taught way up here, and they're just like, oh my god, what am I doing? So we have those kind of issues.

DB Um, I know that you were relatively high in the administrative chain, so what elements were considered when you were setting up the task force? Were you part of that?

M What do you mean? For example?

DB Did you ah, that's a good question, did you want representatives from each one of the schools, departments?

M Right, so in setting it up, this was, um, an initiative, we had a new Dean, and as he looked at the curriculum, the core curriculum, a lot of us had been sort of thinking about it, it wasn't right, it wasn't doing what it needed to do, it was behind the times, it wasn't, as new goals were being established for undergraduates, it wasn't helping the undergraduates move towards those goals And so as one of his key things, and by the way it has gotten him a couple of jobs as provost, um, his curriculum analysis and institution of a new one, um, it had, because the core curriculum is designed by all of the faculty and is required by all of the students it's very key to have stakeholders from all the departments. So on the task force we had membership from every department.

DB Did you require full professorships, were you interested in new professors, staff?

M We try not to hit new professors too hard because they are so burdened with other things. Um, if they are interested we never turn them away but if we never ask because focusing on tenure is such a big deal. This was a huge undertaking. We tried to select faculty, um, who were, um, interested in education. So this is a research 1 university so we have, we have faculty, I think it's great we have researchers, we don't have teaching and research faculty, we have the ideal model of research and teaching faculty together. But that said some faculty are still going to put all their, most of their, effort on their research and they'll teach but they don't really care about developing, they care about doing a good job in the classroom but they don't care about the extra, they'll teach the content mater but they don't care about curriculum or different kinds of things like that So we chose those faculty who we knew were interested in curriculum design, who had some knowledge of curriculum design, um, what's going on in the field. We also included several key staff members including the director of advising and one other person. At that time we had an assistant Dean who was a staff member, he was included. Um, I think the director of advising, an additional advisor, and the assistant Dean were the staff members.

DB Um, following up on that really. How did the task force come together? Ugh, did the central idea come from the Dean?

M Yes, it was a Dean directive. But he knew many of us were interested in moving in that direction, but it was his directive

DB So did he, how did that come forward then? Did he give this task to you?

M It was assigned to me, I was the Associate Dean for Education. He was actually the first Dean that, um, gave us portfolios. So, Harry hired, Harry Morrison, hired us, and, um, we were, um, I sort of represented the life sciences. So I handled everything that came, I was doing soup to nuts around life sciences. And Giordano was doing soup to nuts around physical sciences. And so when Jeff Vitter came he said "I not going to do it this way, I want you each to have a portfolio." So mine became all of undergraduate education at the University. So it was, it was assigned to me. But he was the one who said this was going to happen. He convened the department heads and said this was going to happen. The department heads offered suggestions as well as to who should be on it as well as the rest of us offered suggestions. And he gave the charge. He held the first meeting and he gave the charge to the committee.

DB Did that leave the structure of the task force up to you then? I mean putting it together and all that?

M Right, with input. I had to check with him. I mean I couldn't do anything that he would go "what the hell are you doing?" But, yeah, it was my job.

DB Of the department heads, when he first, um, brought up this idea, ugh, was there buy-in among them?

M Not all. Um, math…

DB Math didn't buy-in?

M Math didn't buy-in. Um, M was on the fence, I'm never sure that they bought-in. They were interested, but and this is a difficult, this is one of the difficulties, is they kept defining everything in terms of M and M students. It was very difficult to get several of the faculty to move out of their discipline. So when you are doing this you have to have your discipline, right, you have to know what your students are doing, but you also have to have the best interest of the college and of the group as a whole, because they are science students. And there were several departments that weren't going to go there. They were trying to take things they already had in place and, and, really sort of push and shove them into meeting a requirement. Many of them liked that we weren't doing a language requirement. Math did not. Math loves the language requirement. So there's a clause, if you look in the curriculum, in the curriculum that these are what's acceptable. But a department cannot add different things but they can restrict. So, at the beginning, I don't know how it is now, math said they would only take the four semesters of language as their language requirement. The other choices were study aboard or two semesters or three semesters of language and one semester of culture because the whole goal was to understand a new culture and if you just take the language, the way they were teaching it now. It could have been in the past, decades ago in 1967 the College of Science established this that they were teaching more culture in a regular language course but the way they teach it now they don't learn language to speak the language.

DB So was there a department, any departments, that were, had a strong buy-in?

M They all had buy-in, selective buy-in. I guess stat had a strong buy-in. That's another deficit is no student, we had a math requirement which was up through two semesters of calculus. But there was no stat course. So remember that the core curriculum was started before stat became a different department and also there was not, there was not an appreciation of the value of understanding statistiM. So just like we asked M, we asked the stat department, they're the experts, to come up with what should be in a stat course college wide. What are the principles of statistiM that would be important for all students. And they designed, and one of the courses they taught could work plus they designed another course. Um, so we added that.

DB Um, so you already alluded to this but let's follow up with it. What changes, did you have any changes in mind that you would have liked to have made before Dean Vitter came up with this charge?

M Right, we knew it wasn't working. Those of us who, so me as associate Dean for undergraduate education I was in a position where, I needed to think about it a lot. We were getting, our accreditation was coming up, so you start thinking about what you're teaching and why you're teaching and what you are actually doing. We were also talking to employers, so there were things coming from employers, coming from those people, so you know, as you well know, the College of Science, we have science educators. Those faculty would talk to me and say, you know, what about this or what about that. So there was a community that was interested in curriculum reform or curriculum enhancement, so, but we didn't have, it was a transition time, not that Harry wasn't interested but Harry was in transition and so he wasn't taking new things on. Whereas a new Dean, the timing was good with a new Dean.

DB So what were some of the things you wanted to change? Before the task force formed.

M Many of us wanted to, um, do more with groups, um, teamwork. Those kind of things were totally absent. A lot of us were concerned with the fact that as Purdue and as the country, the world was becoming more global, our students were not, they were taking a foreign language that wasn't making them global in any way. And a key thing that a number of use were talking about for a long time, is the students were being educated with a lot of depth and detail, but they had no appreciation of what we call it now, the great issues. Big issues in science. How'd it apply to them. Um, and so many people were thinking about designing such courses but there was no place to fit. Because our students are booked, booked to the gills, with coursework, required coursework. Except for math! Math does a great job. Math students can have double majors, they can take all these things, because math has a very nice, constrained set of required courses that allows them a lot of electives. The other disciplines do not. There's like, maybe, one or two like this. And, um, so the students were not appreciating global things and that's where the world was going. Students were not understanding the big issues. They need to understand those kind of things. Those are the kind of things we were thinking about. This allowed us to pull that together and then take care of some of the other things.

DB And again you've alluded to this too, but if we could just, ah, form it better. What changes did, were made? To the curriculum?

M OK, so, um, It changes very specifically. Um, great issues became a requirement! Um, a student had to take one great issues course, and its been great! We got, the EAS faculty have been fabulous. And so that whole set of classes. We've been able to incentivize study abroad. Until more students than ever are studying abroad. Um, students now have an appreciation of stat. Little bit, you know and M which they need, they're going to go forward. If you need to be just a normal citizen, if you are a non-scientist, you need to understand statistiM. Right? You know how to make decisions. I would have liked, we didn't get to this, now that I hang out with engineering a lot, um, and I teach an EPIM course, I don't teach them, I advise them. Um, I've learned so much of the design process which is, in my mind, an elaboration of the scientific method. Right? Um, but it's so front and center in engineering. Especially in these EPIM things. I think that, in fact when I worked on the core curriculum for the whole university, so I was on that committee to get it going and then it got turned over. Um, I was hoping that out of that every student at the university would have some kind of design. Because it's critical thinking, it's problem solving, it's all of those things, um, that we need to have. So, um, language had more choices. They now take a stat course and everybody now takes a M course, takes a great issues course. Um, we, in order to do that we had to, um, reduce our electives, our general education. I'm sad about that. Because we couldn't get, we had to make a promise to the disciplines that we wouldn't take any more credit hours than we already had. There were also fights, and we do these town halls. We make sure we wouldn't debate people, we just write what they had to say. Because, and they get up and talk about all this fluff we were adding. I mean it was just rough. There are points of views in M, in physiM that you just need to know those facts. And that if you look at how individuals have to live in the world that's simply, simply, simply not true.

DB Um, you've touched on some of this already too but what do you consider some of the successful attributes of the changes that were made?

M Um, I think, I'm pretty sure some of our student understand, um, what that's all about. Um, I think study abroad, a global perspective. I think adding stat and M allows them the physical points of critical thinking. I think that was very important. And for me teambuilding. Um, that has been modified and I don't like the way it has been modified. So there were two components. One was learning the principles. And the second was having an experience. Like a science student could be on a EPIM team and that's their experience. Um, from my point of view teaching the principles is a dialog, is a face to face. It's now an online thing. Like oh my god! Um, in order to prepare, I taught our first six-week module. And I used my colleagues in engineering help me. Because engineering, first-year engineering, they do a lot of teambuilding. So I learned from them about teambuilding and they helped me construct that, um. So I've had a lot of, things came up working with, I hadn't taught freshmen in decades. So I interacted with almost every freshmen in the College of Science. We did six-week modules. Um, and it was fun. It was physically hard for me, I do usually three in a day. Cause it's all very physical. You have them moving and doing and thinking and talking. Um, I think they got a lot out of it. Several of them actually came and told me. They also, we got them talking in class, in small groups, which is something that we struggle with for students. And that my area of research is neural basis of learning and memory, in part what we practice and preach is engaging with the material is one way of talking things through. And so if they just sit there in class and just make notes it's like hopeless but if you can get them to talk then the brain processes allow them to engage in the material. And it's a biochemical process, you build new proteins which allow ideas to go into long term memory, it's a very simplistic view, parts of it are true. So, um, that's what I think we moved forward. The other thing, then in retrospect I learned, right after we did that and got that, I learned a lot about politiM and I learned a lot about strategies. And it was, it was a faculty vote, one faculty, one vote. The entire faculty not just the task force. The task force had votes in between to see how we're going to put it all together and whether it all had to stand together or how we were going to have the whole college vote. We were going to have the vote on single things or all together. Those of us who wanted it all together prevailed. Because it was like all these pieces of a puzzle, you couldn't just pull something out. Um, so, that was good. Immediately following, probably at maybe the second year after it was implemented came the big accreditation. And so, I'm so glad we did the curriculum work because the accreditation is all about evaluation and assessment. And now we had some things that we could assess. Because we had been thinking in those terms. Faculty don't, regular discipline faculty, those who are not in education like science education. We don't think about assessment in those terms. OK, we'll put this material in it, OK what are your outcomes. So to get faculty to think about outcomes, which was all about the accreditation, that's how we started the curriculum work. We talked about what learning outcomes we wanted for the students in the College of Science. So we didn't throw out anything, we said what learning outcomes do we want. Now let's look at what we have them do and where are the gaps? First of all, is what we do, where does what we do fit into these outcomes and second where are the gaps? And that's how we finessed it into things like teambuilding and critical thinking.

DB Yeah, the current, the same things are coming up, but so to build on that, are you aware of any unsuccessful changes that were made?

M Um, it's been, the teamwork has been difficult. Partly because now they've taken away the hands-on first part of it. The second thing is that certain departments insisted on, they said, well lab is teamwork. It's not unless you do it appropriately. And so that's where, when you can't get faculty to do what you need to do and so there's a committee that supposed to approve some of these things and when they get fighting or it gets political, I'll approve this for you if you approve this for me. And they're approving courses that don't really meet the intent. So when you don't have people who are invested in it, um, then in those little things it can fall apart. Overall it at least got us discussing new things and it was good timing with the accreditation but I don't know what's happening now. I think after all that work, the goal is to keep things moving and keep thinking but I'm not that's happening.

DB Um, are there any changes that you wanted to make but that were not accepted?

M Right, design, critical thinking. I would really liked to have that in. Um, we put in, um, I don't know where we are now with um, we put in a communication course, we tried it first, because we had this constraint of not being able to add credit hours. Let's see, how did we do that? We did teambuilding, communication, there were three components that we did as six-week modules. When we first initiated it, I can't remember what the third one was. Um, but it turned out that we couldn't fit the communication into the six-weeks. It was just too short. Um, so then we pulled that out and made that a whole course. We were trying to do this so there would be modules. So they would get three components and still have it in three credit hours. But by having to pull this out, I think it's a two credit course. Um, so there were those kind of logistic things that didn't work.

DB Um, kind of a silly question but none the less, on a scale of one to five how would you rate the success of the College of Sciences' core prior to 2007?

M Before the new one?

DB Yes, one to five with one being completely unsuccessful and five exceeding your expectations.

M So, if we define it as reaching the outcomes that the College of Science faculty said they wanted I'd say three. Because when we asked them for the outcomes and compared it to what the core that was in place, the faculty were saying they want these outcomes but the core that was in place wasn't getting them there.

DB So the prior core? So the same question with the new core.

M So I think the new core had the potential of being an eight in terms of that but I think it's probably a six or a seven now simply because, um, of the way it played out. In terms of great issues I think it's a ten. I think there are different component parts that have really done it. I think one of the best things was the great issues. Um, I think that's doing exactly what we wanted it to do.

DB So, a six or seven?

M I'd say a seven, seven and a half.

DB And the prior question about the scales, I just want to get my scales right. So prior to 07 you are saying a three out of ten?

M Right. Simply it's based on, my metric is the outcomes that the faculty stated they wanted.

DB Um, alright, I alluded to this before we started the official interview but I'm using the word reform. And I realize that the word reform is not used in any of the documentation. You said that was on purpose.

M Yes

DB Why?

M Well we, since that core was developed by faculty and some of them are still there, you never want to get people against you from the beginning and tell them the impression that you think theirs' wasn't good. That's why we went to that. Well first we went to the outcomes because the whole nation is going, outcomes is a better way of doing things, right? And second we thought the faculty themselves, not just the task force, we got the whole faculty to vote on what the faculty thought the important outcomes were. So then we were engaging and you don't want to design something that people aren't engaged with but second it isn't what they want. This is a faculty governance situation. And the faculty are very bright and we wanted them to be participating in the outcomes. OK? Once we got the outcomes then we had more experts in implementation in terms of thinking about pedagogy, thinking about curriculum. We had those experts and others on the committee but all of the faculty had to weigh in on terms on what the outcomes should be. We couldn't cover all the outcomes, there were a whole lot of outcomes, but what we did was we ranked them in order of how often they came up. Then there was a falsehood that I had to go, especially in math, they were going to kill me, I had to go department by department and talk. This Dean was all about sending his people out to talk not him. He stood behind us. We took all the arrows, rotten eggs and everything. But the good thing was he was all about talking, right? So I was at this math faculty meeting because the outcomes, we had to list them one to ten but there was no priority. I kept saying that. One to ten, we had ten outcomes or how many we were going to work on. But there's no priority in one to ten. OK? These are ones that all had a lot of votes for it. OK? And so I had these couple of mathematicians who are talking to me about why is this priority? I kept saying these are not in priority. They kept arguing me. I said were you not at the meeting? And they finally said no. I said, well then you don't know. This is not, rearrange it, any way you want. I don't care. These are outcomes that are going to come out that the faculty want to come out. These are the most voted on. The ones that the faculty want most to come out as outcomes. You rearrange the order, I don't care. But it was that debate. He was accusing me of the prioritization. It's this way, when people want to oppose you of setting these straw people up. So they're going to argue about this, when it's like not what we did, and you weren't there.

DB Do you see the use of the word reform as kind of a pejorative term?

M Yes, I do. Especially when you dealing with faculty. Remember that.

DB Well how do you think they see that?

M That you are telling them they are wrong. You're going to make it better. And all we were saying is that we were going to modernize it. We were going to update it. That current students and employers, including graduate and medical schools, wanted different things. Needed different things.

DB OK. This is the last question. Um, and it plays off of that. So, oh, do you consider the changes that were made to the College of Science undergraduate core curriculum to be reform?

M Um, in some cases I think it's more saying this is what we were doing, this is like 40 years later, we hadn't changed it in 40 years. The world is different. Students are different. Employers are different. The graduate schools are different. Those, the medical schools are different. Those places, those institutions, those people who want our students have different expectations. We need to meet them. I see it more as an updating. In some cases, um, I see it as a reform in sense of less rigidity, more options. So that's where I see the reform. All most every outcome has several ways to meet the outcome. I see it as a reform as we are talking about outcomes not just a language requirement, a math requirement, what are you trying to get at with that? So that's where I see the reforming. But that doesn't, but when I say that faculty, oh they always mad, they always mad at me. Um, it's not pejorative toward them, it's saying that was then, we're here now, we're different.

DB So what I'm hearing you say is that you wouldn't really cal it reform.

M Right.

DB In some places maybe but not totally. So this gets down to the definition of the word reform. And I understand that everybody's gonna have their own definition and I've done a little bit of research on the word reform and the best I can come from it is that reform is another word for change.

M Right.

DB So it doesn't have that pejorative, I understand..

M When you deal with faculty who design something, change to what they've done is a bad thing.

DB OK

M So I like it now how the country is trying to go, I don't know if Purdue's going there, but this idea of the accreditors are not like, oh we are going to come every ten years and grill you, but continual assessment, I think that's the brain switch that we all need to assess what we do, and I can tell you, I run this big NSF thing, OMG, they make me assess every moment of every day. But I get it now. They're a little over the top. But I get it. It's the continual assessment and reassessment and reflective… it's part of the, if you go into engineering, or if you are with the EPIM team, ask the students to keep a notebook where they talk about what they do, it's a reflection section. And we use that the record their critical thinking. What did you do, what did you think, what is this, could you do it another way? That's what we always need, we can't be complacent. We can't say oh I do this wonderful course and blah, blah, blah. I'm just going to stop and that's it. Same thing with what's in common. The core curriculum is for all the students. What do our students really need? We need to be always thinking about that. As the world changes, as the disciplines change, as science changes we need to be ready to help those students. Um, we're educators right? We can't be educating a 100 years ago style. We need to be constantly changing.

DB So I want to go back to the word reform again, uh, for the last time. Is there anything that could have been done that you would've called reform?

M I guess if we through out, if we threw it out and that's one of the things that several of the departments wanted us to throw out.

DB Just throw out the curriculum?

M The core.

DB Just the core?

M Yes, just the core and let the departments run it.

DB Oh, that would have been reform.

M Yep. Or either way. If we took over everything that's… I guess I see reform as big changes, where I see what we did was, um, assessment and evaluation to meet the needs. I don't see that as reform. That doesn't mean I see that as a non-significant change. Some of these were very significant changes. But they're not, they weren't, I guess if we said you don't need math any more, as a scientist you don't need calculus, I would not have survived that. That would have been reform.

DB Well that's actually an interesting point. Um, so I said that was my last question but this is actually my last question. Not really so much of a question, who, in your opinion should I talk to? Jeff Vitter obviously I think.

M I would try to get a hold of Jeff Vitter. I have his contact info.

DB Anybody else?

M Um, the staff people. Let me go look at the list. You need to talk to someone unreasonable.

DB Who would that be?

M We got into some huge fights.

DB Math or M people?

M One of the funniest things of the whole thing, was several of my colleagues, we always asked at every step, we send it back to the faculty to get input, OK? And several faculty they didn't give input. And now we are getting ready to vote and all of a sudden all of these people are coming out of the woodwork with complaints, right? Like you had all these chances, they were trying to delay. We had a big faculty meeting where everybody could speak up and we took notes and we could make amendments and we put the amendments up for vote. I thought that was a good process. And that was Jeff Vitter's idea. And then, um, and they would say things well we didn't think this was, I said you had and I would list, they would send me an irate email. We asked you on this date, on this date via email, then we had a public presentation and we asked for input. Amendments were offered, there were votes. At no time were you there or were you participating. Why? Why should I listen to you now? They said they didn't think it would get this far. There's this weird attitude out there about, we were trying to make this participatory, I still think it's the best way to do things. But we had people not participating and then they realize, oh, something is coming down that I may not like but I haven't participated. But they also think that there's no, like, rules. Like they are so important they could put their ideas out there at the last minute. When people had spent a whole year discussing this. And that was like the last straw. No vote, we are not starting over.

William's Interview – January 28th, 2013

DB This is my interview with William It is July 28th, 2013,

W It's not July!

DB My god! January, boy I'm displaced. It's January 28th, it's my daughter's birthday, I would know that. W, 2013, interviewing him around my thesis question about the efficacy, actually not efficacy, um. The faculty and administrator perception of the outcomes of the so-called reform, I'm the only one calling it reform. OK, let's get started.

W So, first question, "what national trends were considered?" I don't think I can answer that question. I think I'm much more in tune with the national trends today. I don't recall what the trends were then. I think there was a, the entire motivation, from my perspective, to revise the core that it had been stagnant for forty or fifty years. I don't know we were necessarily led by trends and other programs. I'm sure were but I can't pinpoint what those trends were.

DB Were you aware of, um, attrition issues in the school of science at the time?

W Yes, and I don't know they're any different today. Honestly, the statistics could bear that out. But the college has always been under scrutiny for having people start in one major and then move into another major. Even leaving the college of science. Many, many examples. I don't know that changing the core changed that at all. But you've got statistics.

DB So your motivation for getting into this project was not really from a point of looking out and seeing national trends.

W Yes, seeing an overwhelming need, but I thought it was a very reasonable question to ask what could we do better? And I think we've done some things better as a result. How was the task force formed? Oh, I don't know, ha! I didn't form but I was asked to be part of it as were a huge number of other people. I do remember a series of meetings, one in particular was held at Jane's Deli. That's all I remember.

DB Was that one Jon Harbor hosted or MC'd?

W W, could've been. You see this is where things get real fuzzy because the coalesce workshops, Jon was involved in that too. And, so, it could've been. I remember David Elmore was there, there were a number of us.

DB Were you a participant or did you have any formal position within this task force?

W I'm trying to remember that I must've been on some subcommittee. But I can't swear.

DB So, um, let me back up to question one or two and ask you some questions. What were your, other than the curriculum being very old, did you see, through your own teaching experiences, did you see any particular things you thought need to be changed?

W Well, I had already, I had back in the late 90's had started a what now is a great issued course. Wh, as the result of a conversation I had with Harry Morrison. And I had the personal belief that there were a lot of important issues, W, that would affect our students either sooner, or certainly later, that there was no place in the curriculum to talk about those. And so Harry sort of challenged me to do something about that so I did. And I did that for I think three years. W, at first it was mostly the biology education students because they had a course they had to take and that course went away. So they were put into my course. And so what I learned from that experience, the bottom line is that, yeW this was, there a lot of things that were very fast moving that affect scientists, politicians, W, philosophers. And there was no real good venue at the university for talking about those.

DB Could you be more specific?

W There was a lot of discussion about bioengineering with crops, the genetic manipulation of crops. And all the ethical and other scientific concerns about that. Nuclear energy, there's lots of issues surrounding about that. So there were all these, hot topics that were evolving so quickly that, there were no textbooks. You had to rely on, you know, current material.

DB So your worry was that the current students at the time would not be what? Aware?

W Not be aware, not have a place at the university where they could explore the issues.

DB Ok, ok, specifically in the College of Science? Or outside?

W YeW, I mean initially it was College of Science students predominately but actually when it grew into the great issues course I always felt that this should be campus wide. It should not be, because you certainly get much broader opinions and points of view if you have people form agriculture and you're discussing, W, agricultural issues. Climate, I mean, geez, the topics go on forever.

DB Do you think they would be restricted, that's not a good word but, to science issues or could, you know there are a lot of other issues out there.

W Well, no matter what issue you talk about, in my opinion, it's not just about science. I mean it's political science, it's economics, oft-times intertwined with agriculture so it's, politics. I mean it's the whole ball of wax.

DB So, um, I'll go down to question number six, that's kind of where we're at. What changes did the College of Science make in the undergraduate core?

W They had a great issues requirement and as you know there are various flavors of great issues. My approach was to keep it very broad. And others, the courses are equally good, tended to take a single topic. Bill Zinsmeister focused on oil, you know it went deeper. What I tried to look at was the interconnectedness of the various issues. I think my own feeling it that it was a positive change. Be interesting to see, I don't know that the students necessarily understood the relevance at the time because students tend to be focused on a major. But maybe in five to ten years they'll look back and say oh, now I appreciate a little more of… I also think that in part that the course was career counseling because it tried to show students, I explicitly made this point whenever I could, that these problems are so complex that, that even though you might think it's a political problem there's a role for a chemist or a computer scientist. Many of these problems require teams of individuals with different skills in order to fully address them.

DB Did you feel that these courses or your interaction with them at least that career counseling was a needed thing?

W W, not that it was needed but I, my sense was, that the students didn't fully appreciate how they could take their discipline and use it in different settings. I have a very specific example. One year I invited the Midwest power authority, it's run out of Carmel, Indiana. I forget what it was called. And he gave a talk and explained how he manages power for this part of the country. I mean it's a very, the power grid is very complex, and prior to that I had each of the students tell me why they were taking this course. And some said because I was interested in it. Some said because I had to. Particularly the computer science majors said "look I'm here because I had to." But what they didn't appreciate was the power grid was a big IT problem. It is a real time information technology problem so after this guy talked a couple of the computer science students rushed up to talk to him. I don't know how long. They all of a sudden understood, er, er, this is something, something I'm being trained to do. So, that's what I meant by career counseling.

DB I get it!

W To this day I thought that was one of the better moments, W.

DB OK how about, are you aware of any other changes?

W So I think another change that was in my opinion, W, for the good, was the requirement of a statistics course. To me all of life is statistics, in fact I've just started reading Nate Silver's book

DB Oh, 938?

W He's the author of 938 but he's a great proponent of statistics and his book is very readable, it's a lot of fun. But people are generally ignorant of statistics and the way real systems work. And so it's also criminal that we didn't require, I should talk I don't think I was required to take a statistics course when I was in college. What I learned I learned from physics. Right?

DB It's highly statistical at some point.

W YeW, but the fact that biologists didn't have to take a statistics course, maybe they in their curriculum. OK, so now that's, everyone has to take one. I think that's good. Um, I personally had a prejudice against language requirements. W, only because I'm not good at languages and when I was a graduate student, W, I had, they, they relinquished the language requirement at MIT. And that was a great day in my opinion. So, and, now I have to temper that, I think it's great if a student wants to take foreign language. W, and I've taken foreign language. W, I took several years of French and I regret I can't speak Spanish. If I have the time maybe one day I'll do that. That's, so I was, you know, I was of two minds on that.

DB You didn't like making it a requirement? That it?

W YeW, in retrospect I think it's reasonable and now you can satisfy the language requirement with language and/or culture. So it's a little more flexible.

DB Study abroad?

W Right. And that would of, I think that would have better for me had I been the student. I didn't like my French teacher in high school so I took five years of Latin.

DB Oh, that's a handy language.

W (gaffaw) YeW, that's the problem. I would have had, handicapped me, although I…

DB In some places it has applications, a lot of English words come form Latin.

W Well anyway,

DB Any other changes?

W Let's see I'm trying to remember, the other changes, W, the lab requirements had been reduced, uh, I don't know that's necessarily bad. They've been a little too much. The original required four, now it's two. But then within a major, you know that's sort of a baseline. And there's also a computing requirement now. I think that's good. That had been I guess considered a lab requirement satisfying…

DB Wasn't that a requirement beforehand?

W No, I think beforehand a computing course was considered a lab course. You know there was some sleight of hand. But to me the biggest improvements have been statistics and great issues.

DB You know, I don't know if I skipped over this but if I remember right you said the changes you would have liked to make before the task force was the great issues. Is that the primary one?

W YeW, I saw that as a real, that was one.

DB You kind of touched on a lot of this already but just to reiterate, um, what are in your mind the successful attributes of these changes? Great society?

W Well, and it's just my perception, I don't, the students agree…

DB That's what this is about, your perceptions.

W I think expose, giving students the opportunity to explore an issue or issues in great depth that don't fit conveniently into, W, a core curriculum like physics or biology. Um, I think that's really good. W, the statistics, everybody should have a baseline knowledge of statistics.

DB Do you know anything about what you would consider the unsuccessful attributes of the core?

W I've, I have heard, uh, that the, the teaming component needs tweaking. I don't know whether it still needs tweaking but I, I, I understand that students didn't exactly appreciate that.

DB Let me give you a piece of information about that from a previous interview which I can do legally. Well, I, ethically, um, the, from a previous interview it was told to me that, originally that the interviewing, I'm sorry the teaming, had a instructor, professor leading a group of students…

W There was a theoretical component..

DB Led by a human being…

W Yes, uh huh…

DB That person really regretted that component, that they changers it from a live setting to a…

W On line…YeW, it's not clear how seriously people take the online stuff. And I don't know what it's like. If it's anything like the, W, FERPA training…

DB They give you the right answer…

W That's what I mean, and you know, what's the, we're just jumping through the hoop to jump through the hoop, uh, give me a break.

DB Anything else unsuccessful that you could think of?

W Not that I'm aware of.

DB OK, and that's what this is about, your perception. How about any changes that you would have liked to seen but didn't get made?

W I can't recall any that were proposed that didn't get implemented that I felt were really essential. No, I can't.

DB This next question, use a one to ten scale, I said one to five in the question, but use a one to ten scale, how would you rate the success of the core prior to '07 with one being unsuccessful and ten being great. Prior to the core…

W OK, so first, I have no objective measure, W, was it successful? You know, we produce some great students. Did we lose students because of something that was in the core or was not in the core? I have no idea. So, I, I say it was probably a four.

DB OK, that's good…

W And, and I don't know that new core is any different than the old core.

DB Well that's actually the next question…

W I know…

DB So, how would you rate the new core?

W W, I, I, again no objective measure, maybe a four point two… I think that, see, so what should be… Maybe I could ask what would be a valid measure of the success of the core and…

DB That's a good question…

W YeW…

DB Could you answer that?

W I'm going to try. So, for those students who want to go into graduate school, W, you certainly don't want to see a decrease in the success rate from those that graduate from the College of Science entering the graduate programs. Of course there are a lot of other things folded in. The other, the other, which may be easier to measure in some sense is how, how well prepared are students having graduated from the College of Science who want to immediately enter the work force? And there you can, you ought to be able to see, are we, are we producing the kind of students that employers want to hire? They look for teaming, they look for ability to present, speak, write. Certainly knowledge within a discipline. I would hope that an awareness of the great issues would actually be a help but…

DB Here's a question that popped up while you were talking. Um, do you see a bachelor's degree in science as a degree you can use or do you need a graduate degree?

W I've seen people, uh, I think you're better off with either a bachelor's or a PhD.

DB Not a Master's?

W Maybe not a master's, maybe, maybe not. But I've known students who graduated with a bachelor's degree and go into industry and they do fine.

DB They were able to find positions?

W YeW.

DB Within science or maybe they had to go outside of science?

W They were doing things that put their science to use. So I think that's still true.

DB OK. So, to this question about, you actually asked and answered, how do you know? How do you know if the old core was ineffective or the new core was more effective? Is it in your mind valid to use numbers? I mean things like a lower attrition rate or an increase in graduation rate, increasing GPA's?

W I think all of those things have other factors that confound the simple answer. So, Nate Silver will tell you, you know, it's not just a cause and effect. It can be quite complicated and how you tease that out is. I mean the whole, of course, underneath all this the K-12 system is undergoing huge change. So the level of preparation of students…

DB It is going…

W YeW, it's going and will continue. So, it's hard to know. But what I think we should be able to measure, we should be able to obtain an answer to the question from the standpoint of employers. Are our students coming out well prepared to join the workforce? Graduate school, you know that's a different question. There you are really looking for a definite discipline. And there the College of Science has always done well and I don't think we've weakened any with a discipline specific program. So, I would be surprised if there were any changes. Due to a change in the curriculum.

DB Um, really at this point I only have two questions left. So, my question is how do you define reform? In light of the College of Science's undergraduate core curriculum? Was it reform in your mind? What is reform?

W I'll have to be like Lance Armstrong and look up the definition… cheat.

DB Oh, yeW. Was it from your perspective…

W Was it a reform?

DB Let's get to that in a second. But from your perspective was it a conscious effort not to use the word or…

W I don't remember whether Jeff ever spoke to that issue or not. I don't know. My guess is that reform may have over promised. I mean, they, promised too much or implied too big a change. W, I'd have to look up the…

DB To you. What does reform mean to you? Without a formal definition.

W I guess to me it would have implied more wide ranging changes rather than tweak here, tweak here, tweak here. Because I think what we did is nothing radical.

DB OK. By radical you mean big change?

W Big change, require every College of Science student to take physics. MIT does that. Every MIT student takes physics. That would have been reform.

DB Just one course? What if you did that, every science student had to take at least one course in every science discipline?

W I think that would have been a bit more radical. YeW.

DB Would it have achieved anything?

W Well, we almost, we don't require it but you certainly get a pretty good sampling, I mean you do get a pretty good sampling now I believe, W,…

DB Do physics majors have to take a bio course?

W Well they have to take a lab course outside, they don't have to but they could…But it's not required. Or chemistry…

DB And they're in chemistry already anyways…

W So that would have been a bit more radical.

DB OK, OK… Um, so the last formal question, at least. Um, so I'm going back to this word reform. Do you consider it to be a reform, however you define reform?

W No, I don't think so. I don't think so. I don't think so.

DB Do you think it required a reform?

W No, I think, W, I, I think it required some freshening. So we, we, have undertaken refreshing our own undergraduate curriculum in physics. I don't know we reformed it but I know of examples where its been reformed. Oregon State, for example, they changed their upper division courses, W, by breaking down the barriers between the different topics. So in the junior year here you'll take an advanced, W, typically an advanced electricity and magnetism course and an advanced, W, E&M course, a mechanics course. What they did is they said let's break down the barriers between the courses. We're going to do, we're going to do topics like waves. Waves in mechanics, waves in E&M, waves in, in quantum mechanics. They called it the paradigms. And to do that, and we looked at this when we were considering changing our curriculum, it required a lot of buy-in from the faculty because different faculty would teach different parts of this course. It was a, it was, it wasn't just a change of topics it was sort of reshuffling the whole deck. That was a reform because it was, it was, radical. It's been very successful there.

DB How do they know that? I mean how did they measure that?

W OK, they've studied it and I,…

DB So your opinion is that it's been successful.

W YeW, and it's been written about W, pretty extensively. But to me that's a reform. You haven't simply introduced a set of requirements or a single new course. They took topics and integrated them in new ways. That's a reform.

DB OK, so you're actually addressing the very last question which is, um, so you answered no to the reform question. OK, so if you answered no, what changes might have been made that would have been a reform in your mind? So what you were talking about at Oregon State?

W YeW, yeW, so you could imagine an undergraduate curriculum or some part of it that is much more integrated across disciplines. Cause really what we've done is we've, you know, still parsed it into these separate categories and, I guess one of the things that attracted me to the great issues courses was that you could break down barriers. And you could mix students with different points of view and with different technical backgrounds. But for the most part, you know we got this statistics requirement, we've got the lab requirement, we've got, you know, eh, eh, it's hardly radical.

DB So what you're saying is that it has…

W And then there's this multidisciplinary component which nobody knows, I mean that's the one thing, that's kind of where we gave up because we said this sounds good let's require it. Who the hell knows what it means.

DB But it's being done.

W I guess, I, I don't know how it's being done. I don't know what students are doing to meet it. W, I do know. Physics majors will take an astronomy course, whoa! That's not what I, I think we came up short on that one.

DB What would be a more interdisciplinary, in your mind, for physics majors?

W Well see, I, I, I wouldn't have it for physics majors. I'd have it for science majors and have something that was more integrated.

DB Across all the sciences?

W YeW.

DB How about engineering?

W Why not?

DB That's interdisciplinary.

W YeW.

DB OK, alright, um, is there anything you want to add that I don't have here about the core or your involvement?

W No, I, I, I, would love to know if it's been successful from the students point of view. But I don't know how to answer that.

DB How would they answer that? How would you get that? Survey?

W I don't know, I don't know. How's a student supposed to answer that?

DB Particularly if they didn't have experience…

W I know…

DB Well you could get at it, I'm guessing, through a survey of some kind about how do you feel about the current curriculum.

W YeW, it might be interesting to query graduates who've been out three to four or five years to reflect back on their undergraduate curriculum. Not just necessarily to target the core but, what do they consider to be the strengths or weaknesses of their undergraduate education at Purdue. And then see what comes out of that. I mean, they would say it was broad enough or wasn't broad enough or who knows.

DB I bet if you asked bachelor degrees, W, who went into industry or business, W, as opposed to graduate students who went on to get maybe their doctorate, that that question would have a different answers.

W Undoubtedly, and even so that would be interesting to hear. We serve both of those groups.

DB OK, so literally this is my last question, this is kind of helping me moving forward. Can you recommend anybody I should talk to that involved in the task force? Particularly somebody with a different opinion from yours, a different view?

W I don't know, I can't guarantee they'd be different, W, you might try Hasam Nakaneshee. He's our undergraduate, W, he's our associate head for undergraduate…

DB Was he on the task force?

W I don't know that he was but, but he would probably have some thoughts. I don't know where he stands on the issue.

DB Who else?

W Gosh…

DB Was there anybody who stood out, particularly against any changes in your mind?

W W, math faculty (chuckles), take your pick.

DB That was brought up in the last interview I had.

W Well, they had a lot of concerns. Um, someone else, she's off campus, uh but Suzanne Hanbrush, Suzanne, she's at the NSF still till August. She's on the faculty in computer science and, uh, I think she would be a good one. I don't remember if she had any particular role but Suzanne would be a good one to talk to.

DB Computer science came up in my previous interview, um, in a number of ways along with math.

W Oh, I know who you should talk to. Buster

DB Oh, yeW…

W YeW, had you, so Buster's teaching a great issues course. So Buster, Buster would be, I'm sure he was knee deep in that stuff. Talk to Buster. And let's see, have you talked to anybody from biology?

DB No, I will be, but do you have, no, I take that back, I have talked to Chris SWley. Of course she was the associate dean. She actually was the person under Vitter who was forming the task force.

W Right, I'm trying to think of, you might talk to Bill Kramer. Bill's got good opinions…

DB Was he part of the task force?

W You see, I don't remember, I just don't remember who…

DB A large number of people.

W YeW, and I can't remember the specifics, all the task forces run together. Let's see, chemistry, W, probably Gabriella Weaver would be an interesting player.

DB And I'm talking to Jon Harbor.

W Who'd we leave out, statistics, Mary Ellen Brock. And if not Mary Ellen it would be, W, I see his name now, Bruce Craig.

DB Yes, I took a stat course from him.

Josh's Interview – Feb 27th, 2013

DB Today is, ah, February 27th, 2013, this is my thesis interview with Josh, um, so we'll just get started. So the first question, I think you did get the questions, First question is; Um, what national trends in undergraduate science, in undergraduate science education were considered in developing the new undergraduate College of Science core?

J So, so the core came about in part because of the national trends to look at more holistically at the sorts of skills and knowledge and experiences that students needed. So what are the crosscutting experiences, capabilities, knowledge that are important for our students? Above and beyond expertise in the particular major that they were doing. So, there some attempt to look across at other universities, the national literature, um, to identify those things that were important for all our students in addition to their content expertise.

DB Could you remember what some of those trends are?

J It's been a while but things that I was particularly involved in and interested in were teamwork, um, the rise in importance in interdisciplinary work, um, variously described, um, communications, so the ability of students to not just write, writing is important, but also the ability to give presentations. So all communication. And then, you know, there was a lot of debate going on, as there is still today, about, um, the issue of a foreign language versus generally more global competency issues. So those are the ones that come to mind.

DB In addition, um, I would, um, let me get to the second question actually. Which is, let's go to that. What problems in undergraduate science courses did you observe that caused you to consider making changes to the College of Science core?

J So, the problems that I observed, and of course my observations, my direct observations were limited to obviously to courses either that I was involved in or courses that I saw as part of peer evaluation. Um, and so what I saw missing from, from this departments courses was, was a function of the way our courses are taught. So faculty design courses and teach them and although you'd like to believe that there is a lot of coordination and we are looking at these sort of crosscutting things, the reality is that most faculty design the course based on what they want to do and maybe what they experienced as a student and what they think is important. So what was falling through the cracks really in our system was the attention to these crosscutting capabilities and experiences that many faculty would say "yeah that's a good thing for a student to know how to communicate orally, I'm sure they get that somewhere but it not in my class." Or "I would ask them to communicate orally and be shocked at how badly they did it, why weren't they trained to do this?" So it was, it was, really I think in this department a product of the fact that there hadn't been a lot of discussion about these types of experiences and capabilities and when everyone individually puts together a course these things are left out. It's not done in a comprehensive way. So in terms of those particular things what I identified is, um, in terms of the foreign language thing, um, you know you have students who know their 473 words in Spanish or whatever they learned in two years of Spanish but actually didn't know anything about foreign cultures and were not prepared to interact with people in that global environment. Um, students don't write well, um, they don't have a lot of preparation and practice in giving presentations, and many of them hadn't thought carefully about or had much experience in interacting either in teams or in teams that involve people who had expertises was very different from theirs. Part of my personal baggage that I bring to this is that, um, I used to work in a company and as someone who used to recruit undergraduate students to work in a company. Um, you know I've interviewed a lot of students and these are the same things I identified in those. That they were often very good at their discipline but couldn't do anything useful because they didn't know how to work in teams, didn't work with people with other expertise, and their writing skills were pretty poor. So all of these things in my mind started to come together.

DB And that's what supported the trends you were looking. Did you at any point have conversations with EAS faculty about these issues?

J Um, the way it worked in the college is that there were, there were a couple of opened meetings and so all faculty were invited from all departments, from all departments were invited to discuss this and, um, that was part of the way that the Dean was trying to do business at the time. Um, that's the way strategic planning worked, how our decisions about. Coalesce these interdisciplinary areas we put a lot of new positions into. And so the mode of operation that was going on at that time was one that would very much have some ideas and some working groups initially put things together but then open it up to the entire faculty, invite everyone to come along and have a discussion and have a voting process to decide what we were to do. Um, I can't recall specific discussions you know at a faculty meeting or you know in some organized way within the department, um, around those things. There were discussions in the hallway and those types of things and there were sort of working groups. I can't recall a department wide discussion.

DB Were there conversations at that level, at the task force level I mean, about, uh, things like, if you are familiar with "Talking About Leaving", if you are familiar with that book, the large number of science major students who are leaving the discipline after their freshman or sophomore year nationally or locally?

J Yes, there was certainly discussion, and that continues even today, about the retention problems with science. And so there was a lot of concern about why are those students making those decisions, would they have been successful if they had stayed in, and if they would have been then why did they leave? Um, were we doing everything we possibly could to provide them with an environment in which they could discover the joys of science and how they could have a wonderful career in that area? Um, to prevent them from leaving if that wasn't the right decision for them. I remember discussions about well maybe it is the right decision for them, maybe they've discovered a passion in vet medicine or communications. By taking, doing the sort of breadth that we, sort part of our liberal education, students are taking course across all areas, sometimes they discover a passion that's not in our college, we expect some students to leave. Um, I do remember a discussion about we're losing the students who could be successful and this sort of odd discussion about, you know, they shouldn't leave. Just because they could be successful doesn't mean it's actually the right choice for them. Um, so there was concern about how do we do things to improve our retention of students?

DB Do you see, the points that you made a little earlier, about teamwork and communication as addressing some of that?

J Um, not really. The long pause indicates that I have to think about that one. Um, as I think about the decisions we made in terms of what we put in place for this sort of science core, the one thing that maybe does address that is the great issues requirement. Not the other ones. Um, so when you think about, you know, teamwork, communication, you know it's possible that you could say that there were some students who were looking for that sort of team experience and, and, and if they perceived that science was all about individuals working individually that that wasn't a good fit for them therefore they left and they didn't realize that in fact most of us work in interdisciplinary teams. So one could make that argument, I don't remember that discussion happening though. That really wasn't the thinking.

DB OK, so the point wasn't really to address, as you said, retention per se, it was to, if I can, to make the science experience broader.

J To make the science experience one that equipped our graduates for their future careers in ways that some of us, but not all of us, thought were important.

DB But not specifically for retention.

J No.

DB OK. Um, so, my next question is what elements were considered in setting up the task force? Were you involved at that level?

J Yeah, I've been sort of trying to dig through my memory banks, so, so at that stage I was involved, um, in, in college administration. So as an Associate Dean, um, and someone who sort of knew the players in the college and someone who, because of my role in teaching, the fact I've won teaching awards, I was often asked my opinion about things. Yeah I was involved in that level and in selecting task force members, however each department was asked to nominate people for the task force. So it wasn't, um, it wasn't handpicked. I mean there was a task force that I belonged to that if I handpicked the members it would have been way easier, um, challenge. And so the departments did, the department heads picked individuals, each had their own process, I don't know how they did that, and this department you pretty much know who, the department knows people who had particular interests or strengths and sticks them on. I was involved in the multidisciplinary task force and that was one where, um, I guess from my perspective there were a couple of departments who chose people for that task force who didn't believe in the importance of multidisciplinary. And that made, I think, for a very rich discussion. I may have been frustrated at the time but it's actually good to have a full range of opinions in the task force rather than everyone signing the same tune. So they were diverse task force, the ones I was involved in.

DB So I, um, maybe this question should come before that one, just broadly how was the task force formed?

J So the task force was formed, so the departments were asked to nominate individuals on the task force and then, you know that's pretty how it happened.

DB Who was making most of the decisions? To form the task force I mean.

J Ah, that's a Dean level decision.

DB Dean Vitter?

J Yes, Dean Vitter in discussion with obviously the Associate Deans. He was largely driving this sort of the vision for how the process would work. Um, he had a style for doing things that was one very much of driving things, but driving a process rather than saying you had to have this outcome. But his decisions about the process sort of encouraged certain things to happen.

DB To throw a word on that would it be egalitarian? I mean was he completely open to the process? Everybody have an equal input?

J Well he wanted all, he wanted all the departments represented. So he wanted to make sure all of the key voices were heard. Um, and his way of doing that was to ask each department to put someone on a committee. Um, that, that is egalitarian in a certain sense but it can lead to rather strange committees. Um, it doesn't guarantee that a committee will be diverse for example.

DB And those choices were being made by department heads?

J Yes. And those are tend to be made in a vacuum so as department head, which is what I am now, I said OK I need someone from multidisciplinary, OK Harbor sounds like the right person. I don't think well what would the makeup of the whole committee look like, you know, will it have the range of perspectives, will it bring junior faculty, senior faculty, men, women, majority, you know. And so, so there wasn't an attempt, if I remember it, to make sure those committees were balanced in that way. Whoever the department head sent that is what happened.

DB So are you saying there was a lack of diversity of different types on the task force?

J I would say the answer to that is yes. Because what tends to happen in, in some of our departments because of the fact that the departments, not all of them, many of them are overrepresented in males, especially at the more senior levels who tend not to choose struggling assistant professors to stick in. So even though we've been hiring in a more diverse way if you look at the mid and later career people, especially at that stage, um, many of them were more traditional, have more traditional views. So those opinions tended to be overrepresented on the task force.

DB OK, that makes sense. Um, I think you have alluded to this question already but, um, what changes did you want to make in the curriculum before the task force formed? So you already answered that in a sense, from your experiences as a business person.

J Yeah. In terms of my personal agendas, you know, I had, I had seen a need in the workplace for some of these types of capabilities. Um, I had personal experience trying to improve writing skills in intro courses that was, um, you know, naïve and, but, but I brought that to the table. Um, I do a lot of stuff internationally so I had some personal views about the importance of being able to, to sort of act in a global situation in ways that didn't necessarily mean you had to speak the language. So I, I you know, like everyone, bring personal experiences to this discussion so I, I personally felt strongly about all of the things that were being pushed.

DB Um, so, this is kind of a follow up to that question, um, and I kinda know the answers to some of this but anyway. What changes did the College of Science make to the undergraduate core?

J So, I think we made some fairly substantial changes. Um, so we changes the requirement. There were new requirements then there were before. Um, we changed what students have to do to meet what you would call the foreign language requirement. And that was one of the ones that took up a lot of debate in the open meetings. Uh, there were a number of people who felt it was wrong to give students options other than taking language courses. So now there were a number of different ways of satisfying that sort of global competencies requirement. So that's a change. Um, we implemented a requirement in teamwork that had two pieces. So an initial training program to understand how do teams work, the theory behind it, the practice and philosophy behind it. And then to take a course on an experience that included teamwork. So that was a change that hadn't been explicitly included before. Um, we included a change in the communications requirements that, um, involved presentations so that's a change. Uh, we introduced the multidisciplinary requirement, um, that's been pretty controversial but that courses had to get approved or experiences had to get approved to meet that requirement. So students had to, had to do that and that was, we'll get the, sort of, after the changes were made how did they actually happen versus what you thought was going to happen. Um, what else did we change? We implemented the great issues requirement, so that was a new type of course. Now people were already teaching some courses that met that requirement that suddenly in this department hundreds of students were coming into courses that wouldn't have come into those course hadn't we changed those requirements. So we fundamentally altered part of what undergraduate students in science did. We didn't change what the, you know, core content, department controlled major stuff. That was up to the departments to do. There were some departments started thinking how can we fold some of these crosscutting requirements into course that our students are already taking to meet our content requirements. So, smart departments are always looking for a win, win, win and so, you know, would implement courses that met maybe with their content goals at the same time the student is knocking off these other requirements.

DB You mention something that is kind of interesting, there was some controversy around the multidisciplinary, what was, what was the nature of the controversy?

J Well so there was a, there are parts of the college where certainly advanced work in that field is not typically done, um, with, and I'm going to put multidiscipline and teamwork together because I was involved in both of those and there were similar controversies about it, um, so, and I'll pick math as an example because this was one of the departments that pushed hard against these things. So the vision of a mathematics researcher that we all sort of vaguely, the misconception we have in our minds but probably not too far, is the individual sitting in a room with a pencil, you know, doing proofs. And that's not how math is done. That encapsulates the push that came from that department, say what's this teamwork thing, we don't need teamwork, this multidisciplinary won't produce the best mathematician, we don't want to, they don't need to spend their time learning how to do stuff with other people. So there was some purists who would say, you know, this sounds fine but it isn't required by all science students because they're mathematicians and mathematicians don't need that piece. And so there was push back from some subsets of the College about multidisciplinary. Do our students really need, you know. And if you ask a senior faculty member and some will say all I ever did was that. We need students who are the best possible people in discipline X why do we want to sort of fritter away their time with the other things like work with people from other departments or working in teams?

DB OK, so was there a resolution to that?

J They lost (laughs). Again, this was something that it came down to a large open meeting and voting about these things so they were, the dominant feeling from the faculty who bothered to turn up and express opinions about these things was in fact it was important to have multidisciplinary experiences and to do teamwork. So there were minority opinions voiced very strongly because this is a college requirement if you were just one subunit of a department you're not going to win that.

DB Right, so, ah, these changes went into effect in the fall 2007, um, so it's 2013 now, five six years later, uh, have you an opinion on the success of any of these initiatives?

J So the college, so once they were approved there was implementation. And you know the devil is in the details. Some of the implementation wasn't a quite as some people expected. There was also an effort at that time to start collecting data. So, um, under the, ah, associate dean for undergraduate education there was an attempt to try and monitor, what are the changes and how is this happening. And under the current associate dean for undergraduate education there's an attempt to complete that process and look back on what has been achieved, what went well, what didn't go so well. And, so, um, there're been attempts to more objectively do that and then we all have our own, you know, subjective opinions based on what we've been involved in personally in this. Um, the, the teamwork, um, requirement had some challenges associated with it. Didn't have many people who were actually trained to do anything with that. Our faculty are wonderful people but most of us aren't trained in many of these areas. We, we may think they are important and we may sort of know something about but we don't, uh, know that from training. So we have to come up with some ways to train students in teamwork and so that was done with a, you know, small groups, staff, and there was an online process and so, you know, how well that worked, I think the juries out on that. Um, but that, over time, that's sort of how we do that. Um, there were concerns about the multidisciplinary work. People really doing multidisciplinary work, or was it just, you know, window dressing around a course that really wasn't multidisciplinary. So, um, I think, you know, I look at the experiences students having in the great issues course. And clearly some things are happening in those courses that wouldn't happen otherwise. Um, in terms of communication skills and writing skills students are getting more practice. That whether there is a measurable difference that's, that's, I'm not involved in the data collection part of that.

DB I'm going to have to look into that. Um, however, another person I interviewed earlier in this process spoke to the teamwork thing specifically. Evidently, as you said, the initial teamwork component was done kind of with a small group but know evidently it's being done online.

J The training part and then you have to take a course to implement it.

DB The previous respondent really talked about how she didn't feel that the goal of teamwork was being met in the training.

J Yeah. I don't think, so I would agree that on its own the training doesn't give students experience in teamwork. And so absolutely I think it would be better it was done in an environment where they are not only learning about the theory of teamwork but they're also immediately implementing it. They're learning in a team. So that would be my stronger, logistically it just turned out to be a nightmare for the college to do that. Um, we didn't have a whole bunch of faculty who, you know, were happy and had spare time on their hands to teach it. So you end up hiring people to do it and, you know, that's one of the tricks of implementation. How do you do this without spending huge amounts of money. Um, and so, the online solution was one that's, that's low cost replicable. Um, if that's the only thing we did it would be completely ridiculous. Wouldn't meet the intent at all. But that's meant to be coupled with students then taking a course where they implement what they've learned.

DB OK, so of the initiatives, um, I think you've hit on this already, which ones do you consider successful and which ones would you consider unsuccessful?

J Well I would say the multi, I would say that the great issues course, um, that, that was a, that's an interesting component of this. Um, but I think the great issues courses are ones I wouldn't, because their departments are heavily involved in them, I would describe those as success. I know what's taught in them, I've actually sat it on parts of those courses. I see the interactions going on, the way people are bringing different disciplines. That is a successful part of it. Um, I think some of the multidisciplinary courses have been very good and they do what they're intended to do. Others not. Um, so in anything like this it's not uniformly successful or not successful but more or less successful. Um, teamwork, you know, I don't have a lot of experience with how successful that's been. In terms of the communications and, and those changes, I don't have a lot of experience with that. In terms of the global competencies, um, I like the change that's happened but I don't have objective evidence to say students are much more competent than they were before.

DB So in that area students don't have to any longer take a foreign language.

J That's correct.

DB They can take some other cultural application…

J Study abroad…

DB Study abroad, right. So, um, how do you feel about the issue about, um, the language issue? Do you think it's important that an undergraduate student have a foreign language?

J Personally I don't think that's important. I think it's important, I think it should be a choice. I would love to see students who are language oriented and want to learn a foreign language, use that to meet the requirement, if that's the choice they want to make. Um, but, but, I'm personally in favor also of students finding other ways to meet that requirement. I, and again that's sort of driven by my own personal involvement. I do a lot of international, I just got back from India, I do work in China. I do a lot of work in international teams. Personally I'm, I'm not a languages person, I am very poor at learning languages but I develop very strong skills in understanding varieties of poor English and helping teams of people who speak many different Englishes actually understand each other and work together. Personally having a skill set that isn't a foreign language but is a good ability to help an international team work together through a common language which is mostly going to be English. I, I think that's actually a very valuable attribute. If I was teaching in a different country I actually might have a different opinion about this because I would say it's actually very important for everyone to learn English because that's the international language of communication. I think in a country where English is the normal language of most of our students I think we're in a different situation.

DB That makes sense. Um, were there any changes that you wanted personally see in the undergraduate curriculum that didn't get considered or didn't get made?

J Um, you know I thought about that and I really can't think of any. Um, you know, were the, the ones we did make did they go far enough, have all the right components, you know, that's more open to question. Um, but no, I was personally a flag bearer for the interdisciplinary thing and the teamwork. And those are ones that I thought might actually go down in flames. Um, they did get implemented. So there was nothing that I was personally really thought was important that we didn't hit.

DB OK

J It was nice.

DB Yeah. Um, so this is kind of a, you know, a number question. On a scale of one to ten how would you rate the success of the core prior to the changes, the old core in other words?

J Oh, um, I guess I would rate it at you know I mean, this is the obvious answer, it's going to be a four and the afterward a seven or eight…

DB That's the next question. So you would give a four to the prior and a seven to the new?

J Yeah.

DB Alright. Um,

J A nine in theory, a seven in practice.

DB OK. Um, So I haven't used a specific word up to this point and I'm going to use it now. In, I've read most of the documentation that I could get my hands on about the task force and there's a word that was never used and that's the word reform. OK? So do you consider this to be a reform? And if you do how would you define reform?

J Um, it's, you're right it isn't a word that's used in it because you have to remember the players here. You know, most of us are well meaning scientists who are not trained in education, who are not trained in organizational management. You know we're sort of, um, well meaning somewhat bumbling fools that are trying to do things we think are important often we don't know the words used to describe the things we are doing. Um, this was an effort at reform. We were changing what was going on in the light of a better understanding of the changing needs of our students. And to me that sounds like a piece of reform. Reform I see has sounds like we did something wrong before. Ah, reform school or something. Um, and so the reason it's not used is probably simply because that community didn't intuitively know, it wasn't a good enough word to choose because no one really quite knew what it meant. Um, that people would have suspicions that it would have baggage associated with it or maybe it's one of those education words. Um, so, so I guess I hadn't noticed that it hadn't been included but may in retrospect it doesn't necessarily surprise me. Because every community uses the words that seem to make sense. I mean, but one of the funny aspects of the multidisciplinary requirement. I was actively involved in that task force and I didn't like that word. I didn't want it called multidisciplinary.

DB What would you have preferred it called?

J Transdisciplinary. And that went nowhere, absolutely nowhere. I would have been happy to make do with interdisciplinary but even that, um, was not well accepted by the larger community because of concerns about what it might mean. People were happy with the idea of multidisciplinary because they thought they could get away with saying OK if I could just put two disciplines in the same course that's multidisciplinary. But I don't have to try and do stuff that we use them together because that would be interdisciplinary and no one knew what transdisciplinary meant. Even though it was the right word for what we were trying to do. So semantics within a community is actually rather important so, the word reform didn't come in because it wasn't a word most of us were used to using.

DB Well, uh, a prior respondent to this, uh, interview, uh, I asked the same question and um. She replied that she felt that, uh, she knew the word reform had not been used and said on purpose. She said that her feeling was that it was a pejorative word. And I think you hit on this. Uh, she said that it, the use of the word sort of intimates that you were doing something wrong or bad. And so we're going to change that to something good. Would you agree with that?

J I would agree with that too and, you know, certainly in the discussions that, um, you know, we have an alumni advisory board and one of the ways you do change management in an organization like this is to help the faculty understand that in addition to their own knowledge about what's important to succeed as a graduate student, you know, there are external constituencies. So having the external advisory board who are mainly business and industry people talking about the skills that are needed and emphasizing the need for communication skills and teamwork and interdisciplinary, all these sorts of things. You know, it was pitched as improving what we're doing and matching changing needs of the workplace rather than we've been doing it wrong for ten years we better change it So…

DB So looking forward you said the current curriculum is about a seven. What changes would you envision going forward that would improve it to a nine or a ten?

J Well there were some potential changes coming up that might actually make it less than a seven. Um, so as you know we have a new foundational core requirement coming in. And at the same time we have the state, um, mandate/encouragement to reduce to a 130 credits, in cases where a 120 credits where we're more than 120. And so these different pressures coming in and so if the college has a requirement that also meets the foundational core than that's a no brainer and you keep doing that and everyone's happy. But if the college has a requirement that doesn't meet the foundational core, which means our students are taking more credits and we can no longer, and we're also having to try to squish down to 120 then at some stage something will have to be jettisoned. And one of the discussion items at the moment within the college is, um, great issues. If great issues don't qualify as science, technology in society then our students will have to take science and technology in society and a great issues course. Well how do you, so that's, how do you do that and still get it into 120. So there were discussions going on about what of our college requirements met the foundational core requirements? And the things that don't map do we really need them or can we afford them? Which is probably a better way of phrasing it. Ah, great issues is the one that surprised us all but the reason it doesn't fit the foundational core is not because it isn't science, technology in society, it fits that description beautifully, but it's too high a level. And the foundational core courses are meant to be things that first and second year students can get into. The great issues courses were purposefully designed to be courses that after you've taken several years of your major you know something about computer science, biology or whatever it is. And you bring that perspective to the discussions at the great issues. It's meant to be more of a capstone experience where the foundational core is meant to be sort of a beginning experience for students. So it's not the either of them is wrong, you can't count one for the other means that there's sort of an additional burden on our students.

DB So the idea to get rid of the great issues…

J The idea is to force the committee that approves the foundational core allow that to count for our students. But if that doesn't work then there's discussion about what, better get rid of it.

DB So your future view potentially is that instead of maybe increasing in terms of effectiveness, the curriculum, it may decrease.

J It may decrease in terms of what we've been trying to do in the college. Now if a student is taking a science and technology in society course as a freshman or sophomore, you know, are they actually getting a lot of the outcome and experience associated with what we're trying to do in the great issues course. It's not that we're going to lose what we were trying to achieve we'll have different things, probably not as effective.

DB Um, actually I think you've answered all my questions, I have one last question. And that is, I'm still developing, um, an interview list. And I need somebody, I need a recommendation if you can of a name that might have an opposing view. That maybe didn't like the idea of changing the curriculum. Or something along those lines. This is completely anonymous by the way. So can you recommend anybody?

J Um, Leonard Lipschitz, former head of the math department.

DB Is he still here?

J Yes. Leonard, I have enormous respect for Leonard. Um, he has some strong views, he's not afraid of voicing them. Um, as head of the math department, you know, when we would have our meeting of department heads, deans and stuff, you know, you knew Leonard would always say something that would always be a challenge. He forced you to think and defend stuff. He wasn't trying to be obstructive most of the time, he wanted things very clear and argued and reasonable, because it sounded good doesn't mean it was the right decision. Tell me exactly, so, so. So Leonard I think would be an interesting person to interview about this and, you know he was a department head in math in this process so, as I've mentioned a couple of times, you know, the distribution of viewpoints was such that often the mathematicians were at one of the extreme compared to the others.

DB That's an interesting conversation probably better another time but the perception of math as a science sometimes gets challenged so that kind of, but does everybody have to be in the same group? I would think not.

J It is interesting when you look across our college I mean we have math, we have statistics, we have computer science, um, so there is , ah, ah, and the actuarial science program within that. So we have things that, that are very different from what often people think of as the core sciences, the chemistry, physics, biology, and so it does make for quite a diverse community so that's why some of the arguments were pretty heated about what fits all of our students. And do you need to be successful as a mathematician doing this. My personal opinion is that the math faculty weren't thinking about what all of their students need to do, they were thinking about the subset who were going to become graduate students like them.

DB So very narrow

J Yeah. It turns out that the vast majority of their students actually don't want to be math majors to be a mathematician, they are in the math ed program. So they have a very different sense of what their mission is compared to the career driven trajectory that our faculty have followed.

Tom's Interview – March 19, 2013

DB This is my interview with Tom, it is March 19, 2013. Um, it's about 2:30 in the afternoon, so we'll begin. Alright Alan, what national trends in undergraduate science education were considered in developing the, uh, undergraduate college of science core?

T Um, well there were a couple of things as I recall. Uh, one was, what was, the feedback we were getting from alumni about our graduates, so it wasn't so much, it was education but it was sort of the applied education. What were they able to do and what weren't they able to do. And, um, was there something we could do about it. That was one aspect of it. And I guess, the alums were seeing it from the standpoint of the undergraduates they were hiring, and also their own experience when they got out into the workplace. The other thing I think we looked at was just sort all those polls and rankings and everything that compared US students with students from other countries. And, um, and I guess maybe a third component was, they hadn't looked at undergraduate education in over 40 years. In 40 years you probably should look at undergraduate education. So those were probably the national components that were out there I know we did spend a lot of time looking at, I mean we did some benchmarking against what other peer institutions were doing but they weren't doing a lot different from what we were doing.

DB How about issues related to retention? Was that a consideration?

T Well it certainly was a consideration for me. I never did get the faculty really excited about retention issues. Um, their perspective is more if they can't cut it they don't deserve to be here. Uh, my concern was, um, I tried, I was doing a lot with data on our students. And so I was looking a lot at, yeah, we had a lot of students that shouldn't have been admitted to science. And I understood that and so I tried to focus on, I don't remember what the percentage was, just say the top half of our class. And we were still losing a significant percentage of those students, we were losing a larger percentage of those below the top half. I mean not top half 50 percentile of their high school graduating class, but top half of our class. Um, so we were still losing a significant number of those students, uh, we were losing more students in the low, lower section, but we were still losing a lot in the upper section. And, again, I was fully ready to accept that we should be losing some of them. They didn't really understand from their high school science experience what being a scientist really meant. And we had some work to do to help them understand that. But we were losing too many in that category from my standpoint. And, so that was my motivation for kind of keep pushing at things, ah, because there were a lot of political issues we were dealing with throughout the whole process. Um, I dealt with a number of, personally just because here I am a non faculty member, a non PhD person, and I had a significant role in at least the early stages of that. So I was very careful to not put my opinions in but rather to organize and present and highlight when I could to shape the direction.

DB It sounds to me, if I could play off what you said that you were playing some role of a student advocate?

T Yes, definitely. Yeah, I felt like, you know, I made sure that we had students that were part of our, not only in our focus groups but in our, at least a token representation in the task force that was considering the curriculum proposals.

DB I think it's ethical for me to, um, to bring without names, bring in comments from other respondents thus far. Uh, I know that from the research I've done on qualitative research. So, um, you are the first person I've talked to that recognized the retention issue. Everyone else I've talked to, when I ask that question, they just said nothing. Their concerns were kind of what you said earlier about the quality of the student that was being turned out. But in my research for this project what I found in terms of national numbers was, the retention issued was the big one. Big national issue. So I was a little surprised at that.

T We have, we have a number of folks, probably still are a number of folks, who somewhat have their head in the sand about that. And, they're used, they get rewarded, they're used to dealing with PhD students. And all but the very best of our undergraduate students are not going to be PhD students. So there's a whole different mindset about a PhD student versus an undergraduate. And the results you want out of those kind of people. And that was the biggest challenge throughout was to get them to think about undergraduates and not just the science student.

DB A number of national researchers in this area have also commented on that fact that that undergraduate group that aren't going to go on to be PhD's, that's where the science teachers come from as well. And, so, ostensibly go on to teach future science students and potentially PhD students. So, it's kind of an iterative loop. And I think not paying attention to that is not wise.

T I think one of the political tricks, I guess, I would say, I don't know if it was effective or not but instead of saying don't even think about the PhD students, I said think about the PhD students. And you know you only want this percentage of the graduating class to end up being a PhD. So we have to think about them as undergraduates, what preparation are we going to give them so they can be the better PhD students. So, I mean I also pointed out, I mean I had my pie charts out that showed what percent of our students that went on to graduate school, went to medical school and all those kind of things. As a part of it to show, well and the medical students were, they actually got some earplay from the faculty as well. The fact that they were going on to a professional program. That carried some weight with them. The ones going out to work didn't carry much weight. There we had to use the alumni feedback to kind of shape the thinking there a little bit.

DB Um, I think we already talked about this but I'll just ask it anyways. What problems in undergraduate science courses did you observe that caused you to consider to make these changes in the College of Science's curriculum?

T What I started looking at were the sequential courses myself. So, most of our students were taking a, well they were taking all, at least a three, most of them a four course sequence in calculus and math. And, so when I was pointing out were how many students, I did my grouping into how many got an A or B, students who got a C and students who got a D or F. And showed, of each of those categories, what they did in the next course. Basically I was predicting what students would do in the next course. And we were, what we were finding was if you didn't get an A in the first course you weren't getting through the fourth course in four semesters. And, um, that was a surprise to the faculty. Because they thought, I mean I think they thought that all the A and B students go on and get an A or B in the next course, they're going to be in the next course, but they didn't think about the shrinking population because the way the grading scale was working in those courses. So I did that in calculus, I did it in chemistry, which should be just a two course sequence. Physics didn't carry that much weight because there weren't that many students taking two semesters of physics. But then I started crossing disciplines a little bit, you know, they got this in math, this in chemistry, what did they get next, in organic chemistry or whatever. And, so, what I was finding was that the, that the grading scale in those courses was really weeding them out even though they didn't think it was. It was weeding the students out. More than they wanted them to be weeded out. Because they were only thinking about the course they were teaching not a whole set of courses. So that's what I observed in courses that caused me to wanna, the other thing, not so much in the calculus, but more so in the chemistry and the biology, somewhat in physics, and definitely in computer science, the, the material in the first course was getting added onto year after year after year because we know about those disciplines. And, so, you know, this course up here, we want to add this course in here, which means this one, you know they just kept adding things in. So it, we didn't do a really good, strong study but, we did, at least I looked a little bit at the syllabus from the course ten years ago versus now. And there was a significant additional amount of coursework in those early courses. And there hadn't been much compensation to deal with that. So our students weren't necessarily getting that much better to be able to deal with them.

DB Right. So, um, you know playing off that idea, I mean, were there ideas of changing curriculums? Probably would be difficult to do.

T And one of the things we jumped Tay from pretty quickly was telling the computer science faculty what the curriculum should be for computer science students. That's why we went with the core idea rather than sort of a more comprehensive, we were hoping the departments would pick up an item. I doubt they have.

DB Um, I don't know how much you were in on this but um, what elements were considered in setting up the task force?

T Um, actually I was in quite a bit of those discussions early on. We, we wanted, we wanted as broad a representation from the faculty as we could get. We asked the departments heads to select, we wanted the undergraduate committee chairs from each department on the committee. And then we asked that the other faculty members, and I don't remember, even now I think it's like three from each department, if I remember right. We wanted, um, we wanted faculty members that would be open to undergraduate education ideas. Whether they had much practice in that themselves or not didn't seem to be as important. And we were looking for, I'm trying to remember, we had a few assistant professors but we wanted tenured professors as much as we could get it because we knew they weren't going to be rewarded for this work.

DB So, this was Jeff Vitter's idea or not?

T Yeah, (long pause), I believe it came out of discussions that we had in staff meetings. I'm not sure it originated with Jeff but Jeff certainly championed it.

DB But he had to, he was the dean.

T Right. And, um, Jeff did everything, he pushed it hard and fast.

DB OK, I wouldn't know that but thank you. Um, so, in those initial days, uh, when this was coming to fruition, and set up the task force, uh, you were involved in that process kind of from the get go then.

T Pretty much, yeah. Because pretty early on I, looking back on it now I think it was a mistake, life has turned out fine but uh, Jeff pushed for me to be an assistant dean and I challenged him on that, I mean it was a great honor, but I challenged him on that knowing the culture in the College of Science. And, uh, I didn't have a doctorate. And I certainly, I didn't have faculty rank. Both those were issues. Both of those were definitely issues. So I, in some ways I probable didn't embrace that as fully as Jeff wanted me to. Again, it was sort of what got me in trouble. Um, but I think, I don't think I could have pushed any harder, Jeff got in trouble for as hard as he was pushing on things.

DB Alright, that's OK, um, so, uh, again we've kind of touched on this, how was the task force formed? Jeff says to you and other people I want to form a task force. What happened?

T And I as I recall, this is going to be speculation because I don't have notes to go back and look at. As I recall, um, we talked about it in the dean's staff meeting, we translated that over to the department heads meeting which happened regularly and, uh, it was sort of, I think the selling point that got everybody on board was we haven't looked at this in 40 years. So I think that was the selling point, well I mean it's worth looking at we haven't in 40 years. And, um, and then so basically each department head was to select their representatives to the task force. Ah we had me and the head of advising…

DB You were not head of advising at the time?

T No, cause I was moved to assistant dean.

DB Who was head of advising?

T Well it was Beth Burnett for some of that and then Carry Daley. Um, and then we, um, I also was working with the science student council so we used student council representatives. We had, I think, two from there. And then we had a couple of people from the community that were alums. That, um, they didn't attend a lot, you know we tried to keep them informed of what was going on. So, so we had a fairly broad representation. I was thinking we had somebody from outside of science but I can't think of who that was right now. We certainly talked about it whether we…

DB Might have been from engineering or…

T Yeah, or education, but I don't, I can't tell you right now who that might have been. Thinking about who's on the committee so. They certainly didn't have a big voice.

DB Yeah, right. If you weren't faculty you probably didn't have a voice except maybe for you.

T Well I didn't have, the voice I had was an administrative voice, try to keep things moving. I, I, I, again, I'm sure I shaped some of the discussion by how I presented things but I really took the role on of what are your ideas, let me organize them.

DB OK, that makes sense. So, um, again, um, I, you probably didn't get to voice some of this but did you have any changes that you had in mind that you would like to see made before the task force was formed? Probably from your role as an advisor. What changes would you have liked to see?

T I, I would have liked, I wanted to see, um, two things that I can think of. One was an introduction to a science way of thinking early on. There was an assumption that students had it and they didn't. So to do something to help them think about things more scientifically. And then the second was to have, to have more experience with what they were doing. And not just, not just lab work, um, we ended up putting a fair amount of experiential things into the curriculum. And they're still there but. Um, where we recognized internships and research and study abroad kind of things as part of the undergraduate experience to broaden their thinking rather than just getting so focused on calculations or experimentation. But what impact is this going to have in the world that I live in.

DB So would that have been extra course work? That would have been a problem, right?

T It, it, more course work would have been a problem. I guess even more so now from what I understand, they're wanting even less hours in the undergraduate program. Um, what, what we tried to do was to put some experiences in that were not semester long experiences. To, um, so maybe you would get, I don't remember exactly how we ended up playing it out. For instance, the study abroad, we had to have so many experiences as part of your education. Volunteer time and some other things that went into all those kind of things. But you had to present documentation of that probably with paper. There was part of it but it was sort of a check off you know that you did it. But, um, but it emphasized to the students that there was more than just the book learning that needed to be done here. And so it got, tried to get them to think about that early on in the whole program. And to, you know if the student had an internship in their discipline to give them some credit in some way for that. So it, in a sense credit without adding to their credit hours. It was, it was an experiential requirement. And we also tried to take into account, we had a number of international students, um, it was going to be more difficult for them to get internships and those kinds of things. So what could we do that would give them some experiences there too that would still count? But would be comparable and, I mean the hard thing for the faculty sometimes was to step back and say what is it we want to accomplish with all this? What are our overall goals? And then keep comparing the actions we're taking against those goals, were we meeting what those were? So, I can't remember if you're going to get to this or not, the process was really to start with what do we want to accomplish with our curriculum?

DB Go with that, what did you want to accomplish with your curriculum?

T That's what, I, those are some of the things I don't remember, we had I think a list of 8 or 10 principles that we wanted to accomplish.

DB Things like teamwork?

T Right.

DB Ah, communications

T	Right.

DB	There was another one, great issues.

T	Yes.

DB	Being more current with what was going on, those kind of issues?

T	Yea, like I said there was a list that we came up with. So we did that before we really started looking at the actual curriculum itself. So that we could then go, because, you know, why reinvent things if we are already accomplishing some of the things in the current curriculum? We don't, we don't have, just check it off and go on with it. And then we could focus on things that we're missing but used to be there like the great issues. The great issues, I mean we look back on our own curriculum from the 50s and 60's and there were great issues courses.

DB	Were there really?

T	Yeah. And, um, so those were some of the things, again it was sort of easy to pull them back because we had a number of aging faculty members who remember that from their own experiences and they think their own experiences was the best. So some of those things were fairly easy to pull back and say why aren't we doing that anymore? And how could we do that, and the other thing that was different was, as I recall, I don't know where it ended up, we talked about getting at least some component of those great issues at the beginning rather than at the end. And I don't know if that's happened or not but that's one of the things we talked about. Cause the great issues in the 50's and 60's was more of a capstone sort of thing.

DB	No, it happens early on now.

T	Good, good.

DB	So that actually leads into the next question. And just based on your own memory, obviously I'm not going to be picky. Um, what changes did the college of science make to the curriculum? Do you remember?

T	Um, I would say across the board there was more consistency with the kind of math, the kind of science, the kind of, um, liberal arts that all students were getting. Um, we had really, from an advising standpoint it was getting quite difficult to get students to think you know, whoa, we starting in computer science and wanted to go to physics. To be able to make that change, make it right at the beginning or without losing time to graduate. Because things had diverged so much from department to department. And so there was hope there would be somewhat more of a common year to year and a half of work that people could play around a little bit and say, you know, I came in wanting to be a chemistry major but now that I'm looking at all this more I really like the mathematical side of it more but I really want some those chemical things so physics maybe would be a better fit for me than what chemistry would be. And before then, you know, if you didn't start in physics it would take you another year. And, still may do that, but there was enough other common core there that would translate because, chemistry and physics isn't a good example because they were taking the same math. Some of the others with taking different math. Yet things had moved, biology is still probably taking a different math. So there were some things like that that we didn't succeed on. They wanted to have a little bit more common core in.

DB The four things that have been somewhat constantly brought up were the great issues, uh, communication,

T Cuz that was, you know, no science student needed to communicate.

DB So that included reading, writing rather and presentation, those were the two component s of that, and then, um, teamwork was also greatly mentioned and the fourth one was multidisciplinary.

T And that was, I think that's a good thing but that was coming out of the multidisciplinary approach from the faculty and the different research areas trying to be combined so it was a, I mean it was the right thing to do but it was also an attempt to understand the faculty are going to embrace this a little bit more if they see the potential to shape some student s to look like them.

DB Right. So this question, to continue that conversation, this question you may not be able to answer but, uh, what do you consider to be the successful attributes.

T Well again I haven't seen it implemented but, uh, I would say, including communication first of all was a big deal, um, well actually, pretty much those things you mentioned, the multidisciplinary aspect, I think that's important just because whether our students were going to be pure physicists or pure chemists the majority of our students are going to work in the world where that purity isn't important. And whatever they produce is going to have to interact with people from other disciplines whether they're in science or outside of science. So, so having a mindset to think about that as an undergraduate felt to me that it was going to prepare them better for being a successful citizen in the world no matter, you know they might end up in economics or whatever but they still understand the relationship between these different components. I thought that was important. Be able to communicate about that I thought that was important. Um, the great issues and multidisciplinary have some similar things to them but, but the great issues, the idea behind the great issues is, at least when we first thought about it, was to not just be science but sort of how science fits into the world. Um…

DB STS, science and technology in society?

T Yeah.

DB Something like that?

T Yeah. Um, and again because of what I was saying earlier I think those things are still, those would be valuable. And what was…

DB Teamwork.

T Teamwork, teamwork, yeah. And again clearly in the world that we're in hardly anything happens with a person in a room by themselves.

DB Except ion mathematics.

T In PhD mathematics but very few of our students in mathematics went on to a PhD. So from an undergraduate standpoint to be able to understand how, first of all how, how, I mean when I, one on one with some of the math faculty that I was talking to, they were, they were a little resistant to some of these things. And I had, coming out of the math department, I had a little bit of, you know I could talk their language a little bit, and so one of the things I just tried to point out to them was that they didn't want most of our undergraduate students in offices next to them some day down the road but they wanted, they understood, and the need to have undergraduate mathematics majors from a job security standpoint and to, to again be that pipeline. And there has been some acceptance, for example the actuarial science program, which was already, it was getting a lot of traction, it clearly was something that wasn't purely mathematics, but you needed a lot of mathematical abilities. But you also had a lot of other, you had to have economic capability, you had to have some computing abilities. And so while there was resistance from the math department they were also seeing the opportunities that were coming from the multidisciplinary research things for them. So, um, being able to talk to them about teamwork, because again even if they are going to do multidisciplinary work they're going to do it alone, as a pure mathematician. So, um, so yeah math wasn't that hard of a sell in the long run. It took a little prompting to get them to think about it but it wasn't that hard in the long run.

DB OK, how about unsuccessful? What, do you know, you may not know that as well though, if there were any unsuccessful components.

T I would, I would have anticipated that the most unsuccessful would have been the experiential. Trying to, first of all to evaluate whether it was a valuable experience and who it was going to do it.

DB OK. I, I've heard some comments that the teamwork component has not turned out as well as they liked. What I know is what I've been told is that when it started it was in a two component thing where there was an education or teaching about how to work in a team and then an application component. And they switched the teaching, which was a real live situation to an online component. I've heard some complaint that that's not going as well as they anticipated.

T Well, science faculty don't have a long history with teamwork. And, and I would think that it might be difficult to get the faculty to accept that people like us could serve a valuable role by fostering a teamwork environment, you know, how to, how to work as a team. So they aren't used to doing it themselves, it doesn't surprise me.

DB The other, and I don't want to say complaint because it's not quite right, the other sticking point that I've heard is that, um, is that the diversity issue, the experience, the experiential part, um, particularly in foreign language where you could substitute a cultural event for a foreign language. Do you have any feeling a about that?

T (sigh) I thought it was a good idea because I'm not sure that the way, I'm not sure the way foreign language is being taught that a fourth course in a language was adding that much to the student's education. I've not traveled extensively but I've been around a little bit and I know that English is used practically everywhere. So that, that doesn't mean we shouldn't have a foreign language requirement because I also know that wherever we went I felt really out of place because I didn't speak the language. But even more importantly I felt like when I've been different places understanding that there is a culture different than ours, that the way they view the world isn't the same way we view the world. And I don't know that if you spend all your time getting the right tenses of your verbs down, that that's giving you that kind of experience. So I think that there was room for both I thought that learning a language, some level of learning a language, not only helped in learning the language but it helped you think about how to process ideas. I'm not sure they ever, students in those classes ever caught that. But, but, but it was sort of like when I was teaching math for elementary teachers. We could have taught addition, subtraction, multiplication, and division just like they are going to teach but we did it in a different base, than base 10, because it forced the student's to start thinking about what happens when you put two numbers together, what, you know, instead of just, you add two and carry the one, you know…

DB That's critical thinking.

T Right.

DB That forces critical thinking.

T Right.

DB So maybe that's what you are kind of getting at.

T So, so there is, I think there is value in learning a foreign language because again it gets you out of your comfort zone, it forces you to think about abstract ways of representing ideas. And that's what science is about. Is to think about abstract things in a different way. And so I was all for keeping some foreign language requirement but I also felt like we needed a cultural experience as well because you know our students were going to be working in the world not in Indiana.

DB Right. So you don't, or do you, have any idea about how that has turned out?

T I do not.

DB Um, were there any changes that you would have liked seen made that didn't get made?

T Um, I would have liked to see the departments give up some of their credits, which they didn't really want to do but in terms of components I was real pleased. I mean I felt like when we started with, you know again those big picture ideas, um, that was what I felt like should be part of a core curriculum in the sciences.

DB So, I, I, I know the issue about courses within departments, uh, but had they given up three hours or six hours would you have wanted to replace those with one of these experiential courses or something like that or just lower the number of hours?

T Well, lowering the number of hours would not have been a bad idea. With the other experiential things being in there. But that wasn't a very high priority. I would have said, I would have expanded some of those core, I, I would have, how to be a scientist. I would have had, I think maybe there's, I think we ended up one course in a great issues kind of thing, I would have had two. I would have had maybe one, maybe one in both. So it would have been things like that more than reducing the hours I think.

DB OK. And then I don't know how you can answer this but technically on a scale of one to ten how would you rate the success of College of Science's core prior to '07, you probably can answer that, with one being really bad and ten being great?

T Um, we didn't have that, uh, I was going to say we didn't have that much of a core. We had, a third of our classes were liberal arts type classes. But there was no cohesion to them at all. So I'd maybe give them a 3 or a 4. I mean I, I, I felt like one of the things that I could sell science over engineering, for instance, was that the percentage of our coursework that was education was what you expected out of an educated person. Ah was a higher percentage. And we had a lot of flexibility in it. Um, too much flexibility I think but I think, I felt like it was a selling point for those students who, who wanted to think about technology and why things happened but also wanted to think about things we didn't understand yet. And, you know, how are you going to understand something, I don't know how to explain it exactly but, I used to say it all the time, how, how are you going to, how are you going to discover some new concept if you don't even know to look for the concept? And, and I thought like that the general education forced our students to think a little bit. Again I felt like the new plan for the curriculum was going to focus that thinking a little bit better.

DB OK. Let's give that a grade then. After '07 on a one to ten scale how did you feel the success of the new curriculum.

T Well again, whatever transpired or not, on paper it looked like a seven or eight to me. I thought it had made quite an improvement.

DB So you had high hopes.

T I did.

DB Um, Alright, now this is kind of, we're getting near the end here, this is kind of interesting for me because, um, I've read through as much of the documentation as I could get my hands on. Uh, and something jumped right out at me. The word reform was never used. And, uh, so was that on purpose? Or did it just happen by accident?

T I don't remember any purposeful…

DB Well it was never used. So…

T What did they call it then?

DB Change or review, we're going to review the curriculum. We're going to, uh, change the curriculum. The word reform was never used. So in light of that, um, how would you define reform in the light of the College of Science's undergraduate core curriculum? IN other words was it a reform? I guess, how do you define reform?

T Um, I, I would say it was more iterative than a reform. Reform I would have said, in my mind, when you reform something you sort of start over from scratch. You may, you may pull in good the components that are out there. You know if there is a block that's working, why tear it up and start over again? But you put all your blocks out on the table and then you pick up what you need. We didn't do that. We just, iteratively, we tinkered. I felt like we tinkered pretty extensively on some things.

DB Ok, ok to follow up on that, and the answer you're giving is consistent with what everyone else is giving, uh, if fact a couple of respondents talked about, they didn't use the word reform because they felt it was pejorative. Reform means you are doing something wrong. So if you have to reform it then somebody has to own that. Right? They didn't want to do that. So what, in your mind, what would you have done to actually make it a reform?

T I would have deconstructed our current curriculum into components and evaluated each of those components. I can't, first of all going back to that standard that we wanted to get our curriculum to. But, um, I would have looked and said, I would have gotten Tay from, well calculus is five credits so it has to be five credits. I would have gotten to what is it we want to accomplish and is it possible to create a course that's calculus and chemistry together? I don't know…

DB So really do some basic retooling?

T Right.

DB But that would have meant getting into department level courses.

T And, not only departmental courses but the engineering curriculum and the pharmacy curriculum because we weren't going to have our own courses to do this, we had to use the blocks that already existed. Now the thing that sort of irked me in all this was when engineering went through their change to curriculum or reform to their curriculum, whatever they called it, ah, you know, our courses changed to what they wanted.

DB Really, I did not know that. It's a political issue?

T It's a political issue. So, ah, and engineering was the bigger dog on campus so, so and they were going to populate courses, which is more money. So, so we had some blocks that we had to use no matter what.

DB So, ok, you know I'm pretty near to the end of this now. Um, but since you've brought up math a number of times and you were act5ually in the math department, I think, and from prior respondents, everybody has said that math was a problem.

T And I probably thought they were less a problem than others thought.

DB Yes, and I'm getting that. It's very interesting. How, but, who in the math department would you suggest I talk to?

T Hum (long pause)

DB Now I'll tell you, I have approached Leonard Lipschitz and he has not replied to me.

T That's no surprise. Leonard actually, Leonard and I got along amazingly well. Um, but I, I can't tell you why. But, uh, I mean, I understood my place and, I didn't always like it but I understood it. And, I, I felt like I knew how to, I knew how to push Leonard's buttons appropriately. So I do think Leonard would be a good person to talk to. Um, I'm trying to remember who else…

DB Richard Penney? I have some names in the math department.

T Richard I think certainly would have understood, I think he was on a committee. And he understood, he would have understood it because he was so involved in actuarial science which included a lot of those components that ended up as part of the curriculum. Bruce, he's not in math he's is stat, the stat people help sway the math people some. Bruce, why can't I remember his last name?

DB I think I know who you are talking about.

T The biggest problem with math was they had half or more of the science education students in science and they had no education faculty. So, uh, that was one of the reasons they were I think perceived as being more difficult to work with. Because they didn't understand, they didn't have somebody to go back to in their department that would advocate the education speak.

DB So no one was doing math education at the time?

T No, no math faculty.

DB So it was being done by what? Graduate students?

T By education faculty members.

DB Who had a math background.

T Who had a mathematical background. So, yeah, I don't know if they still don't have anybody. When I went through there were, it was a size.., I mean it was at least three or four math ed faculty members. Grayson Wheatley, I don't know if you remember Grayson Wheatley.

DB I thin k they're getting rid of all of them. Not just in math. They haven't replaced Krockover.

T But anyway I, I think because there wasn't that education component in the faculty, they were a little bit harder sell on some things. But once they embraced it they were fine with it. So, I, I said, I know that Jeff and Chris in particular had problems with math and they were pretty much, math was pretty much my responsibility to talk to. And, like I said, I felt like we got along fine. And we did things by consensus, we didn't have to, you know, do it over math's dead body. Uh, they, they joined in, they, they accepted things that we did.

DB That sounds good. Do you think that there is anybody in particular that could give me good information?

T Uh, somebody like Rex Fodrey. Do you know Rex?

DB I don't know the name.

T He certainly would be in a position to tell you how it's working at the ground level. He's, he's the head of the biology advising area. And you know, he's been there long enough to know what is was like before and what is it now.

DB I'm also going to be talking to Jeff Vitter. At the end of the month. I'm going out to Kansas. Anyone else?

T Um, (long pause). If you wanted another department from an advising point.

DB I am going to be talking to a number of advisors. Nancy

T Nancy would be good.

DB OK, I think we're done. Thanks you very much.

Ralph's Interview – March 29th, 2013

DB Good morning it is March 29, 2013 and I'm at interviewing Ralph. So, um, Ralph my first question, and we can go through these in as little or great detail as I think the time gives us. But, um, I, the first question is, ah, in starting the, uh, curriculum review at Purdue in the science curriculum, for the undergraduate science curriculum, what national trends in undergraduate science education did you consider while developing the undergraduate College of Science core?

R Right. Well what primarily drove the science curriculum was an increasing understanding that what makes people successful in the real world is not just the pure science background but it's a whole set of traits and skills around lifelong learning, interaction with others, and all of the activities of communication and working together that enables success. So it's not just enough to understand a scientific area or to, you know, or have a passion in making certain discoveries. You've got to be able to translate that into the real world with people and, uh, um, people from all different backgrounds in order to bring that kind of discovery to light. And we live in an increasingly global world so, uh, you're going to be more and more interacting with people across the globe and how to effectively work together and, and partner, to, you know, if you're involved in a multinational company or you're developing something to export you've got to understand a lot of things beyond just biology or chemistry.

DB So, um, adding on to that a little bit, um, did you, or what problems did you see in the undergraduate science courses that you observed that led you to making these changes?

Well the thing that initially just spurred this in my mind was my first, what did we call it, um, science council? It was the equivalent of the senate for the College of Science. And representatives of all the departments in the College school at the time, uh, that met to talk about governance issues and so forth and among the things they dealt with was curriculum. And we must have spent close to an hour talking about something as trivial as a name change for a course. And I realized, at first I thought this was kind of a joke cause I was new and these guys were pulling my leg. Then I realized they were dead serious that this was a burning issue to them. And what really struck me was that the curriculum in any discussion about it just got buried in minutia. And there was no rational to the entire curriculum. There were so many just requirement and exceptions. Just understanding what the set of requirements were was daunting. And trying to see some, um, um, some reason for it all was just missing. So it really led me to the conclusion that we need to just start over from square one and ask the questions what are we trying to do in our educational process, what do the students really need to succeed, what common aspects does every student need to have and that should be a college component. Every individual major had its own individual set of requirements. And that drove the process. So, ah, it really came out of this realization that this was just an incredibly intricate and not particularly meaningful set of requirements.

DB So a question I kind of want to add to this, not on the sheet I sent you, but were retention issues in the School of Science, or nationally, an issue that you talked about?

R Yeah. We wanted to make the curriculum more relevant. And that was definitely an issue that we were losing students. We were getting great students to come to Purdue and in fact we were a draw to Purdue. The recruitment office frankly would tell us that these students are not going to graduate from your college but they think they want to and they're going to find out for whatever reason they don't want to do that, um, and if we don't admit them to your college they won't come to Purdue. So we were kind of a, ah, almost a mechanism to admit people to the university who weren't going to end up being science majors. A lot of those students really did want to be science majors and they just did not resonate with the curriculum. And I think a lot of that was the difficulty of the first year curriculum being kind of just thrown upon them. And not paying attention to these other important aspects that are going to help make them successful. That was definitely a part of it.

DB So, um, just to play on that a little bit more, the national data, I don't know if you looked at national data, ah, but, uh, the national data is showing, uh, somewhere between 50% to 70% of the beginning science majors, nationally, dropped out of science curriculums. Was that a concern, an awareness at the time?

R Uh, yea. It's even more so in engineering, yeah, it's definitely a concern, um, and we were aware of the importance of growing STEM graduates. That was a, that was definitely an important component. Let me go run off, just to jog my memory of what the big goals were.

DB You know I do have some documents with me.

R Oh, you do?

DB Yeah.

R Oh, that might be helpful.

DB What I have is the, uh, pre, um, the pre change curriculum and the post change curriculum.

R OK, that would be good.

DB So this is the post change and this is the pre core curriculum. I also have some other documents, uh, which is a comparison of the current core requirement to the old core requirements.

R OK, these are the six we had and here they are relabeled a bit.

DB So, um, just following up concerning that at least. So setting up the task force, I'm assuming that you were the main motivator behind that? I mean it was your idea? What elements, when you started to think about setting up the task force what elements did you want?

R Well we, I mean we actually I would say had a miss that first year. We spent one year with the task force and then we had to restart basically after that year. Um, the reason is because I realized that a task force was really just a set of individuals and they weren't tasked as they, perhaps to the extent they should have been that they would represent departments. They were a set of individuals primarily. And you can't get the entire sense of the school at the time, now a college, from just that set of individuals. And so as much as they did interesting work, they came up with interesting ideas after a year, it became clear that if we were going to do something as major as changing the curriculum when changing the name of a course could be a life or death decision, there was just no way that was going to work. So we restarted and instead actually got every single faculty member involved. And the way we did that, we followed that approach here at KU, is that we asked every department to convene multiple faculty meetings and just discuss what are the key outcomes or goals that our curriculum should achieve? Um, things like communication or, um, multidisciplinary concerns. And, and then we consolidated the list so that we essentially eliminated duplicates and asked them to prioritize what those goals, and what came back was essentially consensus and that consensus was what these six outcomes are that are listed here that went forward. And if we hadn't done that I think what would happen is that every faculty member would be skeptical, skeptical that oh you know I don't really agree with this or that. The fact that they came out of the units themselves gave a lot of credibility to the whole effort and allowed it to go forward. People understood that we really sought their input and if they disagreed with one of the outcomes it was because the reason we went forward with what we did was because we had this overwhelming majority saying these are the important things. So individual disciplines had their own major requirements but as far as what should be common to everyone there was really remarkable consensus. And then it was filling in the details which still had brought forth a lot of potential contention such as should study abroad equate to taking language courses, that sort of thing. But the fact that the goal itself was listed there as a key one is, um, was really a driving force in how this got, um, ultimately approved. And it was approved something like 58% to, um, 42, or 60-40, something like that. So pretty good record.

DB So when you were setting up the task force, um, did you, did you just give the charge, did you delegate particular duties to people…

R Yeah. Chris Sahley led the efforts. She oversaw the, um, task force and then there, uh, the new task force that resulted from that that kind of worked with the departments to get a hold of their input. Ah, she did a great job.

DB So she was the one responsible for contacting individual departments and getting faculty from each department or maybe the department heads?

R Well we collectively did that because we would meet with all the department heads on a regular basis. So, you know, that was their charge to do that, they organized that and Chris and Jon Harbor played a big role. They, they uh, they took the results in, um, that is how we determined, you know we did a statistical analysis to, ah, look at what is, what are the correlations and it was pretty apparent that, ah, I think five out of the six were like overwhelming everyone. Put them as the top priorities and then, um, the sixth one was also very high up. And I remember like which departments, I don't know which outcome that was.

DB Well I've talked to Chris and Jon Harbor as well so they, broadly, essentially said the same thing. Although I didn't understand that Jon was a focal point, he was a primary person in this process?

R Yeah, yes.

DB OK. Um, were there any specific changes to the curriculum that you wanted to make before the process started? Did you have anything in mind I mean?

R Um, well, generally I had in mind things that related to communication skills, um, working effectively together and having some broader perspective than just your major. So you could look at the more global problems.

DB So communication was one.

R Communication was one, multidisciplinary aspects, um, but you know the details, we really relied on the departments to kind of identify the, um, key outcomes, the goals that would be relevant and went with that so...

DB So, um, this gets into a little bit of detail I think that you are probably looking at right there, do you remember what changes were actually made to the undergraduate core?

R Ah, yeah, yeah, I would say the biggest ones had to do with things that related to, uh, um, what we call teamwork or, um, working together. I, I think, um, let's see what was the word we used to, uh, I think we, we used, um, maybe we went away from teamwork to teambuilding because there was some faculty who regarded this as just trying to get people to think alike and to be automatons and not to be creative. Which is actually the opposite of what we wanted. Um, so just, it was just something that no department had ever contemplated before in its requirements.

DB Teamwork?

R Yeah, teamwork.

DB Or teambuilding?

R Teambuilding, so it was definitely something new in that aspect.

DB So, ah, um, you already mentioned communications, teamwork, I think you also mentioned multidisciplinary?

R Yeah, yeah, that was another aspect that would not typically be in any requirements of a major, was certainly wasn't in the college requirements. Ah, just that notion of, of um, going beyond your major so that you were able to synthesize using other perspectives . How that relates to a given problem because all of the major issues facing society certainly, that deal with science, are more and more multidisciplinary. And there's no one set of skills will solve a problem, you have to collaborate and work from many angles. And that also brings in why it's important to be able to work with people because no one person's is going to be trained as an expert in all these areas. You have to communicate and interface with people with totally different backgrounds and skill sets.

DB Um, were there, was there any resistance to that kind of idea? At least defining what teamwork or I'm sorry multidisciplinary, what that meant?

R Yeah, oh yeah. Sure, um, and in fact what we settled on I believe was in terms of what students would need to do to satisfy this requirement is one they could take sort of a capstone course that, in a course, looks at a problem from multiple perspectives. So if they're geology majors there may be, um, issues that are brought up as well in physics or mathematics or economics that in the same course they look at all those aspects of a given problem. Um, I also thought it was important, um, that hey I think it's great if people double major or minor in subjects. And that getting two majors you, you, you definitely get well beyond just that double perspective and in your mind even if you don't take the course that in itself is using those two disciplines, explicitly, if you've gone to enough detail to get two double, to get a double major, two majors, then you have really in your mind I think synthesize in a very deep way two different paradigms and approaches. And that's another way of kind of getting that perspective because you've probably have gone well beyond just what a single course would do which would really be at a more superficial level. So we wanted to, ah, I was especially interested in encouraging double majors too, so I didn't want everyone to take necessarily one course that tried to do this multidisciplinary perspective within a course I was also encouraging students to do a much deeper dive into two disciplines or more, be a double major.

DB So were you thinking two science majors or a science and a liberal arts?

R Yeah, it could, yeah, it could be economics or, um, it could be communication or it could really be across the university.

DB Another issue, another one of the outcomes was the great issues curriculum. How, how did that go?

R The, uh, the great issues, uh, came in as sort of, uh, I don't know part of the just more desire to have a strong liberal arts component and be able to be aware of, um, of these kind of just perspectives that, uh, any scientist should be aware of. It's just, it's more of the breadth component of the curriculum.

DB Were there any other, uh, changes, uh, well, were there any changes that you remember at least?

R The, uh, well let's see, uh, with respect, well, besides the courses themselves the, um, just the fact that there were particular outcomes and, ah, each outcome had a variety of options to satisfy it, um, was probably the major change because there was definitely a connection between the courses people took and what was being achieved whereas before it was just a set of requirements that probably had this overarching idea behind it when they were first thought of but over the years as they're modified and this exception, that exception, they're just a bunch of courses and people didn't understand what they were about. So that was probably the most major thing. Particular outcomes dealing with communication and teambuilding, um, multidisciplinary, um, those were just not even present in the curriculum. Ah, there were liberal arts, there were breadth requirements, we just reformulated them more explicitly to document what they were there for.

DB Now, I, I, I realize that you left at some point and you may not have been following up on what's happening but do you have any understanding of what of these components have been successful?

R You know I have, I have not, um, kept up and I meant to call Chris and just get her perspective but I have to admit that I'm not up on that aspect of the curriculum, um…

DB I completely understand that. Uh, how about this one. Um, were there any changes at the beginning, maybe even before you started the formal process, had in mind that didn't get made? Is there anything you wanted to do that didn't get made?

R Uh, let me think. I, I think, I think pretty much these six goals, um, captured the essence of the, um, I'm, you know when these came back from the departments, uh, this seemed to be really capturing the essence of what scientists should know. And what students should, how students should come out of Purdue's, I was quite happy with the outcomes and as the outcomes were developed into options, course options for experiences. I thought it turned out very well.

DB Great. Um, there's a question that I need to ask because as I reviewed those documents and some others that I have, um, there was a word when I started this process myself reviewing that was not there. And that's the word reform. Did you purposefully avoid using that word?

R Reform?

DB Yes.

R Ah, I don't, I don't remember that. I used to, um, I used to say when we were starting the process that, um, the curriculum dated back to, ah, I think it was actually around forty years or so and it's always a good practice every forty years or so to look at how you are teaching what you teach and why you teach. And, um, I don't remember a conscious choice of using it or not using it.

DB Do you consider, so this gets into semantics a little bit, um, it depends on how you define what reform means. So whatever definition you might use do you consider this a reform or, um, a, as another respondent said a tinkering. How would you describe it?

R I would say it's a major reform.

DB A major reform?

R Yes, a major reform or really just starting from scratch, a total redesign. It was much more than a tinkering. Tinkering is sort of the process that happened over the preceding forty years.

DB OK, so if I can ask, how, and I think you just did, how would you define reform then? A major retooling?

R Yes, it's a, it's a new framework, a brand new framework that makes, it was significantly different from the old curriculum and, uh, I think moved the college forward in very significant ways.

DB OK, good, I appreciate your time.

Dan's Interview – April 8, 2013

DB OK, it's April 8th, 2013, this is my interview with Dan for my thesis concerning faculty perceptions of the review of the College of Science's undergraduate core curriculum. So my first question, um, actually if you don't mind I think I'm going to kind of, a pre-question, if you will. What was your involvement in the task force and, and the pre-curriculum and the post curriculum, what was your involvement?

D Um, I've been trying to reconstruct that because it's, obviously been a while since I was doing that. Um, but I was a member of the task force for a couple of semesters, um, and I think I was chosen primarily because the fact that I represent the area of biology science teacher preparation. And in addition to the, um, um, 100% College of Science faculty I think they want to try to be inclusive in terms of thinking about the science teacher education program as one of the components of the College of Science too. So I think that's why I was selected to be part of that committee.

DB How early in the process? Was that at the beginning, did you come in a little later?

D Uh, I was actually kind of in the middle. I was not there from the very beginning. Um, I was asked actually to replace, I'm trying to remember who's spot I was asked to fill on a temporary basis. I think it was Ken Robinson from the biology Dpartment. Um, and I enDd up also staying on longer than I expected or longer than I thought I was going to be asked to participate. So it was pretty much in the middle. And, uh, I did that I think maybe for two semester and then I left the committee, um, and I know the committee's work continued on after I was there. So it was for a brief period in the middle as things were going on.

DB Ok, that's good to know. Um, so, you may not know of the answers to some of these questions but just tell me what you do know. Um, are you aware of any national trends in unDrgraduate science education that were consiDred while Dveloping this new unDrgraduate core?

D Uh, I'm not sure about national trends as far as other universities were concerned but, um, I do know that one of the driving forces that I kept hearing over and over again was employers were saying, those who employed College of Science graduates were saying Purdue's graduates were coming out inaDquately prepared in things like teamwork, inaDquately prepared in critical thinking, inaDquately prepared in a variety of different areas. Um, and so I think that in large part that's what motivated the committee to start looking at things like the composition, the communication types of skills that were there, teambuilding, um, the multidisciplinary experience and so on.

DB OK, and that’s a typical answer I’ve broadly been getting to that question so I’m going to throw in there an adDndum in there that I have been doing. There are other national trends, um, other than those, uh, basically built on retention and attrition. Do you, did you have any, did you hear any conversations, did you have any conversations about those issues?

D Yes, um, I knew for a long time and I think the biology Dpartment, although they didn’t trumpet this, they acknowledged that they were having problems with, um, attrition for the biology majors. Um, and I know the College of Science as a whole was working on that too. So, yeah, that’s a good point. I think that was another driving factor. So, ok, at the end point apparently the graduates of the College of Science were not meeting the needs of the employers once they graduated. But earlier on there were perceived to be some problems with we’re not offering the right kinds of experiences to our stuDnts in orDr to, um, keep them in the College of Science. Have them graduate in the majors that they started in and so on.

DB OK, beyond, uh, you just said, uh, kinds of experiences to keep them in the school, were there any other discussions about possible reasons for stuDnts leaving science or biology?

D Uh, well I think it was, um, I’m not coming up with anything right off the top of my head, anything in particular.

DB OK. That’s fine, so for you personally and since you are a biology professor, uh, what, did you see any problems in the unDrgraduate science courses that you observed that caused you to think about making changes to the curriculum?

D Well, uh, I might be different from some other biology professors or COS professors because, of course my appointment is only 40% in the COS, and my primary interaction with COS majors was in the teaching methods class with the biology education majors. And I encounter them, those stuDnts, in either, most of them it was the next to the last semester that they were in the program, right before they would do stuDnt teaching or perhaps it was their junior year and they were going to stuDnt teach in their senior year. So I didn’t have a whole lot of interaction with them during the earlier parts of their programs. And my interactions were really pretty limited to them at this course. So that’s going to be an answer I’m going to give you on a regular basis as I scan down through your questions here because I did not regularly interact with biology majors or other COS majors throughout their program. I saw them during one very brief moment in the program and that was methods class and then following up with stuDnt teaching.

DB I unDrstand that caveat, um, but consiDring that, did you, in those stuDnts did you see any issues that caused you concern?

D Um, not as far as their overall preparation for teaching. Uh, again for that small portion of the population coming out of the COS, the bio teaching majors, I thought generally speaking they were pretty well prepared. Um, however, I unDrstand, I unDrstood at the time, uh, part of the rationale for why the College was interested in moving to some of these new core requirements for, not only biology teachers but for the larger population of COS graduates too.

DB OK, um, and again because of the point you came into the task force but, what elements, do you know what elements were consiDred in setting up the task force?

D Ah, I'm not sure Again because I was not there from the beginning I don't know what the rationale was.

DB OK, that's a fine answer. Um, what changes did you want to make before you, since you came in the middle, what changes would you have liked seen maD when you came into the task force?

D Changes in the old COS core? Um, I guess, um, again I have a bias towards the biology teaching majors. I guess I was, the thing I kept in the back of my mind was making sure that those who were going through a science teaching major in the COS whether it was biology or chemistry or whatever, um, that the unique nature of their program combining the vast majority of the COS requirements with the COE requirements to get a teaching license that the new things that were being brought on board for the COS core requirements would not disadvantage those who were in the science teaching programs, would not create an additional burDn for them because as it was whether in the old core or new core, um, their program is a really Dlicate hybrid of the COS requirements and the COE requirements for obtaining a teaching license. And it's very carefully constructed and I wanted to make sure that if w things were being brought on board that it wasn't going to throw a wrench in the program for science teaching majors.

DB It's essentially a double major really.

D It's very close to it. Not quite a double major but again in biology with the exception of, I think, maybe two content courses, all of the other requirements for a regular biology major are what the biology teaching majors have to take. And then you've got the education course work thrown on top of that.

DB Right, right. So, um, can you, from your point of view, can you briefly state what changes were maD?

D Uh, well I saw the end result of the new requirements.

DB Can you comment on them?

D I think it was a good iDa that, um, the very general and very broad core requirements unDr the old system were maD more specific. And that there were some elements of things like, I actually thought team building and collaboration was a really good iDa. And I know that was one of the messages coming back from the employers to the COS that people coming out of the programs, regardless of the college or Dpartment, didn't have a lot of good really collaborative experiences as part of their unDrgraduate work. And therefore once they got into team situations in the work place they didn't seem to be particularly well prepared. So I was pleased to see some of those things put into place. Probably that was one of the ones that I thought was going to be a really good piece. And then the language and culture piece that was in there, especially the cross cultural kind of thing. Part of the general complaint was that the stuDnts coming out of the COS were not particularly well rounDd in terms of their background. I went to a small liberal arts college for my unDrgraduate education so I fully unDrstand what it means to have a well rounDd unDrgraduate program. And I unDrstand the benefits that can come from that. So I thought a couple of the components like the team building and the language and culture were really good pieces to be introducing and I didn't think it was going to be at the expense of the other parts of the traditional science curriculum.

DB So you kind of answered, at least touched on the next question. What did you consiDr to be one of the successful attributes. So that would be the team building?

D Well initially I thought that was, I had hopes that was going to be a successful attribute. I knew that participating in the task force as I did not everybody was in agreement that that was going to be a particularly good component. So I had high hopes and I thought that was a good piece to be including.

DB On the other siD of that were there any changes that you consiDr to be particularly unsuccessful?

D No, as I was looking at the list here, um, again I thought it was just the overall iDa of more clearly specifying what were the range of experiences that graduates neeDd to have and putting it into some of these categories. Smaller categories probably meaning more specific categories than they had been in the previous core.

DB OK, so, um, again your point that you came into this project, um, were there any changes that you might have envisioned that didn't get maD? That you'd have liked?

D Uh, no, again I can't remember anything specific.

DB OK. Um, alright this is kind of one of those taking a qualitative into a quantitative area but, on a scale of one to ten, um, how would you have rated the pre-2007 curriculum, the core curriculum? One being really bad and ten being in the iDal the greatest.

D Um, I guess I didn't at the time I joined the task force and my knowledge of the old core at the time, I probably would have given it a rating of probably like a six or something like that. I didn't, I wasn't aware of really serious problems with it and so that's my rationale of giving it a rating of at least five. Um, but I also knew that there were some relatively small things missing. And again with the iDa of having a more well rounDd kind of experience for the COS grads. So that's why I'd probably give it that rating.

DB OK, so conversely after the 2007, how would you rate the new curriculum?

D I probably would have given that closer to a seven or eight. Again because I was pleased to see the specificity that was incluDd in the new version.

DB OK, um, I have two questions left and they are kind of related to each other. In the documents I've read for this there was a word missing interestingly from al of them. And that was the word reform. So, um, do you, ah, two questions really. How would you Dfine reform in light of this curriculum and based on that Dfinition would you call this a reform?

D Well reform is one of those terms that has multiple meanings. When I think of the term reform I think of something that's a pretty fundamental change. I don't think of something that's tinkering. I think of something that's more significant change, that is very carefully thought out, um, alternative approaches are consiDred and Dbated and usually a consensus is Dveloped of all the stakeholDrs involved. Um, and then careful thought is being put, should be put into how it's going to be implemented and then how it's going to be assessed, the success of the reform. How are we going to measure whether this is actually doing what we intenDd it to do or not. Um, to be perfectly honest I did not think that the change in the COS core requirements fell unDr that category of reform. I didn't think it was a fundamental change because many of the same kinds of thing reappeared in the new core requirements. Um, they were, I thought, given the audience, carefully thought out, however, I thought one of the real weaknesses of the whole plan was, it was all COS faculty who were discussing this. And when I said earlier, stakeholDrs who were involved, I didn't see any stuDnts on the panel, didn't see any employers on the panel, ah, um, trying to remember if, um, Alan Welch was on the group, he was one of the leaDrs of the group, and rightfully so because he was representing the advising team from the COS too. At the time he was director of that. So it was good that that part of the population was incluDd. But I thought there were a lot of players who were not incluDd in that. And so, and then I thought a lot of this was implemented, it was phased in. There was a program that I thought it was Earth and Atmospheric Science that agreed to pilot several of the components. Um, but I wasn't really clear on how the success of the reforms was going to be assessed and evaluated.

DB So, playing on that, um, are you aware of any of the results?

D I'm not.

DB Uh, is that because you haven't looked or because they haven't been published?

D I think it's both. I did not personally follow up to see if there were results and if there were results published, um, boy I certainly don't remember that it was any kind of a well communicated effort.

DB OK, so last question really, um, you really answered the reform question, at least to my satisfaction very nicely, uh, and you also kind of answered this too but… I guess two questions, um, what would have maD it a reform, you already sort of answered that, but were there any specific parts that, um, for you would have maD it truly a reform? And, I guess connected to that question is, is that something that should have been done?

D Um, I did, I think I touched on a couple of things. One would be, would have been a broaDr representation of different stakeholDrs. From the beginning, throughout the entire process to ensure that perspectives from stuDnts, from employers, from faculty, those who are on the campus with stuDnt right here were well represented and became part of the consensus making process. That neeDd to take place. That was one of them. Um, and then the last part was, there was a lot of time, even in the couple of semester I was involved, there was a tremendous amount of time and effort that was Dvoted to changing the requirements, ah, without any kind of a systematic way of asking the question 'were we successful' 'does this make sense' and again without having representation from the stakeholDrs and follow up with the stuDnts, with the employers, with the faculty, with the advisors and everybody else, without having something in place I don't know how you could have said if it were successful or not.

DB OK, so do you feel, um, that, that, using your Dfinition of reform that, ah, this is something that should have been done?

D If they were serious about making significant fundamental change in the COS requirements, yes.

DB OK, so you don't feel that was done then? They weren't, not that they weren't serious about it,

D No, they were very serious about what they were doing. I think they were fairly narrow minDd about what they were doing. And they weren't consiDring, necessarily, um, the longer term consequences and how they would measure the longer term consequences of the changes they were planning to implement. Both on campus and off campus after the graduates left.

DB OK, so here's an ad hoc question that I just thought of. Are there any specific things that you might have come up with, I know I'm asking this off the cuff, are there any specific things that you might have come up with that would have maD it a reform for you?

D Me personally?

DB Yes, you personally.

D Um, I don't know how I personally could have, I mean the kinds of things I was just talking about to make it a real reform, those would have involved a whole bunch more people, a whole more time and effort…

DB And a consensus?

D Absolutely. Absolutely. And so I don't know if one individual, I mean I might have been able to throw some iDas out on the table. As I said before, there were parties on the task force who were from the get go seriously against a lot of these iDas. And so the compromise and the consensus that was reached is probably, um, in hindsight that's probably, um, about as good as it could have been done given some of the parties involved. And again, I think, I got the impression, this was me personally, that you know a lot of time and energy was being put into this and a whole lot progress didn't seem to be maD and so I think at a certain point people said OK we've come this far let's make sure we get this new set of requirements advertise, get the word out to faculty, let's think about how we're going to phase it into the different majors in the college, um, and that's about all we can do at this point.

DB OK, sorry I came up with one more question. Um, either at Purdue or, um, nationally in large four year public universities do you see a need for reform of science curriculum, unDrgraduate science curriculum?

D Um, again I can't speak with a whole lot of authority on the entire unDrgraduate curriculum because I work with just that very small audience. They have very specific needs, those who are going into the science teaching major. I'm really not familiar with the vast majority of the stuDnts in the COS.

D Thank you!

Joan's Interview – April 12, 2013

DB It is April 12th, 2013, approximately 10:40 and this is my interview with Joan who is an academic advisor for Earth, Atmospheric and Planetary Sciences. Thank you Joan, um, let's start the intervie w and again if you really don't know an answer to any questions you are perfectly free to say I don't know. So, the first one is, um, what national trends in undergraduate science education were considered in developing the undergraduate college of science core?

J The administrators, DeaJ, and some of the faculty had been getting input from employers that said we want students that can work I teams, will understand the importance of group work. The trend is going to be that all the sciences, scientists and engineers are going to have to work together to solve the problems. There is probably not going to be just one person out there coming up with the discoveries, it's going to be everybody working together. So that was part of it. The employers again were telling the University that they need students who could communicate scientific information to various groups. They needed people who had knowledge of other cultures and were aware that we were a global economy, a global world, and not just Midwest or east coast or whatever that happeJ to be. So those were the things influencing the change.

The other thing that was going on was, ah, was a little bit more of a practical approach was, ah, the curriculum had not been changed in over 40 years. It surely needed some updating. And then, um, this is um, part of Dean Vitter's, um, um, goals. With being Dean he sort of let it be known that he was going to be moving on at some point. He was planning to be a college president or provost somewhere and he knew it was important to have something that we could show that we did here or he did here that he could take with him to his next, um, the next step along the way. He made that clear to the people around him, you know, he was interested in looking at things. And he did interview later for other jobs and did leave. And part of his, um, um, portfolio when he left was how he completely redid the undergraduate education in the College of Science at Purdue University. So there were some personal and professional emphasis there as well.

DB Let me ask a couple of follow up questioJ. Number one, I've heard this statement you made about employers telling Purdue… How are they telling Purdue? I mean were they calling up people on the committee or Dean Vitter or how was that information being traJmitted?

J That I don't know. It was given to us in meetings, um, it was put into, um, documentation about this that employers, so this would be whoever was talking to whomever here at Purdue so… Didn't have specifics on that, um, we have alumni boards that come back.

DB Some of the information was coming from alumni you think?

J I'm assuming so, um, the COS does a lot for their alums in terms, you know we have banquets, we can, in October, all kinds of things. Um, when we have, um, there's an alumni council that meets with the DeaJ and ah, current students. And if these people are involved in undergraduate education I'm assuming they are attending conferences, and maybe reading publicatioJ that also talk about trends.

DB OK, that's what I'm mostly interested in, um, you're not aware of any publication that are talking about that need, this is more word of mouth.

J I think a lot of them were probable reading the Chronicle of Higher Education on a regular basis so I'm assuming that, um, regional or national groups that they belong to were probably looking at similar things. Like, I'm assuming that Chris Sahley would be part of some coJortium of other universities. The DeaJ probably get together and do those kind of things. But that information was never traJmitted to us or given to us at that level.

DB Here's another follow question that I've asked practically everyone about. Uh, you just mentioned a number of things that I've heard from prior interviewees, the one thing that I've brought up is the issue of attrition in the school of science. Was that an issue at all, both nationally and I know at Purdue as well how there was a high dropout rate out of the school of science.

J Yes, um, that was one of the things that they were looking at and I hadn't quite remembered that because Purdue is set up so that you chose a major when you come in. You don't have to but it's, there are opportunities if you are like 60 or 75% sure it's probably a good idea to do that. At least let us know what you are thinking about. The college of Science was coJidered a feeder school for just about everybody. So, um, we had a larger couJeling staff in place, we had everything really organized, ready to go. So somebody who couldn't get into engineering was to come to science. You couldn't get into pharmacy or nursing you could come to science. Even had students who couldn't get into management because their math scores were too low, they were told to come to science which has a higher expectation of math than management did. They were told to come here. So we were the dumping ground or in nicer terms we were a feeder school and they said, admissioJ regularly said 'oh you've been turned down before but we're going to place you in the College of Science' and everybody said 'yes!' Part of science philosophy probably some years ago would be they would find a program they loved here in science and they would stay. You know they were already here, they're being advised, they see the opportunities in chemistry, biology, physics, math, EAS, stats, actuarial sciences, a number of programs. If you are not going to get into engineering maybe you should look at the math program here or chemistry if not chemical engineering or you know something. You could go to other schools too. Um, we had career couJeling available, so it was supposed to be, um, what admissioJ was doing, that we were not happy with the rate of attrition but there was some opportunity there as well.

So, changing the curricula was to make the students more marketable whether they were in love with science or coJidering science, we let students come in undecided, undecided completely or undecided science. You know the whole thing just to give students the opportunity to sample what we had. The problem has been that the students have not been successful in the courses, so when they fill in a survey they say I've changed career goals, um, something like that. But probably 90% or even higher are failing grades or inadequate grades in math or other science courses. But they don't really put that on a survey so yeah we were always concerned but. Like 30% of the people would start and finish but the rest would come in through Purdue's CODO process and things like that.

DB So you had an attrition rate as high as 70%?

J We did at the time yeah.

DB That's a unique issue, if you will, at Purdue, um, are you or the committee aware of or did anybody talk about any national trends in terms of attrition in science?

J Um, yes, there have been, um, fewer students finding success in science programs. So I'm sure that was part of the idea about listening to employers because we were not, we were kind of switching from an economy that said get your degree and you can go out and do anything. Employers were looking for people with more specific skills. Um, they were also planning long term but not really telling us up front, then there were some other things that they wanted to add in, hoping students would do. They always wanted students to leave with research or interJhip experiences and so on. So some of those experiential, which we'll probably get into later, was on the back burner but we really didn't talk too much about in the beginning, but that has been something that they have added in. There again, employers, we want you to leave so that when you go to a job or a graduate program you've got this extra business that's going on. But, um, yes, science was suffering, we have more students trying to go to college than in past years, like in the sixties it was somebody who's affluent, male, possibly white, who is coming to college, um, they didn't need much just here's a pencil, a slide rule, a class ring, go to it type of thing. But as we began to, um, realize that, um, more women needed to be in college, uh, we have more diverse, cultural diversity coming into college. There've been a lot of changes since the sixties in colleges. The COS said OK let's also try to make some changes that might be open to more students. Um, we have some students that might not make perfect grades but they are really good in a research lab, have entrepreneur skills, things like that they can take with them, whatever background they have, whatever focus they have, so I think it was looking to more ways to be inclusive but I don't think it was stated like that. But it was just understanding all the trends in college.

DB Is it fair to say that the focus was more on the needs of the employers that the students needed to meet, the specific needs of the employers was more important or more emphasized than the high attrition rate?

J I thought they were equal. I interpreted it as we've got to do things we need to do here. We need to address, um, enrollment, attracting, retaining students, and we also need for them to be able to leave here with the skills they need to be successful because it, um, the philosophy is, this isn't meant to sound harsh, but you're guaranteed an education you're not guaranteed a job, but your education, like surveys that president Jiscke did found out, and I don't remember at the time because these surveys are too long ago for me to give you the percentage, but I'm going to say it was over 60%, it might have been as high as 80 or 90% of the students, were addressing and coming to college to get a job. The philosophy of coming here to get an education as my only goal wasn't there. The students do want to get an education but they also want to get a job. They are interested in grad school, medical school, you know whatever it happeJ to be, or I'm going to go work in this industry or I'd like to see what I can do about this problem, whatever. So, um, he wanted to make programs aware of what the students were telling us they wanted. And the other thing too was that if you have, um, say an honors student and she has great scholarship and she comes in, she does fou years in, let's say biology. And goes out to find a job and she can't find a job and then she's furious with the school. This is not a happy person because she was special all through school, she was coJidered a high achiever all through college. She goes out with her bachelor's degree in biology, maybe she's looking at being what she might coJider being a lab technician rather than a senior level biologist. So there might have been, that was an actual student who was just, um, she was somebody who would say, you would ask her do you work or something, and she would say I'm supporting myself through college would be her statement, so you would say oh where do you work and she would say I have scholarships. So she would use scholarships as putting herself through school. And, um, um, had a very strong seJe of what she wanted to do and who she was and things like that. So, um, I think that those types of students, um, a student who's maybe not had that much support from everyone throughout the whole time, maybe the C student will not have those expectatioJ. But they are still our student and when they leave here they need to be able to have the skills to, as much as they can, be able to know how to interview, things they need to bring with them to, I have had students who refused to join student clubs and do interJhips and said I'm going to this city and work in this job, it's a very selective career path like atmosphere science, and it took them a couple of years but they did it. They did it their way. So, um, you never know for sure what the student is going to need. But I wonder on some level at least from an academic advisor perspective, if they weren't looking for ways to help students achieve their goals, even if they weren't the same goals, like the faculty may think you're here to get an education, you're here to learn as much science as you can, don't worry about the job because you'll find a job. And all this was way before 2008, 2009 when things really changed.

DB Um, this question I think you'll be able to aJwer well. Um, did you see any problems in undergraduate science courses that caused you to think that there needed to be changes made?

J Um, students had a lot of things they needed to do. They had, um, they had 18 hours, 18 credits, a lot of liberal arts courses, working all day. They had four semester of foreign language, uh, plus everything else they had to do. We didn't require students to take Com 114 which is the basic communicatioJ course, because they were probably in other courses presenting papers or doing something so we felt like that, we had a lot of science students who weren't comfortable getting up in front of a group. And, ah, so, um, even though it was really popular with about half of our students it probably it probably wasn't preparing them well for what's ahead for them. When they interview they may have to give a presentation, if they were fortunate or unfortunate enough never to have that experience in a classroom, they hadn't had communicatioJ since high school, they may not go for a job they need because it was those types of skills they need to develop. Um, the other part of that was difficult was the math department. Those students could mostly take math courses and one or two lab sciences and they didn't have to have a background in chemistry, physics, you know they could mostly take just math courses. Everybody else had a very well-rounded program but math was the one that was a little bit, uh, lopsided like they would take usually maybe the easiest science they could find or maybe one they could stand. As it turJ out those were some of the issues that I think the math department was agaiJt this because they didn't want to have to change that for their students. They could have set up their own college of mathematics and not had to dealt with this at the time. They were really unhappy about that. The rest of us were kind of looking forward to maybe a reduction of some of these things like, the general education requirements went from 18 to 9, cut it in half. But then they added some things later which we'll get into, it was sort of frustrating but yeah, it looked like a good thing to do, it seemed like it was really worth the effort and time to do it.

DB Um, do you know, these are a couple of questioJ about the task force itself, but do you know what elements, I think you've already hit on some of this, what elements were coJidered in setting up the taskforce?

J Yes, they wanted all the departments represented, they wanted faculty, they wanted academic advisors, um, they wanted, um a good representation of people who were working with undergraduates, things like that. So they tried to get people who wanted to do this, um, and maybe some who didn't. But yeah, just represent as many people, big group, huge group.

DB Um, do you know how the taskforce was formed?

J I don't remember that. That would have been back in 2003 when it started and our department was actually the lead. We, actually we ran it first, we had a sample core that we did. We implemented that, I think, in 2005 or 2006, so it was our majors and, uh, then I think maybe actuarial science were the ones who had a pilot group that we did.

DB OK, um, did you, specifically, see any changes that you would have seen liked made?

J Yeah, um, when they set up the gen eds, before you know you had to have two from this category, two from this category, two from this category, they just couldn't leave the two's alone. And they said you had to have depth in something. So, um, but they weren't going to count like economics or they weren't going to count this, so they just kind of mucked it up again. IJtead of saying something like you get to choose three gen eds, go choose what you need, just let them run with it, just let the students have some freedom there, they didn't. They set this up so you had to have two from a certain area or they made a logical sequence. So we had to have all these statements, statements, statements about this, that just made it complicated. And then, um, they reduce the foreign language because they said really if you are completing the 202 level, you're really not fluent. So, if you go to a foreign country you have to have, or another country to study, your 202 level is probably not high enough. So, they, um, dropped that down to that you needed semester one and two of the same language and the third course could either be a third course in a language or some aspect of culture or diversity. And that's, um, been a little challenging but, um, they were really trying hard to give the students an opportunity to just learn more about other cultures so it's been a little awkward but not as awkward as the general education elective. Um, I guess I could talk later about some of the other things, um, some of the other problems we had.

DB Um, but you said something that, just a second ago, that the 200 level foreign language was really not enough to be fluent so was the idea to make them fluent?

J No, they said that we need you to understand another culture.

DB But not necessarily the language.

J Right, because you're not going to be at the 202 level unless you minor or major in a language, study abroad and spend time in another country or you have family or friends who have, you have an opportunity to get to know that culture and things like that.

DB The focus was more on, um, diversity as opposed to specifically learning to be fluent in a language. I've heard that too before.

J They thought it was going to help them do whatever they needed to do up ahead and now.

DB OK, so this might be the opportunity to talk about some of those challenges but, from an advisor's point of view, you probably know the changes, what the changes were, you've already been kind of talking about that anyways but. What changes were made to the undergraduate core?

J	OK, they were, they added multidisciplinary saying that you had to have evidence that you can do more than just your core science, they wanted the cultural diversity piece, they wanted the teamwork piece, and they wanted something to do with great issues. Because there again employers were saying our students that you are seeing don't necessarily know how to aJwer a question about, tell me something about this one of the, an issue, they're just not doing that. This generation was beginning to fade away from magazines and newspapers and things of that sort and end up being, social media was not what it is now, but they just didn't see an overarching understanding of issues. So they threw that in. Um, so that's what was added. They also made sure that everybody had to leave with two two-course sequences in lab sciences which had not, everybody was doing it except mathematics. So those were changes that were made.

DB	OK, the next two questioJ connect right into that. So, again from your point of view what were the successful things that were changed?

J	Um, the students loved the fact that they didn't have to pretend like they knew how to speak a language when they did not. Um, the students are, um, finding, um, that they are, um, learning more about the planet or other areas that are covered in great issues. Um, they are actually taking something with them, an appreciation they did not have before.

DB	So they like that course now?

J	They are getting a lot out of it and they also have enough to choose from that they can, ah, if they now that one is just ten times more work than another one like writing papers or doing things like that and they're not into that, some people love projects, they like group work, they like writing papers, others pack their suitcases and go to the core square, it's you're giving me this and I can give this back to you. You know it's more like quizzes and lectures and things like that. So, um, they are getting some comfort from that. Um, because we, um, are in our program we gave them more electives, took out so many required liberal arts courses, that gave them the chance to leave their major with more courses from their department, more courses from another area. So we were able to add more free electives to our student's program. So I think they are benefitting from that. So I think when the students saw that they were happy. I mean some of them wanted to switch. They saw the new core and said I want to switch to this. So we finally had to set up say if you were this far along in your program do not try to switch, because some of the classes won't be offered and things like that. They, um, the students saw this as a plus.

DB	Overwhelming positives. But on the other side of that were there things that you felt were uJuccessful?

J	Yeah, I think the multidisciplinary was, um, was not needed. Not needed, um, everybody was already doing all of this except math. When they changed the program they already made everybody multidisciplinary. There, again I'll use this department, you cannot leave here without math, calculus, statistics, um, computer programing, chemistry, physics, in some cases biology plus your major courses whether it was atmospheric science, geology, or environmental. Plus you are doing languages, liberal arts courses, so I don't know how more multidisciplinary you could get. When it first started it was this horrible process of trying to prove that you were multidisciplinary. And they have a, um, committee that would approve, if somebody had an experience that was multidisciplinary. Give you an idea, we had a guy who was doing an interJhip and he was doing computer programing and public relatioJ work in addition to atmospheric science. A physics person looked at this and said that's not multidisciplinary. The guy was getting ready to graduate. So it was too arbitrary, it was, um, um, it wasn't well defined. And so once you change the curricula in the core you didn't need multidisciplinary. It was so much work, extra work. The other thing they did was the teamwork, they weren't quite sure what to do with that. They decide that you needed principles and experience. That you had to understand teamwork from I think it was Meyers-Briggs. If you didn't know those terminologies and you couldn't look at your group member and say that you're this or that, you didn't know teamwork. OK, so, from the beginning the principles, the teamwork thing, was just, they offered it on Saturdays, football weekends to get people in. The course times conflicted, they tried to offer it three times during the semester. They had a Dean and a grad student trying to teach it, they had an administrator trying to teach it. It was just all over the place. And some of the things they would have them do in there were not science related. So it was kind of of tough. I think that's, um, it's one of the things they are still looking at is do we need to teach a module on teamwork. The module is still being taught and you still have to have both. I had a student come in who all his life has been, just a few minutes ago, who all his life has been a member of a team, knew exactly what to do, said I have to write a paper in my xxx science class about teamwork. He's already been through the module but he has to write another paper. So it's, um, oh you had to have teamwork your freshman year and then they backed off and then they said you have to have the teamwork module within a semester of your teamwork experience. They just didn't know what to do with it. And it was just, it's been exhausting. All these years trying to work with that and it's kind of up for a vote about whether or not they'll keep it.

DB OK, so one of the prior respondents I talked to about this very issue, she was very pro teamwork, really, really pro teamwork, and she said it began well because they actually had an iJtructor teaching principles of teamwork but then sometime later they eliminated that part and went to an online curriculum about principles of teamwork. How do you feel about that? Do you think it was better when there was a live iJtructor or, what do you think?

J Well, um, if you are standing there pretending you're an egg trying to hatch, I mean we all look for ways to get students engaged in something and somebody's going to think it's fun and somebody else over here is going to say really, I have to do this? So I don't know, I think the students do need to understand that when you are in a chemistry lab or a physics lab or something like that, there is going to be somebody who doesn't pull their weight, so how do you do that? You're going to have somebody with lots of energy in the beginning but not at the end. Somebody's going to come along at the end and sparkle and shine but they kind of dragged their feet the whole time. So yeah, it's OK but, I think the online has been OK because they were, the goal was for people to recognize terminology, understand concepts, and recognize yourself. You can do that in an online module. I think that makes seJe. Um, and then you have a way to apply it in the exact course that's the companion course to that. So I thought that that was not a bad thing to do unless, um, because there's a lot of teamwork that goes on all the time every day for these students. It started long before they got here and it's going to continue long after we leave. Um, or they leave and we don't know how they're doing so, um, if they keep this then I think the online part is OK because they are actually doing the teamwork in their computer science class or physics lab. The physics lab is set up, it won't function unless you work in teams.

DB OK, um, again this is like a personal question but, were there changes you would have like to see or thought would've been really positive but did not get made?

J No, I probably would have just left some things out like the multidisciplinary. And teamwork, I think I would have tried to come up with something different than what they had.

DB Was that from the get go? Not from hindsight?

J Yeah, it was like you're going to teach this five week module three times and we just had problems with it. And we had DeaJ teaching the class which was great but I mean it was just so much effort put it for this one credit five week class. It was like…

DB The same for the multidisciplinary too, would you have eliminated it from..

J There was no need because, the only problem was the mathematics department. And they were going to have to go into the new core, so it fixed it, so you didn't need it. We would have faculty members, um, at meetings saying you can't teach teamwork or leadership, you either have it or you don't. I don't agree with that, I think you can expose people and it can grow and expand. Um, but, it just didn't seem that, um, there was also a rush to get everything implemented, you don't want to drag your feet once you make a decision. But we were starting the new curricula for everybody and we didn't have the courses. We were like, yeah. Then again with multidisciplinary, you know we didn't have courses for great issues. I thought the great issues was a good idea. Um, the teamwork was like maybe we need to rethink this. I thought the teamwork should come in through Boiler Gold Rush. I thought that would have been a good time to teach everybody, every program about teamwork. This is different but Boiler Gold Rush ended on like a Wednesday or Thursday, students were supposed to have some down time and as those students moved in maybe they can help them. But those two or three day off from Boiler Gold Rush turned in to be a time when things happened that probably shouldn't have. Either realize how homesick they are or the guy who is currently running it said we'll just buy them a keg because they are trying to figure out. I wasn't aware there was that much of a problem but I always thought there should be a community service project at the end of Boiler Gold Rush. You spent the whole week learning about this place, meeting other people, you've had food, music, you've done all of this, take all of this energy and help somebody, let's do a community service project. Let's do teamwork and a community service project right there in BGR and you're done. I think something like that would have been marvelous.

DB So, on scale of one to ten with one being completely bad and ten being beyond expectation how would you rate the College of Science's core prior to 2007?

J Probably about a seven, I'm sure students left here with a really good education it was just a lot of work. I'm not sure they were getting everything they needed so let's just give it a seven.

DB OK, same question but then with the new core.

J I would move it up to an eight. I think it improved it a lot, um, but like I said the multidisciplinary just throws it all off. We have students who don't know what you're going to do when they are already multidisciplinary. And nobody will listen to you about that so…

DB OK, the last two questioJ are kind of for me the key to this study. So I'll read this verbatim to you but we can talk about it, um, how do you define reform in light of the College of Science's core curriculum? So how I view that question is more the point of how do you define reform?

J Is reform, um, something where you are looking for a specific outcome?

DB I'm going to let you define that. So you tell me what you think reform is. But before you do that though let me also put this point in there that, um, nowhere in the founding documents that I've read so far in this the word reform was never used. So, it's missing so much that it seems coJpicuous to me. So I'll get to that point in the second question but the first point is how would you define reform?

J To me reform is probably something huge. It's big, it's not oh let's tweak it a little, let's add this. Reform is big.

DB Like changing the entire curriculum?

J Yes, um, you've got thing out here, outcomes you need to assess or you need to address. So reform would be, um, something that would, um, move mountaiJ as opposed to oh we'll just add this course or something like that. So, um…

DB That's actually a good definition, so the follow up on that, the last question, do you coJider, based on your definition, do coJider what the College of Science did with the undergraduate core to be reform?

J Yes, because they were, um, actually looking at things in terms of, ah, feedback from maybe alums, if you happen to be that, you're saying look I went to school here and it was great, um, I learned what I needed to know but coming into this world now these students need to be from day one need to work with diverse populatioJ, they need to work with people with different personalities and work ethics than they do, they need to be able to present, they need to meet the customers, they need to be able to talk to their boss and convince him or her that they need this or that. So I thin k it was so sincere on that that wanting the student to have, um, a communication course, being able to understand teams, being able to understand what issues they are facing, this planet, this globe. I think those, um, which we hadn't had before maybe not huge reform but an important reform that would make our students better qualified for the next step, whatever it is. We're still getting them maximum you know voltage to go out there and do what it is they want to do. So, um, the other thing they did with this curriculum was that they said we're not going to just let it sit here, in five years we have to look at it, every five years we have to go back and look at it. And that's where we were last year, trying to look at it.

DB Did they?

J Yes, but they are still not working on some things like the multidisciplinary, the science, the general education electives that two sequence thing. But I think iJtead of just dropping that they're going to come in and say you have to have one from social sciences or one from, they just can't leave it alone, they have to go back in, like I said muck it up again. IJtead of just giving the kids a chance to pick out what they need. They may be doing you know a certificate or doing a minor, it was things they need to play with that. Um, so, um the idea of the five years I think is good but if you still have people dragging their feet then the five years turJ into six years, you know here we are a year later and nobody seems to know. The other opportunity that's on its way here is something called university core. And that had a lot of things going into it that I don't really want to get involved with this conversation but, um, that too, we're supposed to be getting that ready for the fall students and we don't know what it is.

DB They haven't decided on that have they?

J They kinda had decided but how we put it together for this. So they are asking us to make changes in the current science core, they're asking us to include the university core but we don't exactly know how that's going to fit in. So it's very difficult to do right now because we want to drop something like they're kind of hesitating on the multidisciplinary again, but it's like please don't do this because they already are. And if you are already changing the general education electives to make them more challenging, um, if you have to have evidence of something that we don't have in our program, you know do we have to add that, you know something like that. So if they stick to the every five years and we have people who are willing to look at things and um, and um, look at what needs to be done then I think that'll work.

DB OK, just to reiterate, your definition of reform, this was a major reform then?

J OK, yeah.

DB I'm not putting words in your mouth, I'm just trying to clarify that.

J I, I, I think they were hoping for that yeah.

DB But what do you think?

J Um, yeah probably, um, yes because they really were trying to mold it a little bit to fit what the expectatioJ were today, so it wasn't something where they changed absolutely everything but, um, it was enough of a change in attitude that that could be reforming.

DB So um, lastly is there anything about the process or outcomes that we haven't talked about that you would like to throw in there?

J No, I think we covered just about everything.

DB OK, thank you Nancy.

Betsy Interview – May 2, 2013

DB Good morning, this is May 2nd, 2013, uh, my continuing interviewing for my thesis with Betsy, ah, who is a math advisor…

B No, I, I formerly was a math and statistics advisor, um, from 2006 to 2012. I'm currently manager of the statistical consulting service and a lecturer, um, for introductory statistics 301.

DB OK, that's good news. It's good information but you were still an advisor during the period I am interested in.

B Yeah, yeah.

DB If you don't have an answer to any of these questions that's fine just say you don't know. So the first question, um, what national trends in science education were considered in developing the undergraduate College of Science core? Do you know of any trends that were investigated?

B Not specifically as we talked before. The advisor's were not really part of the decision making process. Although I think that, um, the idea of teamwork and teaming, which you know were kind of a big topic at that time and perhaps now, and being able to write and communicate, um, were also kind of trends at the time that I think they wanted to capture, that's just my opinion as to where they came up with some of these…

DB But those have been repeated in other interviews, teamwork and communication. \

B Yes, being able to write and speak.

DB OK, I'd like to ask you an addendum question. Did you notice any problems in undergraduate sciences courses that caused you to think or to consider making changes in the College of Science undergraduate curriculum?

B Well, most of the changes in the curriculum did not have to do specifically with the science courses, it was really the other stuff that our students had to do.

DB The science core?

B The core, yeah, yeah, the other, um, you know the English requirement and the foreign language requirement, and those kind of things, so I don't know, the science courses themselves were, but then again the decision makers, I don't know what their thinking was

DB What I'm trying to get from you is though because you were an advisor and so you were talking to a lot of students. Did you see any problems, maybe coming from the students themselves?

B In terms of the?

DB Coursework, what they had to take, difficulties in certain courses, attitudes, I'm just throwing stuff out here.

B Well with the group I had were math and statistics majors, um, always felt like having to take other sciences courses was, you know they didn't want to have to deal with that, they kinda preferred not to do any, mum, and just stick with their…

DB How about gen ed stuff?

B Um, you know I think students in general feel like why should I have to learn all this other stuff, I'm sure they've been feeling that for decades, um then the idea you know that this is part of the well rounded human being doesn't seem to matter much to the 18 top 22 year old set.

DB So they wanted to come here, get a math degree and, if they could just take math courses…

B Oh yeah, a lot of them would be happy to just take their major and not have to, they saw all these other things as kind of an annoyance.

DB I want to back to something related to the first question. I want to bring this out because it's not really in here. Um, you mentioned two of the national trends which was communications and teamwork. And others mentioned multidisciplinary work and, um, a forth one great issues. But the trend I was seeing and have noticed and as an advisor maybe you have noticed was the attrition rate. Were you aware of that?

B Yeah, that was part of the problem. And this is always difficult to get the administration to really understand that at the time, and I don't know how this has changed, at the time we were, um, a feeder school, I think we still are, at the time when, um, you know the way students applied you picked a first choice and then you picked a second choice and if you make it to the first choice that, we were the fall back, so you know we were clicked as the second choice a lot of students who we were the back door primarily to engineering but also to some other areas as well, um, and, and, so yes, you're going to have attrition. Purdue makes, pretty much makes everybody chose a major when they're filling out that application. As a parent I know I struggle, my own kids are struggling with this decision, what do I put, what do I put, so they put down anything. And that's what they start in and then they figure it out. They figure out where they're going to go so, you've got this, you know, pressure on science to keep their students but yet students aren't picking it necessarily because they want science. And it was always a struggle, I felt as an advisor that my real allegiance was to the students and not the school. I needed to help that student find the right place for them. Not keep them here if that's not where they are supposed to be. And I still feel that and I'll always buck against that even though the pressure comes down, in the end it's what's right for the kid not what's right for the school. And to keep our numbers, you know we're so focused on numbers, and you know it's bullshit.

DB So, um, if I could just reiterate, uh, your feeling is that the attrition rate out of the school of science is more due to the fact, the admissions process really…

B Absolutely!

DB Than any endemic problem within the school of science.

B Right! And I think those that really felt, um, that they wanted to be in science, kids come in with the idea of what their discipline is like, what science is like based on their courses they had in high school. And they don't really have an idea of how much work it is. And they get here and it's a boat load of work. And they're not ready for it or it's not, it's not as fun as, you know, it might have been in high school. So that's also coming in there to play.

DB So if I were to tell you, um, that on the national scene, and this is well referenced in the literature, that attrition rates out of schools of science nationally is over 50% and most schools probably, and I don't know this for sure, most schools don't have the system we do here where science might be a feeder for other schools, um, that was kind of my focus, that national attrition rate.

B I, I wouldn't be surprised.

DB And just to hypothesize, your feeling, I shouldn't put words in your mouth, your feeling may be that students coming out of high schools simply have a misconception of what science is and are not prepared. Is that how you feel?

B Yeah, I, you know I think it's not necessarily a misconception but it's just not understanding the full scope of what science is. Of what, really get in to upper levels. This stuff they've taken in high schools that's covered in the first semester of chemistry or biology or whatever. And then they're beyond and it gets, and it's really you know it's a whole new ballgame and they're not, I mean. You talk to the biology advisors cause that's where we have so much, there's a ton of attrition from the students that start from biology. Because they all think they're going to be premeds, that all think they're going to med school and then they realize how hard it is and shift.

DB OK, some of these questions, um, I don't think you may know how to answer but, um, do you know what elements were considered in setting up the task force?

B No.

DB Um, and this one too. How was the College of Science task force formed?

B I don't know. I see you have some of the old web pages. I have emails dating back pretty far. If I find anything that might be of any use to you I'll send them on.

DB What I can tell you from previous interviews about this is pretty much Vitter gave this charge to basically Alan Welsh and Chris Sahley, more Chris I think. But Alan…

B But Alan, when was he, I think about the time this was all happening he was, because there had been a split when Kerry Daly came in, um, and the responsibilities were split and then basically they kind of switched roles. Whereas Kerry came in as in charge, the director of advising, and Alan was other projects. Then when all this started basically those two switched and Alan went back to director of advising and Kerry became in charge of all this other undergraduate education stuff. So when I started in 2006 he was associate dean but his role was, um, you know the time line I'm not sure exactly when he left.

DB About the end of 2007. Anyways, this was Vitter's charge, basically he put Chris Sahley in charge but gave Alan Welsh a significant role. This is off the cuff but did you see any changes that you would have liked to made in the curriculum before the task force was officially formed? Did you see anything in the curriculum that you didn't like or that you would like to see changed?

B You know the one thing I thought students really struggled with was the four semesters required of foreign language. That was hard for them to get through. Definitely there was a significant number of students that you know, that was kind of their last hurdle to get through. But you know it didn't really, I didn't, I didn't see that this is all broken and it needs to be fixed. Um, it could be, you know, the level that advisors, you know we get in the mode of we're just the enforcers, we don't you know, I don't remember feeling like this curriculum sucks or anything and we should change it other than that foreign language was hard to get through. The old curriculum was easier to understand by the students. And it was easier because it was kind of more of a check box. And the new curriculum, part of it because of its implementation and refining and it just, you know, it got so confusing and so, the students you know, there were times when we thought you think we're idiots because we keep on getting changes from above about how we're gonna, you know after we already told them x, y, and z is what's required next semester and after registration had occurred they changed their mind about something or refined it and then we had to go back and say oh now this is, that's not exactly what it is. That was the main, that was a huge difficulty. I think we lucked into it and it probably should have taken another year to get it right before it was implemented.

DB Maybe Vitter wanted to get it done before he left.

B I believe that may have had some effect.

DB What from your perspective, what changes did the College of Science make to the undergraduate core?

B Well they, um, the foreign language requirement was reduced, instead of four semesters of a foreign language students could use, um, two or three semesters, I think it was a total of 9 hours, they have two semesters of language, and then another cultural type course. It was a very broad offering, study abroad could be one. Basically any course that had a non-USA type focus. You know you could take a course…

DB Was that a positive change?

B I think that was a positive change. I think it definitely, um, although, and students the first thing they'll do is find loopholes to everything. Um, I mean I'm sure it reduced the number of students taking foreign language because a lot of them could test into semester, test out of a semester or two and then they didn't have to take foreign language they could just take that cultural course. Um, and I think, I think, I don't know that, um, yes you could use study abroad however at the time, and I don't know if that's changed, it had to be to a place where it was not, basically to a place where, you could go to Australia or England, you had to go somewhere that wasn't English speaking. Um, and then around that same time, um, is when our influx of international students came in and or started and that adds a whole other dimension to how do we treat them, foreign language they've kind of got to, that was always a huge thing to deal with. So I think that was positive, I mean I think most students would like to see us totally get rid of foreign language. Other changes, uh, let's see in terms of the, um, gen eds, um, you had to have prior six gen eds broken down between certain categories. Um, then it morphed into, um, three gen eds, two of which had to be in sequence which meant they were somehow related to each other, which I guess made some sense that you had two courses that were, sometimes that relationship was quite tenuous. Um, so I think that was an OK change. The teamwork piece was, has been the most problematic. I think in theory getting two students to work in teams you know, cause, as you and I know in the working world you are always, you are always working with somebody. You know very rarely you're off by yourself doing whatever and, um, and students generally have a very bad attitude towards teamwork because they've gone through that process in high school being stuck on some project, so they hate that. So I think I theory teamwork, um, is a good idea although I don't know that we have ever done that great of a job in implementing it.

DB OK, here's a caveat to this, um, you're, and one of the reasons I really wanted to talk to you is because you are one of the few math, at the time at least, people in math, um, I've been told that the math department resisted this, particularly this idea of teamwork, powerfully and strongly resisted it. Can you give a perspective on that?

B	Well I don't know maybe it's part of the culture of that department, um, I don't know, and I know who was on the committee at that time, and that was Kenji Matsuki, um, he didn't like the whole teamwork idea. Um, he ah, just in general math doesn't like anybody telling them what they're supposed to do…

DB	But isn't that a natural human, I don't think anyone wants to be told what to do.

B	Yeah, it's the personalities of the people how major in math. Um, and to some extent probably that is a discipline that is more solo, you know, than anything and so it's not like a regular lab science where you're definitely, you're working in the lab and you've got people around you that you're working with. So part of it is that and I think it's just, um, I mean, so for example the math department has a hard time to get anybody to be head of the department. And they do their three years and they're the hell out of there. Um, and that's just been kind of, you know, they all see this as not a goal but as a burden and doing um, being on these committees I'm sure is kind of considered thankless jobs. Well and, and so I don't know why the math department is that way I just know they have been, they have been that way. I mean individually there's some very lovely people there but, um…

DB	I can't anybody to talk to me.

B	Yeah, well there's some internal strife in the department right now, the head is stepping down after only two years as head. I think there is some tension between the department and the Dean. So I definitely there is with this Dean there is, you know whatever. I like the guy personally, his kid and my kid are in classes together, but I think from what I've heard there's issues there with…

DB	So a couple of, if I can bring these in, a couple of changes, um, one of them, ah, you mentioned the teamwork, multidisciplinary aspect, ah, any thoughts on that?

B	Well that was one I think that you know kind of sounded good on paper, um, but you know science, maybe not math and statistics so much but most of the sciences are already multidisciplinary and so it was kind of this thing that just was like we're already doing this and the students say that, um, I also work with actuarial science students who are basically doing statistics they're doing math they're doing business they're doing economics, they're doing, they're basically already multidisciplinary. Those kids, I thought that was, um, that was kind of a, as far as implementation, that was a lot of bullshit how we did that, you know. And it was kind of this one that why teamwork became a bit of a boondoggle to implement and there all kinds of you know work arounds that the students would come up with. In fact at the time that this was implemented, um, we started a system in the

College of Science it was called the exception database. And, um, while certain you know a student would petition you know so we kind of had our current set of rules which shifted as far as implementing the curriculum, it was shifting and changing all the time. Um, and a student would come up with something and we'd work out something and it wouldn't kind of be on the approved list and, um, then you would you know submit something and it would get ruled on. Um, at first by Chris Sahley but then that became too burdensome because there was too many of them and then it would be deferred to, well by this time Lynn Horngren was in, but the was a lot. But eventually certain things became, um, precedent setting, you know certain types of things and then that would kind of become a rule and then, so there was you know at the time I left if you went to the exception database, there were probably 4 or 5 hundred requests over several years. I don't know if they are still doing that or not but you know that students will always figure out a way, and it's not always trying to be sneaky, I mean sometimes it is but a lot of times it's not, sometimes it's just creative, it's like hey I'm planning on doing this anyway could we possibly make this work? A person not on the approved list and I don't know how far back, I don't know, I haven't looked at the web page, is there any more, see what's currently OK to meet this, to meet this, and to meet this. Because students want it all laid out in black and white and that's one thing this curriculum didn't do. It didn't lay things out in black and white and it was kind of a in some ways a make your own curriculum within these guidelines and students don't like that. They want it pick one from A and one from B and then…

DB I see that in my own classes. They don't like ambiguity, they don't like…

B Right, they love it if you give them a rubric or something, my gosh they love that, they want to know exactly, and, um…

DB That could be a negative.

B Right, but that's the nature of the beast.

DB OK, one other thing in terms of the changes we haven't talked about is the great issues.

B Great issues, I think, I think again, um, in theory that's a really good idea to get them out of their kind of narrow focus, to see things on a broader scale and my gosh the way communications are now you know what's happening in Dubai ten seconds after it happens or whatever. Um, although, um, the offerings are not always up to that whole ideal, you know, not every EAS course, EAS has actually been kind of the forerunner and they've been, they've taken the lead on that, you know and put some courses out there. And other departments, you know, and math was like, they finally after being pressured for years to do something they offered one. And the first semester they offered it was a fiasco. Because of the way, yeah because the way it was set up, it wasn't supposed to have set up so that you needed this high level of prior math knowledge but it kinda was and, um, you know. It's, I think it has merit, I think it was just too variable. You know certain courses became known as oh yeah take so and so's, of course that happens in everything. Take so and so' course and you don't have to do very much.

DB You've touched on these things already but I just want to bring them out specifically, um, any successful attributes of the changes? I think you kind of mentioned that already to some degree.

B Um, I think the students who stated at Purdue after it kinda had a couple of years working the kinks out, you know, the ones who started in 2007 and actually in 2006 we started what we called the pilot program, um, and I was, my students, my actuarial science students were part of the pilot, Nancy's EAS students were part of the pilot and so we were kind of test driving it and, and they were the guinea pigs, I mean actually those students kinda got a, got a get out of jail free card because, you know, and as things changed they kind of, this is what we are starting with and as things changed and by time, you know, two years later was quite different they can kind of say basically here's the set you got, you can keep those, you can , you know, things that other students later on couldn't do. They were able to do it. They could take two econ courses for their, um, gen ed sequence and later on that was decided no you can't because that was too businessy. Um, so I think, I think well the language, I think…

DB Was the multicultural successful?

B Multicultural, is that what foreign language is called now? I think that was successful, I think, um, you know, and if when you talk to advisors, advisors are always going to, you know they love to get together and gripe about stuff, it's really hard to separate, cause you know, and advisors live in the details. Um, so as soon as, so I think in general that the language was successful I think that the great issues in terms of, um, getting students to think a little more outside of their Indiana focus, um, I think, I hope that the change in the communications and writing, um, you know making that more, cause science students think, you know, why do I have to write, oh heck yeah. You're going to write your entire life. I spend most of my day writing. Um, so I think you know overall, I think teamwork was not successful. I don't think teamwork was successful, I think it was just so, um, it had so many problems and issues and students already had a, you know, every student coming out of high school has got an opinion about teamwork and most of them are not good.

DB And how about the multidisciplinary component?

B I don't think that one was successful. It was too confusing and not well defined as to what it was. I know when I sat down with students and I would have to kind of say, kind of go through my little spiel I would always get to multidisciplinary and I would never have good reasoning for our rational for that. I would say oh we have a multidisciplinary requirement and that has to do with you getting outside the focus of your major. What the heck does that mean? And I would just kind of breeze over that and they didn't ask me about it. Because it wasn't really well defined as to what that really meant.

DB So the next question is, um, you may not have an answer to this one either, would you have liked to see any changes or even currently do you see any changes that you think would be good that really didn't get made?

B Um, I think, you know, we just always wanted to have things clearly defined for us.

DB OK, that's a good point. It went from a clearly defined system to a more ambiguous one.

B Definitely, and, and, things just kept shifting and changing every semester. Um, and then like I said I know I talk to people on the other side of the hall all the time and I know teamwork is all changing, foreign language, you know we went through years and years of making our international students jump through hoops to prove their foreign language to us, that they're fluent in Chinese or whatever, it's like now the thing that we wanted to happen, you come here and you're from another country we know you have language skills in that other, you know that other language. So obviously you are, you are, fluent enough in English to survive here so…

DB That's not always true…

B That's not always true and we have had issues but by the time they are done here they've got it. They know more English than our American students know of the other language. Most of them know very little yet we let them breeze by and these international kids have a much better command of two languages than our students will ever have. So, other changes, ah…

DB I mean if you had a wish list and you could say I'd like to affect that change is there anything that jumps to your mind?

B I just, I would say teamwork and foreign language are ones that I particularly, you know, wanted to see get better.

DB Alright that's fair. The next two questions are silly scale type questions. On a scale of one to ten with one being really bad and ten being better than you could imagine, how did you feel about the College of Science core prior to the change?

B Oh I don't know, I mean, I think it was successful, I don't know what that really means, whether it's successful, I would say a six or seven.

DB OK, then the same question, um, but ah, on the other side after, so the new core?

B That would be shifting depending on the year.

DB OK, how about today, right now?

B I've been away from it for a year and a half so I'm not quite sure…

DB OK, how about when you were last directly…

B I would say we were maybe getting up to a six.

DB So you were lower than the prior, you would rate it lower than…

B Well just because it was still, so you know, it was still changing and shifting even at that time. In 2012 when I left and this was five years in we were still working out the kinks. And, um, you know, in the first couple of years I would probably rate it a three or a four. Um, you know, I would say a six when I left.

DB Fair enough. The last two questions are really an opinion type of question. When I read all the documentation that the task force put out there was an interesting word not there and that was the word reform. OK, so, um, first can you define what reform means to you and second do you consider the changes made in the light of your definition reform?

B When I see, hear the word reform I'm think you're fixing something that is wrong or, or not working or there is just an inherent you now something bad about it. You know that's when I hear reform, um,…

DB And then you are coming in with a set of things fixing those…

B I don't feel, I mean, I think that it probably needed updating.

DB But that's not reform.

B But that's, yeah, but I wouldn't have said it needed reforming, I would say it needed some, some enhancements. Um, but I wouldn't say it needed reform. I think you know to me it seemed like, the thing we kept hearing is it's been forty years since the College of Science changed its curriculum. It's kind of like you don't want to say it's been in place for forty years and so much has changed so I guess we need to sound like we're, we're being progressive here.

DB Right, so, you, in light of that, you really don't think what was done was a reform in that definition, more of an updating in your semantics.

B Yeah.

DB Do you think there needs to be a reform according to your definition?

B No, I don't think there needs to be a reform. I think you know heaven knows what's on the horizon with the pushing towards a university core and, um, you know, all this, perhaps it laid the groundwork what, some of what will happen in the university core. Um, and I can see from a parental standpoint in my own two kids, I've got my first daughter graduating tomorrow right…

DB Congratulations, in what?

B Nurse. And I can see where, you know, Purdue having all these different requirements, everyone doing their own thing doesn't seem cohesive and doesn't seem like we're working together. In some ways it seems like, you know, do they all know what they're doing? Um, and so I think to kind of have a general framework even though the core is going to have to be slightly different from engineering versus HTM or you know some of these departments I'm like, certainly you can't force everybody to have the same level of math and sciences and blah, blah, blah. So I think kind of having a general framework is good, um, but I wouldn't say that, you know, we need reform. I probably wouldn't put that word on it.

DB OK, alright, well I think, unless you have anything about the curriculum you want to throw in there I think I'm pretty much done with my questions. Thank you.

Interview with Sam - 5/9 20

DB What national trends in undergraduate science education were considered in developing the undergraduate college of science core.

S Absolutely nothing.

DB Really. Nothing?

S Nothing, complete and utter absence of consideration.

DB Of national trends

S Of national trends

DB Well then ok what kind of trends, did they look at any trends?

S The problem that you run into is this, there are institutions, I visit them as an external reviewer, where faculty do get together and talk about the overall curriculum. What should it be? Why? What are you trying to solve?

DB Ok

S Ok, we had two forces at work. One was a guy by the name of Jeff Vitter who realized that he was a failure as a dean. That he was considered a failure by everyone that he was surrounded by including fellow deans and the provost and virtually all of the faculty he dealt with.

DB Wow

S And therefore, was looking for a way to pad his resume so that he could go on to a later job.

DB Get a job

S Jeff went to Texas A & M as provost and two fundamental issues happened neither of which we can understand. Number one: The president never contacted anyone at Purdue for advice.

DB Oh wow

S Including people that she knew never any phone call to anyone.

DB This is from Texas A & M?

S From Texas A & M. And number two, within a month or two of his getting there the president was ousted so he became a eunuch.

DB He was kind of a sacrificial lamb in a way?

S And then he moved on to Kansas. And in Kansas apparently he's doing ok. Uh, he did not have the personal skills that one wants in a dean. You know the ability to smooze. He didn't ever listen to anything that women said including associate deans in his college.

DB Yes, I am aware of that.

S I.e., Chris Shaley

DB Right

S Ok, she might as well have been mute because. So Jeff's brother

DB From Louisiana

Was from Louisiana and um got into some trouble as some people remember. One of the great quotes was from his wife who was being interviewed when this incident happened and asked how she would respond. She said I'm more of a Lorana Bobbit than Hillary Clinton kind of person. Anyways. Jeff was bright but he was incapable really of listening to people and misogynist. He was a math computer science person trying to run a school where the dominant department happens to be chemistry and he just never really understood science. He never really understood what the problems were. So anyways, that's an important force, you've got somebody who says we will do something and I'm not going to listen. For example, once the proposed changes were released there were quote unquote open sessions with the faculty but they were maybe an hour long. There was no time at which anyone was willing to listen to a discussion of the issues. So that was a force at work. Number two, it was fairly well recognized by faculty who had been active with the college that we had a curriculum that had flaws in it. You know it was the Chinese restaurant syndrome, choose two from column A and three from column B and people were never all that confident. So we had a general perception that our curriculum was too old.

DB Right 45 years

S And too much of computer science being kidnapped, you know Kuhn the notion

DB Thomas Kuhn?

S Yeah, pre paradigmatic, you know, it just didn't fit anyone's real model and no one could remember it having been created because it, you know, it was 30 years let's say. So there was no discussion at the college level of any goals that we had of how this fit into any trends. Of how this fixed any problems other than the perception that we hadn't really looked at our curriculum.

DB Right

S And so, this is an excuse to do so.

DB Ok, so those are the two reasons why um

S That was genesis

DB OK, That's how it all started. So they didn't look at any external trends?

S Nope no external models were considered

DB Any internal trends?

S Well I mean we knew what the problems were. One of the problems historically has been that the retention of people who come into the college of science for graduation um is as high as any college with the possible exception of engineering. We were very, very good at getting students to come here who then would eventually graduate but they didn't graduate in science.

DB Right

S Like other institutions of our kind roughly one in three

DB A third

S Would graduate. That's not unusual; it's not an usual number. Uh the difference between us and other institutions not benchmark but to whom you'd compare is that at least these kids did graduate

DB Ok

S They just didn't graduate in science

DB Not in science

S There are a lot of reasons for that. One of them dealt with the fact that these kids came as science major's cuz they hadn't ever been exposed to anything else.

DB Right and they didn't really understand what science is

S They didn't understand and so they would go into psychology, they would go into you know other programs on campus. The second problem uh which is one that I've always had a proposal for but everybody who listens to it laughs. The only way of really solving the freshmen problem is to create a college of science and engineering.

DB Oh Ok, I see where you're going yeah

S And admit students to the college of science and engineering and from that point on you don't have to worry about retention. A number of engineers come into science at the end of the first year a number of science students go into engineering this changes the apparent retention although it doesn't have any effect on graduation.

DB I know what you are referring to because a lot of students came into the school of science wanting actually to be in the school of engineering.

S Many of them came in noting that they wanted to be in engineering. Um, but that's an old uh story. The number game is not really as high as people think it is.

DB ok

S The number moving to engineering is considerable the number moving to engineering because that's what they really thought they were going to do when they got here. It's not necessarily as high as people think it might be but that's again a perception. The perception is that they come here thinking that they can get into engineering. The problem of course is that it is harder to get into engineering as a transfer student than it is when you apply for admission.

DB It's maybe a little harder to get into engineering as a freshman than into science too

S A little harder, not substantive but yeah

DB that'd be another study

S Yeah, so anyways the problem from the perspective of the study of this nature is that what you hope would have been done had no relationship to what was actually done.

DB Isn't that the truth in a lot of things?

S it is particularly for big institutions. Uh let me give you an example, I was just out at Arizona State uh for an external review. And uh Michael Crowe, roughly 10 years as president. When he was brought in as president, he was unilaterally believed to be the anti-Christ, everybody. Didn't matter who you talked to thought that he was a horrible ugly incompetent human being. Ten years later he's looked at as a saint. He has not changed, his model has not changed, his position has not changed but the institution finally realized what he said when he got there is this will be a model for the 21st century university. Don't tell me what you have been doing tell me what we should do. And so interdisciplinary studies, multi-disciplinary studies and interactions between schools and colleges and for campuses all those kind of things that now work because of Michael were all of those things that were thought of as horrible ideas when they were first purposed.

DB And just to interject, one of the components to change in this school was a multi-disciplinary component?

S We One of the things that we had is that we are unusual in that we're not a college of arts and sciences. Now there are good things about that and there are bad things. Uh if you compare us to IU which by the way has a college of arts and sciences. There has been discussion of bringing the sciences out

DB Wow

S and it will never happen

DB OK

S because the sciences are the form of livening.

DB It keeps everything running

S In the absence of that then the amount of money going into the arts end of it not going to be (?is not going to be?). So what it does is it brings in revenue, it brings in support. It makes everything look better overall. We don't have one of those; we have a college of science. And the problem that we have is that there are seven departments but that's not really true. There are two groups, there's a group of four departments and then there's a group of three departments and never the twain shall interact.

DB Are we talking physical and life?

S Nope because the physical and life people actually get together.

DB ok

S The problem is math, computer science out of which, which grew out of math historically and when my kids call sadistics. The basic ground rules of what they want for their students is fundamentally different from what physics, chemistry, the biological sciences and earth atmospheric and planetary sciences believe.

DB Is that a valid thing?

S It is a valid perception of a difference.

DB Ok But you don't believe it's real?

S It's real. It's real. Does it, must it occur no. uh and we are evidence that actually you know the school operates but we've had deans from math, from CS. They have not been anywhere near as productive as when we had a dean who came out of this department because they frequently literally didn't understand what the issues were for several years entering in.

DB is that specifically of chemistry or of physical science?

S No it's the sciences. Its science verses mathematics.

DB So you view that as a fundamental difference?

S It a philosophical difference, to calibrate it what I'll do is I'll point out I teach a history and philosophy of science course now for the college for seniors for this very issue.

DB Yeah right

S First time I had the course I had one third of the students were from math. I changed the prerequisite so that they had to have a year of chemistry and a year of physics.

DB Oh wow

S Cuz I can't teach a philosophy of science course to math majors. They just don't understand what the issues are. The fundamental background, you know the philosophical foundations for mathematics verses the science. In this philosophy of science course I have a lot of fun. First day I ask the students give me examples of academic fields categorized into two categories, it is a science it is not a science, and I stipulate that chemistry and physics will be in one category. I tell them I will stipulate sociology in the other and I'll tell why later on in the semester. We debate whether psychology is a science or not. Some people are a little nervous about biology but we put it in there. The question of math inevitably comes up and there is no agreement. They don't want to put it in either of those two categories, it's not a science and it's not a not science. It's a philosophically and it's you know there is a philosophy of mathematics, there are books on it, it can be taught it's not the same. So this is a problem that we have historically had and indeed it is a problem when a vote comes up to make changes in the curriculum. The math department is happy that our students take math, a lot of it. They're not as happy about the requirement the students must take science courses. We don't have an applied math group really. There are places that do you know we don't there's a difference between math and applied math but

DB I always thought physics was applied math

S yeah but anyways so this is a phenomenon that underlies all attempts to revise curriculum within this college.

DB but wouldn't it be true other places too?

S uh it is not as true at other places because most other places don't have a college of science.

DB oh I see

S there are two phenomena that make this a significant problem at Purdue that is not the same elsewhere. Number one: is the existence of the pure college of science. Let's take Arizona State; they have a college of Arts and Science. They have a school of letters and science. You would think that there's some conflict between those two by the way, there is but I understand why there is and I understand how they do it. So the first this is that most, not all, benchmark institutions will frequently have an Arts and Science college. The second thing that happens here is that unlike most institutions we do not have an institutional core.

DB But their talking about it now

S OK this is a direction in which the University is going but for most of my career here people have used the term silos.

DB Yeah I've heard it a lot too

S And because it is, students do not apply for admission to Purdue.

DB Right

S you cannot apply to Purdue, well again there is an exception, we found a way to get it to happen but essentially you apply to a college. The advantage is that for things like general chemistry I can tell you in May how many students there'll be in class in the fall cuz I know how many students the engineers will admit, I know how many students will be admitted into science. I know that number

DB And you can plan

S At There are two big fundamental models. Michigan State is a good example of the other model. At Michigan State you make, you cannot declare a major until you are junior. It is not something that you are allowed to do. You can declare a major preference and engineers worry about that because they do start a vertical system as freshmen but there are no first or second year students who are majors.

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DB Interesting

S The college I went to was intermediate between the two. I knew I was chemistry major but essentially all first and second year students were in a University division that you got out of to go into your m ajor. Purdue starts its major in the senior year of high school because that's when you declare it.

DB Right

S The other way of setting basis for comparison is some work that we did with a living learning community course. Half the students were from science half the students from engineering. The students in first year engineering bond. They all know that they're engineers. They know that some of them will become mechanical engineers and some will be chemical engineers but that doesn't bother them because they bond for all engineers because we all take the same basis core courses. In the college of science those students never bond. The chemistry majors did not feel that they were the same as the ones who were biology majors and neither of those groups thought they were the same as the physics majors. The division was not created, it was intrinsic from day one on campus. I am chemistry major, I'm not a science major

DB That's an interesting point

S And so these things make Purdue

DB Unique

S Unique or one will always have to say virtually unique because it makes our system fundamentally different

DB Right

S Ok so the focus was on practical perception that we had practical problems with our old curriculum getting it done and then we had an individual who said this will happen so you can worry about top down and bottom up. This was a top down

DB and that never is very good.

S at all points

DB I shouldn't have added that. Ok you bring up some great points that I well know the retention issue in the school of science. I also know the national trends in science in general. Um so what I have from and I think I'm allowed to bring in things from other interviews that I have done.

S oh sure

DB except for names of course

S I know pretty much anyone you would have interviewed

DB you know the players. The comments that you just made um I was more or less aware of but not in the detail but hardly anyone else has said anything along those lines. When I ask questions about trends the common answer I've been getting but not from everyone is um business was telling us they wanted our graduates to be this, this and that and those comments were along the lines of better communicators, broader based knowledge

S yeah

DB Multi-disciplinary, be able to work in a team

S yep

DB so those are the things that I've been hearing

S and you know those are real, we have a chemistry advisory committee. When I first got here um I spent time visiting every major chemical company in the U.S.

DB Wow

S I mean there were only a hand full but it was part. What are we doing right, what are we doing wrong? The global consensus is that we are teaching as much content as anyone could expect them to know at that point in time. Uh we were not teaching them communication skills, we were not teaching them to work in groups. We were not teaching them how to work with people outside of their discipline. Um and that was true of others, for example on the ACS lecture tour I frequently talked to chemists in industrial situations who asked the fundamental question how do you convince an engineer to stop giving you the same sample over and over again until you get the answer he wants. Ok we're not unique but ok these trends were there and, and, and they were voche they were not sodvoche but that's mythology ok

DB OK what's the reality?

S you look at what we did, there are things that could be done. UCLA for example has writing across the curriculum project. There are more faculty teaching writing at UCLA than there are in any department on campus. Look at chemical engineering. They have a faculty member over there who is not an engineer much less a chemical engineer. His sole function is to help build communication skills. Ok if we believed those trends, if we really believed them and were willing to work on them there were things we would have done none of which we did.

DB ok

S Now there are/were people there were forces including people who are no longer available to you um who were pragmatic enough to remember we're not going to ever require communication 116. We never have we're not going to in the future and we're not going to because that's not a useful course.

DB Speech making right?

S And now we did say upper level communication courses would be applicable ok but we're not going to do that. We didn't believe that the English courses built writing skills so you know we put in technical writing kinds of so you know we put in options in in in in the basically in the weeds around the core uh to address that but but if if those people really believed what they told you this is not the curriculum we would have implemented.

DB ok I think that's fair. Uh the point I was making before I got involved with doing the interview part of this project the trends I was looking at were the retention issues, not the team work

S Every institution is worried about it and the good news is we're finally getting two things to occur. I worked at the Indiana commission of higher education for quite some time. We finally convinced the commission stop worrying about retention at IPFW don't don't, collect the data and then ignore them. The question is not how what percentage of the freshmen at IPFW graduate from IPFW. The only piece of information you're interested in is what is the ratio of the number of people who are native Hoosiers who graduate at the end of four years relative to the number who entered. Don't assign them to an institution because that's not really where they, the problem is people moved from one institution to the other. Ok, we're not California where that happens three or four times but they do move.

DB Yeah

S And we were calculating retention the wrong way. Furthermore let's calculate retention by asking first of all did you really decide to come to campus to graduate. I use IPFW, they were graduating 17 percent of their freshmen but that's ok cuz a very significant fraction of those students did not come there with the intent to graduate.

DB What was their intent?

S Their intent was to get a couple of years and perhaps an associate's degree.

DB ok

S Or then move to West Lafayette. Ok. The only really important question fundamentally is what percentage of the students who enter higher education graduate and there's nothing magically obviously about four years people have forgotten that five six. The chronicle of higher education had an article about two years ago arguing is ten years a viable time period for looking at graduation of people in the arts and humanities

DB With a Bachelor's degree?

S After the Bachelor's degree

DB Oh after the Bachelor's degree

S And they said no. they said twelve anyways. So the problem we've always had is that the federal government tried to define retention and then we did those calculations which we have to but then we started to think in terms of that.

DB ah ok

S Furthermore we've never really invested the resources that are necessary in doing exit interviews with enough people to really know what retention problems are. Less than five percent of the students who leave this institution leave it because of academic problems.

DB um hum, I believe that

S Ok, the other ones leave it for financial reasons uh or

DB Family reasons

S Family reasons uh or personal, my boyfriend is at you know that kind of reason. So retention is always there, it's something that's always at the bottom of every discussion

DB that's right

S and there's no doubt that people try for a program that maximizes your probability of getting good numbers

DB right. Well that's great information so far um. Let me go to another question but I think you probably have answered this along the way but um this is specific to undergraduate science courses and I know that you have taught a lot of chemistry at least um but have you what problems do you see in undergraduate science courses that would have caused you to consider making changes in the curriculum?

S Ok, once you get into a content domain uh chemistry in particular and definitely physics uh not enough relationship is painted between the content of those courses and the world in which the student lives.

DB oh yeah

S Either in terms of the real world or the world of their career. Uh problem based learning, I remember being exposed to problem based learning when it was first implemented in medical schools in the early 70s and I was teaching medical students in Urbana for one course. And we did problem based learning and the idea behind the problem based learning that we did that we were just brand new at this thing is that we would say when it was obvious students were not attending to topic because they thought they knew it. You know I would come in with questions like a patient presents at any ER, you have 90 seconds to do something before this patient dies. What do you do? And what happened is the students were never able to keep a patient alive.

DB Boy

S This on job kind of way of using the information I was teaching them they had never begun to integrate. Uh my research we've done this with graduate students I have had people come out of the industry ten years or more become a first year organic graduate student and stop behaving as if they were a chemist and start behaving like a student. And in oral exams I've asked the question "when you were at Aldridge, would Aldridge have allowed you to do what you just proposed" and the student would always laugh and they would say no. They understood the problem that I was broaching. So we've been asking that question of how do you get people to stop behaving like a student but within that content of domain of chemistry doesn't make enough connections to the real world physicist frequently makes no connection to the real world.

DB What about math? Would that be the same problem?

S Uh math by its very nature

DB So everything is totally abstract

S Yes to give you the example, a very close friend of mine and from math called me up one day and he said George I'm trying to bring in a couple of real world examples into my differential integral calculus courses and he says I'm looking at some carbon 14 problems uh because you know very simple

DB uh yeah accounting

S yeah first order of ray kinetics, you start with a differential an integral equation. He says I'm not getting anything like the right numbers and I said well what are you using as the half life? And he said 5.73 years and I said um turn that decimal point into a comma. It's 5700 and 30 years. Oh now it's starting to work….anyways….the very nature of mathematics from the time I took it in prehistoric times to this day. It is if people are taught as if they are going to be mathematicians. Uh it is not taught in the context of what and engineer needs, what does a chemist need.

DB I know at one time the physics department here taught their own math courses didn't they?

S People have done that. Uh it's better now than it has been but it's still taught the same way um chemistry presumes everyone taking chemistry as a major is going to stay in chemistry, that by the way is an interesting phenomenon. Talk to psychology departments and they believe that 10 percent of the people who are psychology majors will remain in the field. They build a curriculum around that assumption. Chemists believe that 90 percent of all the majors are going to stay in the field.

DB What does the facts say?

S And so you just well I gotta teach everyone every aspect of chemistry because otherwise and then when you look at organic courses instead of teaching the organic courses that a biologist would need we teach the organic that an organic chemists wants. So I mean this happens in physics and you know it's easiest for me to state it in chemistry.

DB I understand do you, some of the problems you really saw were, and you kinda drew on this earlier the courses the science courses themselves were not applying themselves in any practical sense?

S Right and so what happened is that's one of the reasons why we have Co-Op programs.

DB yeah

S um it helps build pay the cost of education but for the most part definitely in engineering and most assuredly only a handful in chemistry. Uh, the students who do that come back understanding why.

DB hum, ok um I could go on all day about that. Um the next couple of questions you eluded in your email you know that there are what elements that were considered for setting up the task force. Uh how was the college of science task force formed. Can you address any of those?

S it was basically formed by getting volunteers from various departments and the attempt was to get the people who either were knowledgeable or were interested in the question. I mean Buster Dunsmore you know being a perfect example, I mean he was both knowledgeable about what was happening and he was interested in change. And Gabriella Weaver was in there because she was interested in seeing what could be done. Chris Mesena (?) was on that committee for the same reason. Um so you look for volunteers, uh you load the committee with people who want to change. Now that gets you into a problem.

DB right

S And the problem is you now have a committee full of people who want to make changes not necessarily because they understand the problem being solved. If you wanted to get the system solved based on the people who knew what the problems were then you would start it with Chris Saley. Uh you'd bring in Bob Wilde from my department. Ok associate head of the department, you know. Uh Bill from CS um (?) but again you know. You would bring together those people who had been working with undergraduates exclusively the advisor kind of thing. By the way I don't know if there were advisors on that task force. If there were they weren't in a large enough to be critical mass.

DB Well Alan Welch was. He was a head advisor.

S yep but the problem was that Alan just knows patterns but he doesn't he didn't live it on a day to day basis. So that's how you get it started and um

DB Well I think I can piece together the rest of that. I uh, I did, I have talked to Chris Saley and basically her point was that Vitter gave her a charge and Alan Welch kind of tangentially. And that caused a lot of tension I think. And then she went out as you just said to the departments.

S yeah and Chris knew, I mean Chris is a sharp lady and she knew who the people were. So she tried to get

DB A representation

S the representation across the college

DB and the problem is again you have noted already too is math. They really couldn't, Chris describe she really couldn't get anybody to cooperate from math

S There wasn't anybody in, yeah. Um

DB So were there any specific changes that you would have liked to have made to the curriculum before, let's say before the task force was ever formed? You were kind of touching on this issue talking about what is going on in the lack of practicality in the courses. Any changes you?

S the key main characters that I was interested in were the general education requirements in particular.

DB So not the science courses?

S My view is the science courses get defined by the profession but. Ok I'm on the road a lot as an external advisor. I need Deans who understand that we have a American Chemical Society has a committee of professional training and as far as Deans a small institutions are concerned these guys are the anti-Christ. Why? CPT says thou shalt have X number of hours of lecture course. Thou shalt have Y number of hours of laboratory experience. Thou shalt teach the following topic courses. There will be a minimum of two semesters of general chemistry, two semesters organic, two semesters of physical chemistry. At least one but hopefully two semesters of inorganic, there will be two semesters of analytical chemistry, there will be a bio-chemistry course. They say that we also require access in the library in the following minimum number of journals.

DB wow

S ok, so I did a study for the U. S. Department of Education in the early 80s. I looked at one out of every four accredited programs in the U.S. 148 out of 149 taught the same course in the same order. One of them inverted the order.

DB wow

S 75 percent of the people teaching analytical chemistry were using the same text book. And that result as when they wrote the GRE advanced subject exams the chemistry exam was by far the most successful of them all.

DB Cuz everybody was taking the same thing by the same thing.

S you knew what it was. Uh so I'm not as worried about you know the field says this is the content. I am worried about education versus training.

DB So general education versus science education

S And and yeah but I mean my assumption is the content will be education not training but just I became a professor of engineering in 2005 and I know having talked to a number of Deans over there from Linda Katayee (?) on. The difference between education and training over there, they're trained, we're educated.

DB Right

S But it was those general education, what we do, how do we get people to behave? To not only take the course because it is required but to actually value it?

DB That's a tough one

S How do we give them the flexibility to allow them to do what they want to do? How do we let them take minors? Um the chemistry department has seven or eight different undergraduate majors. ACS approved, non-ACS approved, environmental, uh there's a materials one which no one has ever graduated in. There's a biochemistry program, there's a chemical education, ok, uh.

DB Wow

S But how do we get these other things in there so that students get what they need? The joke for us is as a professor in education, the college of education has faculty meetings. People show up. The college of science used to have faculty meetings, it doesn't anymore.

DB Really

S You were guaranteed seven people in the audience

DB Ha ha….seven

S but you seldom got more than ten

DB wow

S And the joke was until you started to talk about the foreign language requirement in which case you'd have 200 people in the room

DB Really

S Cuz people would have strong feelings about it. And they screwed up with the new curriculum because

DB by dropping the foreign language?

S They they argued that foreign culture courses could be used in place of foreign language courses that's stupid. I'm sorry, it's just, it was dumb

DB your opinion?

S Everybody agreed it was dumb. It was one of those things where if discussion had been allowed to continue it would not have been accepted. Um and Vitter just wouldn't let people discuss it.

DB I wonder why

S Because he knew that he wasn't going to get it done if he ever let anyone discuss it.

DB cuz that's all they would want to do is discuss it

S um no the problem that we have again with foreign language is that, the problem is that we are a college of science. Foreign language requirement is very different between the view of chemistry and math faculty and chemistry faculty recognize it. It's not as important as it once was because of translational but I used to read the literature in German without translating, I read it in German

DB Wow

S Now if I ever had a follow a synthesis it was a pain in the ass to get a word by word translation but I could, I could see what was happening in the field and so German, French, Russian uh was not as important as it was but the omission of two full years

DB So you were in favor of that

S I was in favor of keeping it. I was in favor of keeping it because I know Armstrong's 1905 model of education of the model of the gymnasium. I said my chemistry students do not take calculus because they are going to use, they're not. They're going to look, you know 90 percent of them are going to automatically know what the derivative would be or what the integral is going to be because it's obvious, you know, they have seen it before. You know well maybe 10 percent will ever use it, its training in mental gymnastics

DB Yeah

S it's the reason why Latin got studied. It's the reason why Greek was studied

DB Those made you gentlemen

S the phenomena was if you know Latin you understand English

DB Yeah or Greek

S Studying a foreign language allows you to begin to understand the structure of your own

DB That's really ambitious

S Yeah

DB So let's continue on this track. Um the next question that you really kind of started to address already is what changes did the college of science make to the core and to follow up what were successful and unsuccessful. So you have already touched on the foreign language

S Foreign language was a big one. Let's be honest, um you know the, the biggest mistake that they made and I I tried my best on this one. Nobody was going to listen to this. I had no objection to this great issues requirement. I thought it was very useful except they made one egregious mistake and that is they didn't talk to the people in CLA who understand those issues and can teach those courses

DB so you teach it yourselves

S They presumed that those course could be taught by the college of science faculty and I will tell you point blank we know better. We knew better at the time and the people who have been around for a while recognize it. I teach one of those courses next fall, it will be the third time but I'm a very strange individual. I started as a history major

DB Oh

S Uh by bringing together in science education and engineering in learning theory and all those things you know I am more broadly trained and I probably know more about the philosophy of science than anyone in this college

DB ok

S Because it was important

DB I think it's important too

S Strong connection between that and the evolution of learning so. So I can teach a course on the history of science and the philosophy of science. I know what's out there, I know enough examples, and you know, I put it together for grad students I taught it in the honors college for freshmen ok now I teach to juniors and seniors in the college. That's great and Andy Hirsch does a great job

DB I've actually taken his course.

S And I know, that's great. Pete Kissinger is teaching a course I have no idea why. Pete's a lovely guy but

DB Not a good teacher for that

S He's he's a bit far away from the undergraduates as an entrepreneurial, let's put it that way

DB Alright

S That BAS here in town, you know that's Pete's company

DB ok

S Uh they really are just a handful uh Brown over in mathematics, there are just a handful of people

DB Johnny Brown

S	and for most of them it's a stretch. You know my department head, Paul Shepson, could do an environmental science cuz you know he's got a joint appointment in EAS and here

DB	EAS

S	and uh it's it's you know, John Harbor, and when I was working with the honors program purposed a course that he called Damnation, you know, looking at hydrology of water flow and it's control

DB	ha-ha right ha-ha

S	It never sold but uh there a handful

DB	Right

S	That course should be a requirement. I don't have a problem with it but it ought to be taught by people who know something in the field

DB	ok, how about the teamwork component?

S	What teamwork component?

DB	ok

S	ok uh I mean they built on the structure that uh P.K. Embry had in engineering

DB	um hum

S	And in engineering it's there. And in pharmacy, I've got a bunch of students in my pre-chem class from pharmacy, they have a team. They learned that, we don't have it. One of the problems that came in to the thinking was the assumption that a modular approach can be taken and we don't have any evidence to support that. I have evidence that doesn't support it cuz I was a consultant in the U. K.

DB	oh wow

S	uh 10 years ago uh when a lot of their courses went modular and they basically concluded at the end of this that they had to do it because the government insisted but it was a horrible thing.

DB	Do you think that the idea of having a teamwork component a good idea it's just done poorly?

S	I think you need to have a teamwork component but it needs to be. . It can't be done as part of a course.

DB it has to be integrated through the entire

S it's integrated through the field. Ok, it was 1980 in which I introduced teamwork in the chemistry labs where students would do lab reports in groups of three. I knew why, I had theoretical basis for doing this uh but to be honest just let me admit I wanted a lab report from the students but I didn't want them to be spending all of their time writing up lab reports. Ok the lab report was important we've shown that it was essential in their evolution but that doesn't necessarily mean that I wouldn't rather have them spend time studying the content of the course

DB Right

S And this gave me a way to do it. It also decreased you know the historic one was, I would ask my TA's first day I met with them. Do you want to do the labs in groups of three or not? And they always voted to do it in groups of three cuz their not stupid. They know the difference between eight and 24 lab reports.

DB Yeah

S So it decreased the work load on the individual students, it decreased it on the TA's. It forced them to begin to work together ok great. I believe that something that I've been pushing, we've, I used to do the software seminar

DB OK

S and I would tell myself where to sit. How do you differentiate yourself from the vast buesway mass when the time comes to get a job and I said you've got one of three things. If you don't do one of these three you're crazy. Study Abroad. CO-OP, Undergraduate research and I would tell them point blank if you don't do undergraduate research you're a chemistry major you're not a chemist. If you want to be a chemist it is vitally important that you do it so that you begin to understand that by the way is where teamwork is taught.

DB in that kind of environment?

S In that environment

DB ok, so could you you you really couldn't make having undergraduate research a requirement

S uh we have talked about making it a requirement in this department

DB ok

S We decided if 85 percent of your students were doing it anyways you don't need it

DB ok

S but what happened was there were skill sets that were defined and these are important skill sets. Then the assumption was made that you could teach those skills in any course.

DB Ok so we've touched on I think what I've been hearing are the four main changes made which were the um multi-cultural, teamwork, the uh communication and what was the fourth one

S the great issues

DB the great issues. Thank you. So were there any other? I think we touched on all of those

S We did. There's one other thing that happened that I did my damnest to try, I mean no one wanted to hear these things and it was the proliferation of one credit courses.

DB wow

S these God damn one credit seminars

DB Right

S I'm sorry. It's either worth it or it isn't. it's either worth doing something or don't do it at all. And so the dean wanted a dean seminar and every department had to have a freshman seminar and sophomore seminar and junior/senior seminar you know. They wanted to do a seminar to get teamwork in you know it but it was this extension of this modular approach. The idea that you could have three one hour courses

DB Right

S on various skills

DB you didn't like that concept

S It can't be done

DB But isn't that what's happening right now?

S Yeah

DB so, ok no go ahead

S I will argue that it's not necessarily working but I mean I can't give you evidence for it but what I can give you is you talk to these kids. They know the difference between a one and the three hour course.

DB oh yeah

S and when it's a five hour calculus course or a four hour chemistry course and a one hour seminar

DB Right

S In engineering they used they have and 101 course. They called it sleep 100. It was the talking head course.

DB yeah. Well all those courses are

S yeah somebody came in, this is what chemical engineering did. Somebody came in and this is what mechanical engineers. 40 percent of the students had already decided what they wanted to be, the other 60 had it narrowed down. Everybody has to take it, they all have to be there ok.

DB so what gets done? Ok, so here is a stupid question. Hahah I guess I shouldn't start it like that but it's one of these scale things you know like from one to ten. With one being really bad and ten being the best. How would you have rated the college of sciences core prior to making these changes?

S I would have rated it as three

DB Pretty low

S Well you know me me, it had strengths, it had weaknesses ok

DB ok well the same question then but after the changes

S It's still three

DB Still three, no change

S No improvement

DB No improvement

S ok they made certain things better, they made other things a negative. Um unrelated to this but still related uh in education a few years ago uh they decided that cohort education was a good thing and it is. And at small institutions cohort education happens all the time. We're not a small institution. We implemented cohort and it just ripped the guts out of our education major because what happens is chemistry teachers don't graduate from education, they graduate from chemistry.

DB Right

S Physics teachers don't graduate from education, they graduate from physics. We don't have a cohort of people. Now elementary education people good it works ok. They come together, they meet each other, they work together, they form a team

DB There's more of them

S and it works. But now you require it at an institution where there competing course and I can't take. I can take one of the two courses in the cohort but I can't take the other because this is a required course in my field ok. So there are great ideas that can come up in curriculum that work extremely well and I can give you examples of them that don't work when you apply them to a research oriented institution

DB Because of the size?

S Because of the size

DB So you know go on that track if you don't mind for a second. What changes, I guess it would fall under what changes would you have like to have seen?

S ok I wanted to see flexibility

DB Aw

S I wanted to say there are key competencies uh content. If you don't have that you might as well not be a college of science.

DB Right

S Math literacy is a key, it's just gotta be there

DB yeah

S Uh you don't know what aspect you're gonna need but there is going to be some aspect of it

DB absolutely

S I would have liked to have seen real communication, technical writing

DB How to make presentations?

S Real upper level

DB Upper level

S Yeah you can't do this as with it it doesn't work with freshmen cuz they don't have anything to talk about

DB Right right

S Ok they don't have anything to write about

DB Right

S Uh I had this history of philosophy of science course they write two papers. It takes an act of God to get papers out of these kids

DB oh yeah and they are terribly written

S and they are juniors and seniors. They don't know how to write. This is where they have something to write about. This is where this should be done. Find key competencies and say these are competencies that we all need. Don't tell me that mathematicians need teamwork, they don't.

DB and that was their complaint

S They don't need it

DB Right

S As a matter of fact it stands in the way ok

DB So why make them? Is that what you are saying? So that comes under your flexibility banner

S Physics yeah yeah because I mean a single paper can come up with 10 lines and two hundred authors

DB Right

S That's great. They need to do that but they need to do it at a level where they know what they are doing

DB Um hum

S Where it's literally team, it's not teamwork is not the skill. Its teamwork applied to the content area. Uh so find your key real competencies and insist that they be developed. Then talk about these other things that are nice and then say ok how I integrate them into the content courses. Is it, they're not going to work until they are in the content courses. I chaired the University grade appeals committee off and on for 20 years. I know how many cases came to us because a student from engineering was in a liberal arts course. Or one of my favorites a student from engineering went into a Krannert course.

DB hump

S With a standard deviation of grade at the end of the semester on the total scores was 1.2.

DB Whoo, they're all lumped right together

S By a guy who's an economist who literally could not understand why this student was appealing his grade. The kid said you have no evidence that I'm not an A student

DB Wow

S And he was right ok. Within the the the the these brutal requirements you know that basically say you know virtually all this works best when it's in the real world ok. Now the real world for undergraduates is their content ok. Ok so say that those are skills and then say to the chemistry department where are you going to put this in your curriculum? Ok, don't do the ok the the we can go back to 1952 and Dave Osobill and we can basically say students do not learn from the general to the specific. They learn from the specific to the general. Organic chemistry is a perfect example RX+ is not how they learn. Ok that's how you summarize you know a month worth of the organic course.

DB Right

S And that's the problem with COM116. That's the problem with much of the English requirement and that's the problem with doing things like like teamwork. It assumes that you can train these things in the general abstract way of thinking

DB um hum

S And then that will be carried over and everything I know about the constructivist theory says that's not true

DB I yes I would agree with that

S it my, one of my favorite examples, I used to commute to Puerto Rico to work there and there was a flight to Miami west and it landed at 3:30 in the morning now God knows why Americans decided. I knew there was one cab so I always sat at the front of the plane. I got off as fast as I could I got the one cab. I remember the cab cabbie asking me you know how I was. And the only thing that came to mind was ismid mera (?)

DB German

S My Spanish isn't bad, my German isn't bad but they both go into the same file

DB Hahahaha

S And unless I'm very careful before I go to one place or another about refreshing myself ok the wrong thing will come out.

DB Hahahaha

S ok uh we tried to build too many competencies into a program under the assumption that those competencies were teachable competencies.

DB In the general

S At If at all ok you know I'm from a constructivist prospective I'll argue that all you can do is facilitate the

DB I agree

S You you none of these things are teachable

DB Right

S Uh

DB So did did you see then better a better option would be teaching teamwork in the concept of chemistry for instance?

S Sure require

DB Or physics

S Require the department to say ok demonstrate an outcome ok you know demonstrate an assessment an outcome that your students are building. Now whatever that skill is but demonstrate it that you are doing it

DB um hum

S Let's do outcome based assessment. The people involved in this knew what outcome based assessment and what it meant and they still built a program around teaching rather than learning. No evidence of assessment of any of these skills

DB hum

S The assumption was still Abed is an example. Abed 2000 came out on this campus. It was traumatic, cuz Abed was the first of the accreditors to go to outcome based assessment. They said you've only ever given us mechanical data. You know X number of students taking Y number of credits

DB um hum

S We're not going to accept that. Give me evidence that you are building these 12 basic skill sets somewhere in your program. And engineers just had a devil of a time beginning to understand what that meant. NCATE basically understand it and I'm a higher learning commission accreditor so the NCAHLC does understand this.

DB Right

S But we went in with a group of people leading this program who could not get into an outcome based assessment approach.

DB ok

S None of the discussion that did occur at the open meetings ever dealt with outcome.

DB Hum

S They were impassioned speeches by foreign born of how important it was that they had two languages.

DB Yeah

S Not because it was important for their field

DB Right

S Ok great. So the assumption is if I require X number of semesters then I will automatically have a

DB Hum, right

S So that's why I say again, the forces at work got stood in the way of outcome based assessment

DB and that may be the biggest take away from this I think is is the push for outcome based uh assessments on all these things really

S On all these things. Sallie Mason when she was the Provost

DB I remember her

S	Put me on the state transfer and accreditation committee and she knew why. My job was to be an asshole

DB	Hahaha

S	I'm good at it

DB	ok

S	The guys at Ivy Tech made a Provost, female came to recognize that I was put on this committee to give her a hard time

DB	hump

S	I only wanted her to live up to the standards that IU and Purdue used when introducing a course. I said, I said this is what we do when we introduce a course. We put together a syllabus, we tell you what's going to be taught, we tell you how many lectures is going to be taught. We tell you what the text book is

DB	um hum

S	you know we're going and then we're going to discuss it and see at the college and if necessary the university level. I said if you want Ivy Tech courses to be transferable then you'll do that.

DB	hump

S	Leonard Lipschitz

DB	Right Head of the math department

S	Basically said, I do not care what the state law says.

DB	hump

S	I will not authorize transfer credit in calculus from Ivy Tech.

DB	ok

S	Until they essentially did locally what they had done in the south which was work with the local research university to make sure that the courses were

DB	Similar

S	really in deed similar in terms of you know this is what we are trying to do. So at least there was this notion of outcome. When I chaired the educational policy committee one of the things that I had to do was make sure that we changed a policy. That is a course is transferable when you've negotiated an arrangement to transfer. Fine, the fact that you have negotiated the arrangement to happen on campus course transfer does not automatically mean that the online version will transfer as well.

DB ok

S Until you demonstrate that the online version is equivalent to the on campus it will not automatically transfer. And that's because the guys that were in physics were noting uh that there were 150 technology students a semester taking an online physics course from one Ivy Tech campus.

DB Hump

S And it had no relationship to the physics that they were really needed. Was it online yes. Was it a viable course, no so it it it it you know it it it's this notion of looking at the output perimeter.

DB Right

S And saying, if the output perimeter is the same

DB then you are good to go

S Then we will accept it. Uh none of that kind of discussion uh ever ever occurred.

DB wow

S So people wrote their own pod courses

DB Well that's kind of the message I'm getting through these interviews. Um it's kind of depressing in a way but um let me finish or let us finish this with two related questions. And it's more about semantics than anything else. Um when I read through the documents that you put out about the task force um read them several times. There was a word missing, uh oh I don't know if it was missing but there was a word not there. It was the word reform was not in any of the text. So you are aware of that so um how would you, before I ask my more important second question um which is was this a reform. And I think I know what your answer. Uh how would you define reform?

S It can't be defined in the context of uh a a cohort curriculum.

DB ok

S I mean, you could say there are characteristics that you would look for. Uh number one here's a metaphor for it. Uh this afternoon I will send out letter to the people who will be inducted to the teaching academy next fall and then the ones who are nominated are not ok. Uh the teaching academy document for nominations requires that you have a statement of teaching philosophy. Up until I explicitly pointed this out to associate deans year after year I would never see a single reference.

DB Hump

S It was always "I believe", no basis for that belief, no evidence for that belief. Now these are all effective people but they're operating in a vacuum

DB Right

S Of total ignorance. When we created the CIE, I was part of the group that created it. I purposed something that the CIE should do and that is have periodic newsletters that describe theoretical basis like Perry's model. No one on this campus has ever written a document for use even by the teaching academy on something as to me fundamental as Bill Perry's model of intellectual development among college students. People who work with the CIE not the director, the faculty who are actively involved when I mentioned Perry's work had never heard of it.

DB hum

S ok

DB But their educators in other lines other areas of endeavor then

S But

DB Education

S Yeah but they're doing it on beliefs

DB Right I I see what you are saying

S No evidence based

DB Right

S Ok um I helped to create in chemistry discipline based educational research ok. It didn't exist when I got here. Uh true reform should have a theatrical framework.

DB ok

S It's it's like I won't be on an OP or a PhD dissertation defense unless there's a theatrical framework. I I you know you know I happen to have written on theatrical frameworks but the the assumption is that there is a lens through which you look. There otta be reform to me implies evidence based change.

DB ok

S And that's why what we did was not a reform

DB Because there was no evidence used

S It was change. Uh no evidence has been collected since the change was made that it is more effective.

DB yeah but nothing was set out to measure. There were no metrics that I saw.

S There were no metrics

DB How do ya measure whether it was successful

S No attempt, still the college has not attempted.

DB Why do you think?

S I have commented upon this uh in terms of the choice of associate deans. You've got an associate dean whose job is research, ok fine. I know what he does. You've got an associate dean for undergraduate instruction good. So put somebody into the office who knows how to do assessment.

DB ok

S Or at least knows how to get you know Deb Bennett

DB At an associate dean level though

S it's you know the associate I mean that's the individual who should be collecting this information

DB ok

S I routinely pointed this out to people who are deans

DB Since there

S This is not unique to the college of Science by the way

DB Is it unique to Purdue?

S It's not unique to Purdue

DB So doesn't this lack of this person kind of indicate a cultural ignorance?

S Yeah

DB Whether forced or not

S Yeah, it’s it’s

DB Of assessment

S It’s it’s a again to me it’s the same as you show me a teaching and learning philosophy statement that doesn’t have a reference of anything

DB Right

S And I’ll tell you by the way I’ve read enough of these things to know. I know that individual using those words has no idea what the mean. You can see it in the way in which the message is conveyed. Um if it was reform some evidence based some basis should be there for which you start and within the context of action research you know

DB Right right right

S God knows I’ve written about for 15 years. Uh there otta be some measure

DB Right

S And uh I’m on the ACS board of directors and uh and I happen to be on a program review advisory group. Every single program that is offered by the society as part of it’s staff function

DB um hum

S Is reviewed on a four year cycle. We have a face to face meeting when we write the document for this year’s group. Last year I wrote the Boiler Plate language and we use the same Boiler Plate language on every single one of the programs except one

DB hump

S And it said that basically the metrics as described in this report are a good step but not sufficient to insure continued funding. And the only program for which we didn’t use that was the one we said that the metrics for this program are not a good first step

DB Hahira so there you go

S So that’s the problem that you run into with reform

DB I I I like that I heard one other good definition but I like this one too particularly the evidence based outcomes

S Yeah

DB ok alright well um is there anything else that you would like to tell me about the curriculum? You said a lot

S Yeah um one of the things that did happen I remember uh Indiana Higher Education meetings I was there and there was a period of time uh when Stan Jones from Lafayette was a head of the commission

DB I remember

S And um there were a number of people in the room whose first names were the same uh the right honorable

DB oh

S And it's nice to see them there but the discussion got around to having a state mandated core

DB hum for Higher Ed……Wow

S I brought that message back

DB hahaha I bet it didn't go over too well

S And what happened basically is it would have been done if the institutions hadn't reacted prof you know it wasn't a complaint. They didn't tell anybody please don't do this I mean some of us in the room said don't do this, uh give a give a direction to the institution and give them some time to try this but uh the institutions have all gone forward. And you know we are trying for a core

DB Right

S As an institution uh

DB Do you think a cores a good idea?

S It's required. It's must be there

DB ok

S There has to be some one of the things I've been fighting for 30 years is to try to make this a university. It is not a university.

DB What would you define it as?

S Um a loose confederation of schools

DB More training than a university

S No no just too much absolute uh you know control

DB Too many silos?

S At the silo level

DB ok so you want to see more coherence and more teamwork

S Right let me give you an example out of engineering. Linda Ketah you know who

DB Yeah I know who she is

S Every time she got hired she screwed up and then left and went on to another place. And I do know what she screwed up here. It was a big I mean I got involved in in the mop up. Uh the tallyarchin (?) may come to mind. She could have solved it and basically left.

DB wow I didn't realize that

S instead of uh but I remember having conversations with her because this was the beginning of the areo engineering group and uh she asked a question that I had been interested in. why does every school in the college of engineering teach a thermo course?

DB hahaha

S Isn't there one thermodynamics? Shouldn't we be able to have some fundamental course in thermodynamics?

DB The school of Science does that too don't they? There's a thermo course in maybe not biology

S Yeah

DB there's one in chemistry there's one in physics

S there's one in chemistry there's one in physics

DB There was one in EAS too

S and there was one in EAS. Uh but in engineering it it they're really closer together

DB yeah

S than they are uh and everyone laughed. Uh the one I asked her and you know she hadn't actually understood. I said I want you to give me the name of one course taught by the college of engineering that's a service course

DB Well EPICS

S It's not really a course its given credit but there's not a single course in the college of engineering. The college of Science historically has taught 40 percent of all instructional hours. That's a number from about 15 years ago. You know it's still probably similar. A third to 40 percent of all instructional units on this campus most of it service

DB wow didn't realize that either

S yep I mean everybody takes calculus, everybody takes something in math

DB Yeah

S uh ok we just assigned 6000 grades in chemistry for the fall

DB wow

S Now that's a drop of about 1500 from our peak. Our peak was about 7500 students a semester

DB wow that's a lot

S That's a lot of people you know

DB yeah

S um but you can't go over to engineering and take a course that's an elective

DB No you can't right. Ok very interesting

S As I said in the email sometimes more discouraging

Appendix B

The incidents taken from the interviews in Appendix A were grouped into emerging categories. Initially there were 44 (Table 4-4) categories and each incident from each participant was grouped into these categories. After a while it became apparent that there was a degree of repetition in the categories so the initial 44 categories were combined into a final 14 categories (Table 4-5). Table A-1 lists which of the initial 44 categories were combined into the final 14 categories.

Table A-1: Final Categories and initial categories.

Final Categories	Initial Categories
Changes to the Core (Cc)	Changes Made (CM)
	Changes not Accepted (CNA)
	Changes Wanted/Needed (CN)
	Core Curriculum (CC)
Communication and Presenting (CP)	Communication (CO)
	Presenting (P)
	Writing Skills (WT)
Critical Thinking (CT)	Critical Thinking (CT)
Curriculum (C)	Computer Science (CS)
	Curriculum (CR)
	Outcomes (O)
	Success (SS)
	Successful Attributes (ST)
	Undergraduate Science Courses (USC)

	Unknown Successes (US)
	Unknown Changes (UC)
	Large Lecture Classes (LLC)
	Students (S)
	Women in Science (WS)
Faculty (F)	Faculty (F)
	Faculty as Teachers (FAT)
Great Issues (GI)	Great Issues (GIS)
Language and Culture (LC)	Global International (GI)
	Language Requirement (LR)
	Multicultural (MC)
	Study Abroad (SA)
Multidisciplinary (M)	Multidisciplinary (MD)
Ranking (R)	Ranking Post (RT)
	Ranking Prior (RP)
Reform (RM)	Reasons for Reform (RFR)
	Reform (RM)
Resistance (Rs)	Resistance (R)
Science Education Trends (ST)	Attrition (A)
	National Trends (NT)
	Retention (RT)
Task Force (TF)	Task Force (TF)
	Task Force Members (TFM)

Teamwork (TW)	Groups (G)
	Team Work (TW)
Deleted Categories	Careers (CR)
	Faculty Arguments for Reform (FAR)
	Undergraduate Science Education (USE)

Incidents (quotes) taken from the transcripts of the participant interviews were collected into the initial categories. After all the quotes and categories were developed the categories were either combined with similar categories or deleted. The final categories with their associated incidents are grouped below. Each incident is prefaced by the initials of the participant followed by the page and incident number in the transcript. These incidents and coding can be seen in Appendix A.

Changes to the Core

Changes Made (CM)

J 5-1

Um, we changed what students have to do to meet what you would call the foreign language requirement. And that was one of the ones that took up a lot of debate in the open meetings. Uh, there were a number of people who felt it was wrong to give students options other than taking language courses. So now there were a number of different ways of satisfying that sort of global competencies requirement

J 5-2

Um, we implemented a requirement in teamwork that had two pieces. So an initial training program to understand how do teams work, the theory behind it, the practice and philosophy behind it. And then to take a course on an experience that included teamwork. So that was a change that hadn't been explicitly included before.

J 5-3

Um, we included a change in the communications requirements that, um, involved presentations so that's a change

J 5-4

Uh, we introduced the multidisciplinary requirement, um, that's been pretty controversial but that courses had to get approved or experiences had to get approved to meet that requirement.

J 5-5

Um, what else did we change? We implemented the great issues requirement, so that was a new type of course. Now people were already teaching some courses that met that requirement that suddenly in this department hundreds of students were coming into courses that wouldn't have come into those course hadn't we changed those requirements.

R 4-3

W, yeW, yeW, I would say the biggest ones had to do with things that related to, uh, um, what we call teamwork or, um, working together. I, I think, um, let's see what was the word we used to, uh, I think we, we used, um, maybe we went Tay from teamwork to teambuilding because there was some faculty who regarded this as just trying to get people to think alike and to be automatons and not to be creative. Which is actually the opposite of what we wanted. Um, so just, it was just something that no department had ever contemplated before in its requirements.

R 4-4

DB Teamwork?

R YeW, teamwork.

DB Or teambuilding?

R Teambuilding, so it was definitely something new in that aspect.

R 4-5

YeW, yeW, that was another aspect that would not typically be in any requirements of a major, was certainly wasn't in the college requirements. W, just that notion of, of um, going beyond your major so that you were able to synthesize using other perspectives . How that relates to a given problem because all of the major issues facing society certainly, that deal with science, are more and more multidisciplinary. And there's no one set of skills will solve a problem, you have to collaborate and work from many angles. And that also brings in why it's important to be able to work with people because no one person's is going to be trained as an expert in all these areas. You have to communicate and interface with people with totally different backgrounds and skill sets.

R 5-2

The, uh, well let's see, uh, with respect, well, besides the courses themselves the, um, just the fact that there were particular outcomes and, W, each outcome had a variety of options to satisfy it, um, was probably the major change because there was definitely a connection between the courses people took and what was being achieved whereas before it was just a set of requirements that probably had this overarching idea behind it when they were first thought of but over the years as they're modified and this exception, that exception, they're just a bunch of courses and people didn't understand what they were about. So that was probably the most major thing. Particular outcomes dealing with communication and teambuilding, um, multidisciplinary, um, those were just not even present in the curriculum. W, there were liberal arts, there were breadth requirements, we just reformulated them more explicitly to document what they were there for.

J 6-1

they added multidisciplinary saying that you had to have evidence that you can do more than just your core science, they wanted the cultural diversity piece, they wanted the teamwork piece, and they wanted something to do with great issues.

J 6-2

They also made sure that everybody had to leave with two two-course sequences in lab sciences which had not, everybody was doing it except mathematics.

B 4-5

Other changes, uh, let's see in terms of the, um, gen eds, um, you had to have prior six gen eds broken down between certain categories. Um, then it morphed into, um, three gen eds, two of which had to be in sequence which meant they were somehow related to each other, which I guess made some seJe that you had two courses that were, sometimes that relatioJhip was quite tenuous.

S 15-1

Foreign language was a big one. Let's be honest, um you know the, the biggest mistake that they made and I I tried my best on this one. Nobody was going to listen to this. I had no objection to this great issues requirement. I thought it was very useful except they made one egregious mistake and that is they didn't talk to the people in CLA who understand those issues and can teach those courses

Changes Not Accepted (CAN)

M 7-6

Right, design, critical thinking. I would really liked to have that in. Um, we put in, um, I don't know where we are now with um, we put in a communication course, we tried it first, because we had this constraint of not being able to add credit hours

T 9-2

Um, I would have liked to see the departments give up some of their credits, which they didn't really want to do but in terms of components I was real pleased. I mean I felt like when we started with, you know again those big picture ideas, um, that was what I felt like should be part of a core curriculum in the sciences.

T 9-3

Well, lowering the number of hours would not have been a bad idea. With the other experiential things being in there. But that wasn't a very high priority. I would have said, I would have expanded some of those core, I, I would have, how to be a scientist. I would have had, I think maybe there's, I think we ended up one course in a great issues kind of thing, I would have had two. I would have had maybe one, maybe one in both. So it would have been things like that more than reducing the hours I think.

Changes Wanted/Needed (CN)

W 1-4

DB So, um, let me back up to question one or two and ask you some questions. What were your, other than the curriculum being very old, did you see, through your own teaching experiences, did you see any particular things you thought need to be changed?

W Well, I had already, I had back in the late 90's had started a what now is a great issued course. Wh, as the result of a conversation I had with Harry Morrison. And I had the personal belief that there were a lot of important issues, W, that would affect our students either sooner, or certainly later, that there was no place in the curriculum to talk about those

W 2-1

There was a lot of discussion about bioengineering with crops, the genetic manipulation of crops. And all the ethical and other scientific concerns about that. Nuclear energy, there's lots of issues surrounding about that. So there were all these, hot topics that were evolving so quickly that, there were no textbooks. You had to rely on, you know, current material.

W 3-1

So I think another change that was in my opinion, W, for the good, was the requirement of a statistics course. To me all of life is statistics, in fact I've just started reading Nate Silver's book

W 3-2

But people are generally ignorant of statistics and the way real systems work. And so it's also criminal that we didn't require, I should talk I don't think I was required to take a statistics course when I was in college.

W 4-1

DB Study abroad?

W Right. And that would of, I think that would have better for me had I been the student. I didn't like my French teacher in high school so I took five years of Latin.

W 4-2

Let's see I'm trying to remember, the other changes, W, the lab requirements had been reduced, uh, I don't know that's necessarily bad. They've been a little too much. The original required four, now it's two. But then within a major, you know that's sort of a baseline. And there's also a computing requirement now. I think that's good. That had been I guess considered a lab requirement satisfying…

J 1-2

It's been a while but things that I was particularly involved in and interested in were teamwork, um, the rise in importance in interdisciplinary work, um, variously described, um, communications, so the ability of students to not just write, writing is important, but also the ability to give presentations. So all communication. And then, you know, there was a lot of debate going on, as there is still today, about, um, the issue of a foreign language versus generally more global competency issues. So those are the ones that come to mind.

T 5-1

I, I would have liked, I wanted to see, um, two things that I can think of. One was an introduction to a science way of thinking early on. There was an assumption that students had it and they didn't. So to do something to help them think about things more scientifically. And then the second was to have, to have more experience with what they were doing. And not just, not just lab work, um, we ended up putting a fair amount of experiential things into the curriculum. And they're still there but. Um, where we recognized internships and research and study abroad kind of things as part of the undergraduate experience to broaden their thinking rather than just getting so focused on calculations or experimentation. But what impact is this going to have in the world that I live in.

T 6-3

Um, I would say across the board there was more consistency with the kind of math, the kind of science, the kind of, um, liberal arts that all students were getting. Um, we had really, from an advising standpoint it was getting quite difficult to get students to think you know, whoa, we starting in computer science and wanted to go to physics. To be able to make that change, make it right at the beginning or without losing time to graduate. Because things had diverged so much from department to department. And so there was hope there would be somewhat more of a common year to year and a half of work that people could play around a little bit and say, you know, I came in wanting to be a chemistry major but now that I'm looking at all this more I really like the mathematical side of it more but I really want some those chemical things so physics maybe would be a better fit for me than what chemistry would be. And before then, you know, if you didn't start in physics it would take you another year. And, still may do that, but there was enough other common core there that would translate because, chemistry and physics isn't a good example because they were taking the same math. Some of the others with taking different math. Yet things had moved, biology is still probably taking a different math. So there were some things like that that we didn't succeed on. They wanted to have a little bit more common core in.

R 4-1

Um, well, generally I had in mind things that related to communication skills, um, working effectively together and having some broader perspective than just your major. So you could look at the more global problems.

R 4-2

Um, well, generally I had in mind things that related to communication skills, um, working effectively together and having some broader perspective than just your major. So you could look at the more global problems.

B 1-2

Although I think that, um, the idea of teamwork and teaming, which you know were kind of a big topic at that time and perhaps now, and being able to write and communicate, um, were also kind of trends at the time that I think they wanted to capture, that's just my opinion as to where they came up with some of these…

S 20-1

DB So you know go on that track if you don't mind for a second. What changes, I guess it would fall under what changes would you have like to have seen?

S ok I wanted to see flexibility

DB T

S I wanted to say there are key competencies uh content. If you don't have that you might as well not be a college of science.

DB Right

S Math literacy is a key, it's just gotta be there

DB yeW

S Uh you don't know what aspect you're gonna need but there is going to be some aspect of it

DB absolutely

S I would have liked to have seen real communication, technical writing

DB How to make presentations?

S Real upper level

DB Upper level

S YeW you can't do this as with it it doesn't work with freshmen cuz they don't have anything to talk about

DB Right right

S Ok they don't have anything to write about

S 23-1

Let's do outcome based assessment. The people involved in this knew what outcome based assessment and what it meant and they still built a program around teaching rather than learning. No evidence of assessment of any of these skills.

Core Curriculum (CC)

M 1-4

Um, the core curriculum are skills that all faculty or all science stuDnts need

M 2-1

in the College of Science all of the faculty Dvelop the core curriculum, so that's what's across all of the stuDnts. The Dpartments then, the disciplines, create a curriculum for their particular discipline. And the iDa is that the two come together and that's how you get a well educated, um, science stuDnt

M 3-3

because the core curriculum is Dsigned by all of the faculty and is required by all of the stuDnts it's very key to have stakeholDrs from all the Dpartments. So on the task force we had membership from every Dpartment

D 2-1

Changes in the old COS core? Um, I guess, um, again I have a bias towards the biology teaching majors. I guess I was, the thing I kept in the back of my mind was making sure that those who were going through a science teaching major in the COS whether it was biology or chemistry or whatever, um, that the unique nature of their program combining the vast majority of the COS requirements with the COE requirements to get a teaching license that the new things that were being brought on board for the COS core requirements would not disadvantage those who were in the science teaching programs, would not create an additional burDn for them because as it was whether in the old core or new core, um, their program is a really Dlicate hybrid of the COS requirements and the COE requirements for obtaining a teaching license. And it's very carefully constructed and I wanted to make sure that if w things were being brought on board that it wasn't going to throw a wrench in the program for science teaching majors.

D 3-1

I think it was a good iDa that, um, the very general and very broad core requirements unDr the old system were maD more specific. And that there were some elements of things like, I actually thought team building and collaboration was a really good iDa. And I know that was one of the messages coming back from the employers to the COS that people coming out of the programs, regardless of the college or Dpartment, didn't have a lot of good really collaborative experiences as part of their unDrgraduate work. And therefore once they got into team situations in the work place they didn't seem to be particularly well prepared.

D 3-2

And then the language and culture piece that was in there, especially the cross cultural kind of thing. Part of the general complaint was that the stuDnts coming out of the COS were not particularly well rounDd in terms of their background

D 3-3

And I unDrstand the benefits that can come from that. So I thought a couple of the components like the team building and the language and culture were really good pieces to be introducing and I didn't think it was going to be at the expeJe of the other parts of the traditional science curriculum.

D 4-1

No, as I was looking at the list here, um, again I thought it was just the overall iDa of more clearly specifying what were the range of experiences that graduates neeDd to have and putting it into some of these categories. Smaller categories probably meaning more specific categories than they had been in the previous core.

J 5-3

YeW, um, when they set up the gen eds, before you know you had to have two from this category, two from this category, two from this category, they just couldn't leave the two's alone. And they said you had to have Dpth in something. So, um, but they weren't going to count like economiM or they weren't going to count this, so they just kind of mucked it up again. IJtead of saying something like you get to choose three gen eds, go choose what you need, just let them run with it, just let the stuDnts have some freedom there, they didn't. They set this up so you had to have two from a certain area or they maD a logical sequence. So we had to have all these statements, statements, statements about this, that just maD it complicated.

J 5-4

And then, um, they reduce the foreign language because they said really if you are completing the 202 level, you're really not fluent. So, if you go to a foreign country you have to have, or another country to study, your 202 level is probably not high enough. So, they, um, dropped that down to that you neeDd semester one and two of the same language and the third course could either be a third course in a language or some aspect of culture or diversity.

J 5-5

DB Um, but you said something that, just a second ago, that the 200 level foreign language was really not enough to be fluent so was the iDa to make them fluent?

J No, they said that we need you to unDrstand another culture.

DB But not necessarily the language.

J Right, because you're not going to be at the 202 level unless you minor or major in a language, study abroad and spend time in another country or you have family or friends who have, you have an opportunity to get to know that culture and things like that.

J 8-1

No, I probably would have just left some things out like the multidisciplinary. And teamwork, I think I would have tried to come up with something different than what they had.

J 8-2

YeW, it was like you're going to teach this five week module (TW) three times and we just had problems with it. And we had DaJ teaching the class which was great but I mean it was just so much effort put it for this one credit five week class. It was like…

J 8-3

DB The same for the multidisciplinary too, would you have eliminated it from..

J There was no need because, the only problem was the mathematiM Dpartment. And they were going to have to go into the new core, so it fixed it, so you didn't need it. We would have faculty members, um, at meetings saying you can't teach teamwork or leaDrship, you either have it or you don't. I don't agree with that, I think you can expose people and it can grow and expand.

J 8-4

Um, but, it just didn't seem that, um, there was also a rush to get everything implemented, you don't want to drag your feet once you make a Dcision. But we were starting the new curricula for everybody and we didn't have the courses.

J 8-5

you know we didn't have courses for great issues. I thought the great issues was a good iDa.

J 8-6

Um, the teamwork was like maybe we need to rethink this. I thought the teamwork should come in through Boiler Gold Rush. I thought that would have been a good time to teach everybody, every program about teamwork

Communication and Presenting (CP)

Communication (C)

M 1-2

Critical thinking skills and communication skills because they had been given short shrift in the other core, in the original core curriculum

M 1-5

There were also a lot of national trends in terms of communication that we wanted to make sure that science students got those skills

J 5-3

Um, we included a change in the communications requirements that, um, involved presentations so that's a change

J 6-5

Um, in terms of communication skills and writing skills students are getting more practice.

T 7-2

Well again I haven't seen it implemented but, uh, I would say, including communication first of all was a big deal, um, well actually, pretty much those things you mentioned, the multidisciplinary aspect, I think that's important just because whether our students were going to be pure physicists or pure chemists the majority of our students are going to work in the world where that purity isn't important. And whatever they produce is going to have to interact with people from other disciplines whether they're in science or outside of science. So, so having a mindset to think about that as an undergraduate felt to me that it was going to prepare them better for being a successful citizen in the world no matter, you know they might end up in economiM or whatever but they still understand the relationship between these different components. I thought that was important. Be able to communicate about that I thought that was important. Um, the great issues and multidisciplinary have some similar things to them but, but the great issues, the idea behind the great issues is, at least when we first thought about it, was to not just be science but sort of how science fits into the world.

J 4-2

Um, students had a lot of things they needed to do. They had, um, they had 18 hours, 18 credits, a lot of liberal arts courses, working all day. They had four semester of foreign language, uh, plus everything else they had to do. We didn't require students to take Com 114 which is the basic communicatioJ course, because they were probably in other courses presenting papers or doing something

J 4-3

we felt like that, we had a lot of science students who weren't comfortable getting up in front of a group.

J 4-4

When they interview they may have to give a presentation, if they were fortunate or unfortunate enough never to have that experience in a classroom, they hadn't had communicatioJ since high school, they may not go for a job they need because it was those types of skills they need to develop.

B 7-3

I hope that the change in the communication and writing, um, you know making that more, cause science students think, you know, why do I have to write, oh heck yeW. You're going to write your entire life. I spend most of my day writing.

Presenting (P)

J 1-4

Um, students don't write well, um, they don't have a lot of preparation and practice in giving presentations, and many of them hadn't thought carefully about or had much experience in interacting either in teams or in teams that involve people who had expertises was very different from theirs.

Writing Skills (WT)

J 4-5

Yeah. In terms of my personal agendas, you know, I had, I had seen a need in the workplace for some of these types of capabilities. Um, I had personal experience trying to improve writing skills in intro courses that was, um, you know, naïve and, but, but I brought that to the table.

Critical Thinking (CT)

M 1-2

Critical thinking skills and communication skills because they had been given short shrift in the other core, in the original core curriculum

M 2-5

So, we were concerned about the lack of these other skills, the critical thinking, the ability to work in a group, um, no computer science was in our original core

M 6-6

I think adding stat and M allows them the physical points of critical thinking. I think that was very important

M 7-3

So to get faculty to think about outcomes, which was all about the accreditation, that's how we started the curriculum work. We talked about what learning outcomes we wanted for the students in the College of Science. So we didn't throw out anything, we said what learning outcomes do we want. Now let's look at what we have them do and where are the gaps? First of all, is what we do, where does what we do fit into these outcomes and second where are the gaps? And that's how we finessed it into things like teambuilding and critical thinking.

T 9-1

So, so there is, I think there is value in learning a foreign language because again it gets you out of your comfort zone, it forces you to think about abstract ways of representing ideas. And that's what science is about. Is to think about abstract things in a different way. And so I was all for keeping some foreign language requirement but I also felt like we needed a cultural experience as well because you know our students were going to be working in the world not in Indiana.

Curriculum (Cr)

Computer Science (CS)

M 2-2

Students needed to be at least computer literate

M 2-3

M we urged, and we continue to urge, more and more about making it more accessible to women, more approachable to women

M 2-4

this study shows that if you make a class that is more accessible for those that aren't a nerdy, geeky M boys, and you offer that, you will have women and other students in there

M 6-6

I think adding stat and M allows them the physical points of critical thinking. I think that was very important

M 4-5

Math didn't buy-in. Um, M was on the fence, I'm never sure that they bought-in. They were interested, but and this is a difficult, this is one of the difficulties, is they kept defining everything in terms of M and M students.

Curriculum (CR)

T 3-4

And one of the things we jumped Tay from pretty quickly was telling the computer science faculty what the curriculum should be for computer science students. That's why we went with the core idea rather than sort of a more comprehensive, we were hoping the departments would pick up an item. I doubt they have.

T 6-1

Yea, like I said there was a list that we came up with. So we did that before we really started looking at the actual curriculum itself. So that we could then go, because, you know, why reinvent things if we are already accomplishing some of the things in the current curriculum? We don't, we don't have, just check it off and go on with it. And then we could focus on things that we're missing but used to be there like the great issues. The great issues, I mean we look back on our own curriculum from the 50s and 60's and there were great issues courses.

T 9-3

Well, lowering the number of hours would not have been a bad idea. With the other experiential things being in there. But that wasn't a very high priority. I would have said, I would have expanded some of those core, I, I would have, how to be a scientist. I would have had, I think maybe there's, I think we ended up one course in a great issues kind of thing, I would have had two. I would have had maybe one, maybe one in both. So it would have been things like that more than reducing the hours I think.

T 9-4

Um, we didn't have that, uh, I was going to say we didn't have that much of a core. We had, a third of our classes were liberal arts type classes. But there was no cohesion to them at all. So I'd maybe give them a 3 or a 4. I mean I, I, I felt like one of the things that I could sell science over engineering, for instance, was that the percentage of our coursework that was education was what you expected out of an educated person. W was a higher percentage.

T 10-1

And we had a lot of flexibility in it. Um, too much flexibility I think but I think, I felt like it was a selling point for those students who, who wanted to think about technology and why things happened but also wanted to think about things we didn't understand yet. And, you know, how are you going to understand something, I don't know how to explain it exactly but, I used to say it all the time, how, how are you going to, how are you going to discover some new concept if you don't even know to look for the concept? And, and I thought like that the general education forced our students to think a little bit. Again I felt like the new plan for the curriculum was going to focus that thinking a little bit better.

R 1-1

And there was no rational to the entire curriculum. There were so many just requirement and exceptions. Just understanding what the set of requirements were was daunting. And trying to see some, um, um, some reason for it all was just missing.

R 1-3

So it really led me to the conclusion that we need to just start over from square one and ask the questions what are we trying to do in our educational process, what do the students really need to succeed, what common aspects does every student need to have and that should be a college component.

J 4-5

Um, the other part of that was difficult was the math department. Those students could mostly take math courses and one or two lab sciences and they didn't have to have a background in chemistry, physics, you know they could mostly take just math courses.

J 4-6

Everybody else had a very well-rounded program but math was the one that was a little bit, uh, lopsided like they would take usually maybe the easiest science they could find or maybe one they could stand.

J 4-8

The rest of us were kind of looking forward to maybe a reduction of some of these things like, the general education requirements went from 18 to 9, cut it in half.

B 2-1

Well with the group I had were math and statistics majors, um, always felt like having to take other sciences courses was, you know they didn't want to have to deal with that, they kinda preferred not to do any, mum, and just stick with their…

B 2-2

Um, you know I think students in general feel like why should I have to learn all this other stuff, I'm sure they've been feeling that for decades, um then the idea you know that this is part of the well rounded human being doesn't seem to matter much to the 18 top 22 year old set.

B 2-3

Oh yeW, a lot of them would be happy to just take their major and not have to, they sT all these other things as kind of an annoyance.

B 4-2

The old curriculum was easier to understand by the students. And it was easier because it was kind of more of a check box.

B 4-3

And the new curriculum, part of it because of its implementation and refining and it just, you know, it got so confusing

B 6-1

In fact at the time that this was implemented, um, we started a system in the College of Science it was called the exception database. And, um, while certain you know a student would petition you know so we kind of had our current set of rules which shifted as far as implementing the curriculum, it was shifting and changing all the time. Um, and a student would come up with something and we'd work out something and it wouldn't kind of be on the approved list and, um, then you would you know submit something and it would get ruled on

S 2-1

it was fairly well recognized by faculty who had been active with the college that we had a curriculum that had flTs in it. You know it was the Chinese restaurant syndrome, choose two from column A and three from column B and people were never all that confident. So we had a general perception that our curriculum was too old.

S 5-1

The problem is math, computer science out of which, which grew out of math historically and when my kids call sadistics. The basic ground rules of what they want for their students is fundamentally different from what physics, chemistry, the biological sciences and earth atmospheric and planetary sciences believe.

S 6-1

there are two phenomena that make this a significant problem at Purdue that is not the same elsewhere. Number one: is the existence of the pure college of science. Let's take Arizona State; they have a college of Arts and Science. They have a school of letters and science. You would think that there's some conflict between those two by the way, there is but I understand why there is and I understand how they do it. So the first this is that most, not all, benchmark iJtitutioJ will frequently have an Arts and Science college. The second thing that happeJ here is that unlike most iJtitutioJ we do not have an iJtitutional core.

S 6-2

At There are two big fundamental models. Michigan State is a good example of the other model. At Michigan State you make, you cannot declare a major until you are junior. It is not something that you are allowed to do. You can declare a major preference and engineers worry about that because they do start a vertical system as freshmen but there are no first or second year students who are majors.

S 7-1

The other way of setting basis for comparison is some work that we did with a living learning community course. Half the students were from science half the students from engineering. The students in first year engineering bond. They all know that they're engineers. They know that some of them will become mechanical engineers and some will be chemical engineers but that doesn't bother them because they bond for all engineers because we all take the same basis core courses. In the college of science those students never bond. The chemistry majors did not feel that they were the same as the ones who were biology majors and neither of those groups thought they were the same as the physics majors. The division was not created, it was intriJic from day one on campus. I am chemistry major, I'm not a science major

S 7-2

Ok so the focus was on practical perception that we had practical problems with our old curriculum getting it done

S 8-1

I mean there were only a hand full but it was part. What are we doing right, what are we doing wrong? The global coJeJus is that we are teaching as much content as anyone could expect them to know at that point in time. Uh we were not teaching them communication skills, we were not teaching them to work in groups. We were not teaching them how to work with people outside of their discipline. Um and that was true of others, for example on the ACS lecture tour I frequently talked to chemists in industrial situatioJ who asked the fundamental question how do you convince an engineer to stop giving you the same sample over and over again until you get the aJwer he wants. Ok we're not unique but ok these trends were there and, and, and they were voche they were not sodvoche but that's mythology ok

S 8-2

you look at what we did, there are things that could be done. UCLA for example has writing across the curriculum project. There are more faculty teaching writing at UCLA than there are in any department on campus. Look at chemical engineering. They have a faculty member over there who is not an engineer much less a chemical engineer. His sole function is to help build communication skills. Ok if we believed those trends, if we really believed them and were willing to work on them there were things we would have done none of which we did.

S 10-1

Ok, once you get into a content domain uh chemistry in particular and definitely physics uh not enough relatioJhip is painted between the content of those courses and the world in which the student lives.

S 11-1

And so you just well I gotta teach everyone every aspect of chemistry because otherwise and then when you look at organic courses iJtead of teaching the organic courses that a biologist would need we teach the organic that an organic chemists wants. So I mean this happeJ in physics and you know it's easiest for me to state it in chemistry.

S 12-2

the key main characters that I was interested in were the general education requirements in particular.

Outcomes (O)

M 8-6

Well first we went to the outcomes because the whole nation is going, outcomes is a better way of doing things, right?

M 8-7

And second we thought the faculty themselves, not just the task force, we got the whole faculty to vote on what the faculty thought the important outcomes were

M 9-1

And the faculty are very bright and we wanted them to be participating in the outcomes. OK? Once we got the outcomes then we had more experts in implementation in terms of thinking about pedagogy, thinking about curriculum.

M 9-2

We couldn't cover all the outcomes, there were a whole lot of outcomes, but what we did was we ranked them in order of how often they came up.

C S9-3

So I was at this math faculty meeting because the outcomes, we had to list them one to ten but there was no priority. I kept saying that. One to ten, we had ten outcomes or how many we were going to work on. But there's no priority in one to ten. OK? These are ones that all had a lot of votes for it. OK? And so I had these couple of mathematicians who are talking to me about why is this priority? I kept saying these are not in priority. They kept arguing me

Success (SS)

W 6-1 Definition of success

I'm going to try. So, for those students who want to go into graduate school, W, you certainly don't want to see a decrease in the success rate from those that graduate from the College of Science entering the graduate programs. Of course there are a lot of other things folded in. The other, the other, which may be easier to measure in some sense is how, how well prepared are students having graduated from the College of Science who want to immediately enter the work force? And there you can, you ought to be able to see, are we, are we producing the kind of students that employers want to hire? They look for teaming, they look for ability to present, speak, write. Certainly knowledge within a discipline. I would hope that an Tareness of the great issues would actually be a help but…

W 6-2

YeW, it's going and will continue. So, it's hard to know. But what I think we should be able to measure, we should be able to obtain an answer to the question from the standpoint of employers. Are our students coming out well prepared to join the workforce? Graduate school, you know that's a different question. There you are really looking for a definite discipline. And there the College of Science has always done well and I don't think we've weakened any with a discipline specific program. So, I would be surprised if there were any changes. Due to a change in the curriculum.

J 6-2

Um, the, the teamwork, um, requirement had some challenges associated with it. Didn't have many people who were actually trained to do anything with that. Our faculty are wonderful people but most of us aren't trained in many of these areas. We, we may think they are important and we may sort of know something about but we don't, uh, know that from training. So we have to come up with some ways to train students in teamwork and so that was done with a, you know, small groups, staff, and there was an online process and so, you know, how well that worked, I think the juries out on that. Um, but that, over time, that's sort of how we do that.

J 6-3

Um, there were concerns about the multidisciplinary work. People really doing multidisciplinary work, or was it just, you know, window dressing around a course that really wasn't multidisciplinary.

J 6-4

So, um, I think, you know, I look at the experiences students having in the great issues course. And clearly some things are happening in those courses that wouldn't happen otherwise.

J 6-5

Um, in terms of communication skills and writing skills students are getting more practice.

J 7-2

Well I would say the multi, I would say that the great issues course, um, that, that was a, that's an interesting component of this. Um, but I think the great issues courses are ones I wouldn't, because their departments are heavily involved in them, I would describe those as success.

J 7-3

Um, I think some of the multidisciplinary courses have been very good and they do what they're intended to do. Others not. Um, so in anything like this it's not uniformly successful or not successful but more or less successful.

J 6-3

Um, the students loved the fact that they didn't have to pretend like they knew how to speak a language when they did not.

J 6-4

the students are, um, finding, um, that they are, um, learning more about the planet or other areas that are covered in great issues. Um, they are actually taking something with them, an appreciation they did not have before.

J 6-5

because we, um, are in our program we gave them more electives, took out so many required liberal arts courses, that gave them the chance to leave their major with more courses from their department, more courses from another area.

J 6-6

So we were able to add more free electives to our student's program. So I think they are benefitting from that. So I think when the students sT that they were happy. I mean some of them wanted to switch. They sT the new core and said I want to switch to this

Successful Attributes (ST)

M 6-5

Um, I think study abroad, a global perspective (successful attribute)

M 6-7

And for me teambuilding. (successful attributes)

W 4-4

I think expose, giving students the opportunity to explore an issue or issues in great depth that don't fit conveniently into, W, a core curriculum like physics or biology. Um, I think that's really good. W, the statistics, everybody should have a baseline knowledge of statistics.

J 7-5

DB Study abroad, right. So, um, how do you feel about the issue about, um, the language issue? Do you think it's important that an undergraduate student have a foreign language?

J Personally I don't think that's important. I think it's important, I think it should be a choice. I would love to see students who are language oriented and want to learn a foreign language, use that to meet the requirement, if that's the choice they want to make. Um, but, but, I'm personally in favor also of students finding other ways to meet that requirement.

J 7-6

Personally I'm, I'm not a languages person, I am very poor at learning languages but I develop very strong skills in understanding varieties of poor English and helping teams of people who speak many different Englishes actually understand each other and work together. Personally having a skill set that isn't a foreign language but is a good ability to help an international team work together through a common language which is mostly going to be English. I, I think that's actually a very valuable attribute.

T 7-2

Well again I haven't seen it implemented but, uh, I would say, including communication first of all was a big deal, um, well actually, pretty much those things you mentioned, the multidisciplinary aspect, I think that's important just because whether our students were going to be pure physicists or pure chemists the majority of our students are going to work in the world where that purity isn't important. And whatever they produce is going to have to interact with people from other disciplines whether they're in science or outside of science. So, so having a mindset to think about that as an undergraduate felt to me that it was going to prepare them better for being a successful citizen in the world no matter, you know they might end up in economics or whatever but they still understand the relationship between these different components. I thought that was important. Be able to communicate about that I thought that was important. Um, the great issues and multidisciplinary have some similar things to them but, but the great issues, the idea behind the great issues is, at least when we first thought about it, was to not just be science but sort of how science fits into the world.

T 7-3

Teamwork, teamwork, yeW. And again clearly in the world that we're in hardly anything happens with a person in a room by themselves.

D 3-3

DB So you kind of answered, at least touched on the next question. What did you consider to be one of the successful attributes. So that would be the team building?

D Well initially I thought that was, I had hopes that was going to be a successful attribute. I knew that participating in the task force as I did not everybody was in agreement that that was going to be a particularly good component. So I had high hopes and I thought that was a good piece to be including

Undergraduate Science Courses (USC)

M 6-3

They now take a stat course and everybody now takes a CS course, takes a great issues course. Um, we, in order to do that we had to, um, reduce our electives, our general education.

J 1-3

So in terms of those particular things what I identified is, um, in terms of the foreign language thing, um, you know you have students who know their 473 words in Spanish or whatever they learned in two years of Spanish but actually didn't know anything about foreign cultures and were not prepared to interact with people in that global environment.

T 2-3

What I started looking at were the sequential courses myself. So, most of our students were taking a, well they were taking all, at least a three, most of them a four course sequence in calculus and math.

T 2-4

And, so when I was pointing out were how many students, I did my grouping into how many got an A or B, students who got a C and students who got a D or F. And showed, of each of those categories, what they did in the next course. Basically I was predicting what students would do in the next course.

T 2-5

And we were, what we were finding was if you didn't get an A in the first course you weren't getting through the fourth course in four semesters. And, um, that was a surprise to the faculty. Because they thought, I mean I think they thought that all the A and B students go on and get an A or B in the next course

T 3-1

And, so, what I was finding was that the, that the grading scale in those courses was really weeding them out even though they didn't think it was. It was weeding the students out.

T 3-2

More than they wanted them to be weeded out. Because they were only thinking about the course they were teaching not a whole set of courses.

T 3-3

the other thing, not so much in the calculus, but more so in the chemistry and the biology, somewhat in physics, and definitely in computer science, the, the material in the first course was getting added onto year after year after year because we know about those disciplines.

T 3-4

And there was a significant additional amount of coursework in those early courses. And there hadn't been much compensation to deal with that.

Unknown Successes (US)

J 7-4

Um, teamwork, you know, I don't have a lot of experience with how successful that's been. In terms of the communications and, and those changes, I don't have a lot of experience with that. In terms of the global competencies, um, I like the change that's happened but I don't have objective evidence to say students are much more competent than they were before

Faculty (F)

M 9-1

And the faculty are very bright and we wanted them to be participating in the outcomes. OK? Once we got the outcomes then we had more experts in implementation in terms of thinking about pedagogy, thinking about curriculum.

M 9-3

So I was at this math faculty meeting because the outcomes, we had to list them one to ten but there was no priority. I kept saying that. One to ten, we had ten outcomes or how many we were going to work on. But there's no priority in one to ten. OK? These are ones that all had a lot of votes for it. OK? And so I had these couple of mathematicians who are talking to me about why is this priority? I kept saying these are not in priority. They kept arguing me

J 10-2

Yes. Leonard, I have enormous respect for Leonard. Um, he has some strong views, he's not afraid of voicing them. Um, as head of the math department, you know, when we would have our meeting of department heads, deans and stuff, you know, you knew Leonard would always say something that would always be a challenge. He forced you to think and defend stuff. He wasn't trying to be obstructive most of the time, he wanted things very clear and argued and reasonable, because it sounded good doesn't mean it was the right decision. Tell me exactly, so, so. So Leonard I think would be an interesting person to interview about this and, you know he was a department head in math in this process so, as I've mentioned a couple of times, you know, the distribution of viewpoints was such that often the mathematicians were at one of the extreme compared to the others.

J 11-1

It is interesting when you look across our college I mean we have math, we have statistiM, we have computer science, um, so there is , W, W, and the actuarial science program within that. So we have things that, that are very different from what often people think of as the core sciences, the chemistry, physiM, biology, and so it does make for quite a diverse community so that's why some of the arguments were pretty heated about what fits all of our students. And do you need to be successful as a mathematician doing this. My personal opinion is that the math faculty weren't thinking about what all of their students need to do, they were thinking about the subset who were going to become graduate students like them.

T 1-9

And, so that was my motivation for kind of keep pushing at things, W, because there were a lot of political issues we were dealing with throughout the whole process. Um, I dealt with a number of, personally just because here I am a non faculty member, a non PhD person, and I had a significant role in at least the early stages of that. So I was very careful to not put my opinions in but rather to organize and present and highlight when I could to shape the direction.

T 2-1

We have, we have a number of folks, probably still are a number of folks, who somewhat have their head in the sand about that. And, they're used, they get rewarded, they're used to dealing with PhD students. And all but the very best of our undergraduate students are not going to be PhD students. So there's a whole different mindset about a PhD student versus an undergraduate. And the results you want out of those kind of people. And that was the biggest challenge throughout was to get them to think about undergraduates and not just the science student.

T 2-2

So, I mean I also pointed out, I mean I had my pie charts out that showed what percent of our students that went on to graduate school, went to medical school and all those kind of things. As a part of it to show, well and the medical students were, they actually got some earplay from the faculty as well. The fact that they were going on to a professional program. That carried some weight with them. The ones going out to work didn't carry much weight. There we had to use the alumni feedback to kind of shape the thinking there a little bit.

T 2-5

And we were, what we were finding was if you didn't get an A in the first course you weren't getting through the fourth course in four semesters. And, um, that was a surprise to the faculty. Because they thought, I mean I think they thought that all the A and B students go on and get an A or B in the next course

T 3-2

More than they wanted them to be weeded out. Because they were only thinking about the course they were teaching not a whole set of courses.

Faculty as Teachers (FAT)

M 3-4

some faculty are still going to put all their, most of their, effort on their research and they'll teach but they don't really care about developing, they care about doing a good job in the classroom but they don't care about the extra, they'll teach the content mater but they don't care about curriculum or different kinds of things like that

Great Issues (GIS)

M 5-4

And a key thing that a number of use were talking about for a long time, is the students were being educated with a lot of depth and detail, but they had no appreciation of what we call it now, the great issues. Big issues in science. How'd it apply to them.

M 5-5

And, um, so the students were not appreciating global things and that's where the world was going. Students were not understanding the big issues. They need to understand those kind of things.

M 6-1

Um, great issues became a requirement! Um, a student had to take one great issues course, and its been great!

W 2-1

There was a lot of discussion about bioengineering with crops, the genetic manipulation of crops. And all the ethical and other scientific concerns about that. Nuclear energy, there's lots of issues surrounding about that. So there were all these, hot topiM that were evolving so quickly that, there were no textbooks. You had to rely on, you know, current material.

W 2-2

Not be Tare, not have a place at the university where they could explore the issues.

YeW, I mean initially it was College of Science students predominately but actually when it grew into the great issues course I always felt that this should be campus wide. It should not be, because you certainly get much broader opinions and points of view if you have people form agriculture and you're discussing, W, agricultural issues. Climate, I mean, geez, the topiM go on forever.

W 2-3

They had a great issues requirement and as you know there are various flavors of great issues. My approach was to keep it very broad. And others, the courses are equally good, tended to take a single topic. Bill Zinsmeister focused on oil, you know it went deeper. What I tried to look at was the interconnectedness of the various issues. I think my own feeling it that it was a positive change

W 2-4

I also think that in part that the course was career counseling because it tried to show students, I explicitly made this point whenever I could, that these problems are so complex that, that even though you might think it's a political problem there's a role for a chemist or a computer scientist. Many of these problems require teams of individuals with different skills in order to fully address them.

J 5-5

Um, what else did we change? We implemented the great issues requirement, so that was a new type of course. Now people were already teaching some courses that met that requirement that suddenly in this department hundreds of students were coming into courses that wouldn't have come into those course hadn't we changed those requirements.

J 6-4

So, um, I think, you know, I look at the experiences students having in the great issues course. And clearly some things are happening in those courses that wouldn't happen otherwise.

J 9-5

And one of the discussion items at the moment within the college is, um, great issues. If great issues don't qualify as science, technology in society then our students will have to take science and technology in society and a great issues course. Well how do you, so that's, how do you do that and still get it into 120. So there were discussions going on about what of our college requirements met the foundational core requirements? And the things that don't map do we really need them or can we afford them?

J 10-1

W, great issues is the one that surprised us all but the reason it doesn't fit the foundational core is not because it isn't science, technology in society, it fits that description beautifully, but it's too high a level. And the foundational core courses are meant to be things that first and second year students can get into. The great issues courses were purposefully designed to be courses that after you've taken several years of your major you know something about computer science, biology or whatever it is. And you bring that perspective to the discussions at the great issues. It's meant to be more of a capstone experience where the foundational core is meant to be sort of a beginning experience for students. So it's not the either of them is wrong, you can't count one for the other means that there's sort of an additional burden on our students.

J 10-2

DB So your future view potentially is that instead of maybe increasing in terms of effectiveness, the curriculum, it may decrease.

J It may decrease in terms of what we've been trying to do in the college. Now if a student is taking a science and technology in society course as a freshman or sophomore, you know, are they actually getting a lot of the outcome and experience associated with what we're trying to do in the great issues course. It's not that we're going to lose what we were trying to achieve we'll have different things, probably not as effective

T 6-2

the other thing that was different was, as I recall, I don't know where it ended up, we talked about getting at least some component of those great issues at the beginning rather than at the end. And I don't know if that's happened or not but that's one of the things we talked about. Cause the great issues in the 50's and 60's was more of a capstone sort of thing.

R 5-1

The, uh, the great issues, uh, came in as sort of, uh, I don't know part of the just more desire to have a strong liberal arts component and be able to be Tare of, um, of these kind of just perspectives that, uh, any scientist should be Tare of. It's just, it's more of the breadth component of the curriculum.

R 5-1

The, uh, the great issues, uh, came in as sort of, uh, I don't know part of the just more desire to have a strong liberal arts component and be able to be Tare of, um, of these kind of just perspectives that, uh, any scientist should be Tare of. It's just, it's more of the breadth component of the curriculum.

J 8-5

you know we didn't have courses for great issues. I thought the great issues was a good idea.

B 6-2

Great issues, I think, I think again, um, in theory that's a really good idea to get them out of their kind of narrow focus, to see things on a broader scale and my gosh the way communications are now you know what's happening in Dubai ten seconds after it happens or whatever.

B 6-3

I think it has merit, I think it was just too variable. You know certain courses became known as oh yeW take so and so's, of course that happens in everything. Take so and so' course and you don't have to do very much.

Language and Culture (LC)

Global-International (GI)

M 5-3

A lot of us were concerned with the fact that as Purdue and as the country, the world was becoming more global, our students were not, they were taking a foreign language that wasn't making them global in any way.

M 5-5

And, um, so the students were not appreciating global things and that's where the world was going. Students were not understanding the big issues. They need to understand those kind of things.

J 4-6

Um, I do a lot of stuff internationally so I had some personal views about the importance of being able to, to sort of act in a global situation in ways that didn't necessarily mean you had to speak the language.

Language Requirement (LR)

M 2-6

In terms of our language requirement, we required language up to, I guess, two hundred and two or four semesters. That the goal of that requirement was to help students have some cultural appreciation outside of their own culture.

W 3-3

I personally had a prejudice agaiJt language requirements. W, only because I'm not good at languages and when I was a graduate student, W, I had, they, they relinquished the language requirement at MIT. And that was a great day in my opinion. So, and, now I have to temper that, I think it's great if a student wants to take foreign language. W, and I've taken foreign language. W, I took several years of French and I regret I can't speak Spanish.

J 1-3

So in terms of those particular things what I identified is, um, in terms of the foreign language thing, um, you know you have students who know their 473 words in Spanish or whatever they learned in two years of Spanish but actually didn't know anything about foreign cultures and were not prepared to interact with people in that global environment.

J 4-6

Um, I do a lot of stuff internationally so I had some personal views about the importance of being able to, to sort of act in a global situation in ways that didn't necessarily mean you had to speak the language.

J 5-1

Um, we changed what students have to do to meet what you would call the foreign language requirement. And that was one of the ones that took up a lot of debate in the open meetings. Uh, there were a number of people who felt it was wrong to give students optioJ other than taking language courses. So now there were a number of different ways of satisfying that sort of global competencies requirement

T 8-3

(sigh) I thought it was a good idea because I'm not sure that the way, I'm not sure the way foreign language is being taught that a fourth course in a language was adding that much to the student's education. I've not traveled exteJively but I've been around a little bit and I know that English is used practically everywhere. So that, that doesn't mean we shouldn't have a foreign language requirement because I also know that wherever we went I felt really out of place because I didn't speak the language. But even more importantly I felt like when I've been different places understanding that there is a culture different than ours, that the way they view the world isn't the same way we view the world. And I don't know that if you spend all your time getting the right teJes of your verbs down, that that's giving you that kind of experience. So I think that there was room for both I thought that learning a language, some level of learning a language, not only helped in learning the language but it helped you think about how to process ideas. I'm not sure they ever, students in those classes ever caught that. But, but, but it was sort of like when I was teaching math for elementary teachers. We could have taught addition, subtraction, multiplication, and division just like they are going to teach but we did it in a different base, than base 10, because it forced the student's to start thinking about what happeJ when you put two numbers together, what, you know, iJtead of just, you add two and carry the one, you know…

T 9-1

So, so there is, I think there is value in learning a foreign language because again it gets you out of your comfort zone, it forces you to think about abstract ways of representing ideas. And that's what science is about. Is to think about abstract things in a different way. And so I was all for keeping some foreign language requirement but I also felt like we needed a cultural experience as well because you know our students were going to be working in the world not in Indiana.

J 5-4

And then, um, they reduce the foreign language because they said really if you are completing the 202 level, you're really not fluent. So, if you go to a foreign country you have to have, or another country to study, your 202 level is probably not high enough. So, they, um, dropped that down to that you needed semester one and two of the same language and the third course could either be a third course in a language or some aspect of culture or diversity.

J 5-5

DB Um, but you said something that, just a second ago, that the 200 level foreign language was really not enough to be fluent so was the idea to make them fluent?

J No, they said that we need you to understand another culture.

DB But not necessarily the language.

J Right, because you're not going to be at the 202 level unless you minor or major in a language, study abroad and spend time in another country or you have family or friends who have, you have an opportunity to get to know that culture and things like that.

B 4-1

You know the one thing I thought students really struggled with was the four semesters required of foreign language. That was hard for them to get through.

B 4-3

Well they, um, the foreign language requirement was reduced, iJtead of four semesters of a foreign language students could use, um, two or three semesters, I think it was a total of 9 hours, they have two semesters of language, and then another cultural type course. It was a very broad offering, study abroad could be one. Basically any course that had a non-USA type focus.

B 7-2

I think in general that the language was successful I think that the great issues in terms of, um, getting students to think a little more outside of their Indiana focus,

GB 14-1

They they argued that foreign culture courses could be used in place of foreign language courses that's stupid. I'm sorry, it's just, it was dumb

S 14-2

um no the problem that we have again with foreign language is that, the problem is that we are a college of science. Foreign language requirement is very different between the view of chemistry and math faculty and chemistry faculty recognize it. It's not as important as it once was because of traJlational but I used to read the literature in German without traJlating, I read it in German

Multicultural (MC)

T 8-3

(sigh) I thought it was a good idea because I'm not sure that the way, I'm not sure the way foreign language is being taught that a fourth course in a language was adding that much to the student's education. I've not traveled extensively but I've been around a little bit and I know that English is used practically everywhere. So that, that doesn't mean we shouldn't have a foreign language requirement because I also know that wherever we went I felt really out of place because I didn't speak the language. But even more importantly I felt like when I've been different places understanding that there is a culture different than ours, that the way they view the world isn't the same way we view the world. And I don't know that if you spend all your time getting the right tenses of your verbs down, that that's giving you that kind of experience. So I think that there was room for both I thought that learning a language, some level of learning a language, not only helped in learning the language but it helped you think about how to process ideas. I'm not sure they ever, students in those classes ever caught that. But, but, but it was sort of like when I was teaching math for elementary teachers. We could have taught addition, subtraction, multiplication, and division just like they are going to teach but we did it in a different base, than base 10, because it forced the student's to start thinking about what happens when you put two numbers together, what, you know, instead of just, you add two and carry the one, you know…

B 7-1

Multicultural, is that what foreign language is called now? I think that was successful, I think.

Study Abroad (SA)

M 2-7

science students were also not taking advantage of study abroad and we felt that was an important opportunity for students.

M 2-8

As long as you were embedded in another culture, you weren't with your American Purdue friends just hanging out in another country, but you were embedded.

M 6-2

We've been able to incentivize study abroad. Until more students than ever are studying abroad

M 6-5

(successful attributes) Um, I think study abroad, a global perspective

W 4-1

DB Study abroad?

W Right. And that would of, I think that would have better for me had I been the student. I didn't like my French teacher in high school so I took five years of Latin.

Multidisciplinary (MD)

W 8-4

And then there's this multidisciplinary component which nobody knows, I mean that's the one thing, that's kind of where we gave up because we said this sounds good let's require it. Who the hell knows what it means.

W 8-5

I guess, I, I don't know how it's being done. I don't know what students are doing to meet it. W, I do know. Physics majors will take an astronomy course, whoa! That's not what I, I think we came up short on that one.

W 9-1

DB What would be a more interdisciplinary, in your mind, for physics majors?

W Well see, I, I, I wouldn't have it for physics majors. I'd have it for science majors and have something that was more integrated.

J 1-4

Um, students don't write well, um, they don't have a lot of preparation and practice in giving presentations, and many of them hadn't thought carefully about or had much experience in interacting either in teams or in teams that involve people who had expertises was very different from theirs.

J 5-4

Uh, we introduced the multidisciplinary requirement, um, that's been pretty controversial but that courses had to get approved or experiences had to get approved to meet that requirement.

J 5-6

Well so there was a, there are parts of the college where certainly advanced work in that field is not typically done, um, with, and I'm going to put multidiscipline and teamwork together because I was involved in both of those and there were similar controversies about it, um, so, and I'll pick math as an example because this was one of the departments that pushed hard against these things

J 5-7

So the vision of a mathematics researcher that we all sort of vaguely, the misconception we have in our minds but probably not too far, is the individual sitting in a room with a pencil, you know, doing proofs. And that's not how math is done. That encapsulates the push that came from that department, say what's this teamwork thing, we don't need teamwork, this multidisciplinary won't produce the best mathematician, we don't want to, they don't need to spend their time learning how to do stuff with other people.

J 6-1

DB OK, so was there a resolution to that?

J They lost (laughs). Again, this was something that it came down to a large open meeting and voting about these things so they were, the dominant feeling from the faculty who bothered to turn up and express opinions about these things was in fact it was important to have multidisciplinary experiences and to do teamwork. So there were minority opinions voiced very strongly because this is a college requirement if you were just one subunit of a department you're not going to win that.

J 6-3

Um, there were concerns about the multidisciplinary work. People really doing multidisciplinary work, or was it just, you know, window dressing around a course that really wasn't multidisciplinary.

J 9-1

Transdisciplinary. And that went nowhere, absolutely nowhere. I would have been happy to make do with interdisciplinary but even that, um, was not well accepted by the larger community because of concerns about what it might mean. People were happy with the idea of multidisciplinary because they thought they could get Tay with saying OK if I could just put two disciplines in the same course that's multidisciplinary. But I don't have to try and do stuff that we use them together because that would be interdisciplinary and no one knew what transdisciplinary meant. Even though it was the right word for what we were trying to do. So semantics within a community is actually rather important so, the word reform didn't come in because it wasn't a word most of us were used to using.

T 7-1

And that was, I think that's a good thing but that was coming out of the multidisciplinary approach from the faculty and the different research areas trying to be combined so it was a, I mean it was the right thing to do but it was also an attempt to understand the faculty are going to embrace this a little bit more if they see the potential to shape some student s to look like them.

R 4-6

YeW, oh yeW. Sure, um, and in fact what we settled on I believe was in terms of what students would need to do to satisfy this requirement is one they could take sort of a capstone course that, in a course, looks at a problem from multiple perspectives. So if they're geology majors there may be, um, issues that are brought up as well in physics or mathematics or economics that in the same course they look at all those aspects of a given problem. Um, I also thought it was important, um, that hey I think it's great if people double major or minor in subjects. And that getting two majors you, you, you definitely get well beyond just that double perspective and in your mind even if you don't take the course that in itself is using those two disciplines, explicitly, if you've gone to enough detail to get two double, to get a double major, two majors, then you have really in your mind I think synthesize in a very deep way two different paradigms and approaches. And that's another way of kind of getting that perspective because you've probably have gone well beyond just what a single course would do which would really be at a more superficial level. So we wanted to, W, I was especially interested in encouraging double majors too, so I didn't want everyone to take necessarily one course that tried to do this multidisciplinary perspective within a course I was also encouraging students to do a much deeper dive into two disciplines or more, be a double major.

J 6-7

YeW, I think the multidisciplinary was, um, was not needed. Not needed, um, everybody was already doing all of this except math. When they changed the program they already made everybody multidisciplinary

J 6-8

There, again I'll use this department, you cannot leave here without math, calculus, statistics, um, computer programing, chemistry, physics, in some cases biology plus your major courses whether it was atmospheric science, geology, or environmental. Plus you are doing languages, liberal arts courses, so I don't know how more multidisciplinary you could get.

J 6-9

When it first started it was this horrible process of trying to prove that you were multidisciplinary. And they have a, um, committee that would approve, if somebody had an experience that was multidisciplinary

J 8-3

DB The same for the multidisciplinary too, would you have eliminated it from..

J There was no need because, the only problem was the mathematics department. And they were going to have to go into the new core, so it fixed it, so you didn't need it. We would have faculty members, um, at meetings saying you can't teach teamwork or leadership, you either have it or you don't. I don't agree with that, I think you can expose people and it can grow and expand.

B 5-5

Well that was one I think that you know kind of sounded good on paper, um, but you know science, maybe not math and statistics so much but most of the sciences are already multidisciplinary and so it was kind of this thing that just was like we're already doing this

B 5-6

I also work with actuarial science students who are basically doing statistics they're doing math they're doing business they're doing economics, they're doing, they're basically already multidisciplinary.

B 7-5

I don't think that one was successful. It was too confusing and not well defined as to what it was. I know when I sat down with students and I would have to kind of say, kind of go through my little spiel I would always get to multidisciplinary and I would never have good reasoning for our rational for that.

Rankings (R)

Rankings Post (RT)

M 8-2

So I think the new core had the potential of being an eight in terms of that but I think it's probably a six or a seven now simply because, um, of the way it played out. In terms of great issues I think it's a ten. I think there are different component parts that have really done it. I think one of the best things was the great issues. Um, I think that's doing exactly what we wanted it to do.

M 8-3

I'd say a seven, seven and a half.

W 5-4

W, I, I, again no objective measure, maybe a four point two… I think that, see, so what should be… Maybe I could ask what would be a valid measure of the success of the core and…

J 8-2

DB That's the next question. So you would give a four to the prior and a seven to the new?

J YeW.

DB Alright. Um,

J A nine in theory, a seven in practice.

T 10-2

Well again, whatever traJpired or not, on paper it looked like a seven or eight to me. I thought it had maD quite an improvement.

D 4-2

I probably would have given that closer to a seven or eight. Again because I was pleased to see the specificity that was incluDd in the new version.

J 8-8

DB OK, same question but then with the new core.

J I would move it up to an eight. I think it improved it a lot, um, but like I said the multidisciplinary just throws it all off. We have stuDnts who don't know what you're going to do when they are already multidisciplinary. And nobody will listen to you about that so…

B 8-2

I would say we were maybe getting up to a six.

B 8-3

DB So you were lower than the prior, you would rate it lower than…

B Well just because it was still, so you know, it was still changing and shifting even at that time. In 2012 when I left and this was five years in we were still working out the kinks. And, um, you know, in the first couple of years I would probably rate it a three or a four. Um, you know, I would say a six when I left.

S 19-2

It's still three

S 19-3

ok they maD certain things better, they maD other things a negative. Um unrelated to this but still related uh in education a few years ago uh they DciDd that cohort education was a good thing and it is. And at small iJtitutioJ cohort education happeJ all the time. We're not a small iJtitution. We implemented cohort and it just ripped the guts out of our education major because what happeJ is chemistry teachers don't graduate from education, they graduate from chemistry.

Ratings Prior (RP)

M 8-1

So, if we define it as reaching the outcomes that the College of Science faculty said they wanted I'd say three

W 5-3

OK, so first, I have no objective measure, W, was it successful? You know, we produce some great students. Did we lose students because of something that was in the core or was not in the core? I have no idea. So, I, I say it was probably a four.

J 8-1

Oh, um, I guess I would rate it at you know I mean, this is the obvious answer, it's going to be a four and the afterward a seven or eight…

J 9-4

Well there were some potential changes coming up that might actually make it less than a seven. Um, so as you know we have a new foundational core requirement coming in. And at the same time we have the state, um, mandate/encouragement to reduce to a 130 credits, in cases where a 120 credits where we're more than 120. And so these different pressures coming in and so if the college has a requirement that also meets the foundational core than that's a no brainer and you keep doing that and everyone's happy. But if the college has a requirement that doesn't meet the foundational core, which means our students are taking more credits and we can no longer, and we're also having to try to squish down to 120 then at some stage something will have to be jettisoned

T 9-4

Um, we didn't have that, uh, I was going to say we didn't have that much of a core. We had, a third of our classes were liberal arts type classes. But there was no cohesion to them at all. So I'd maybe give them a 3 or a 4. I mean I, I, I felt like one of the things that I could sell science over engineering, for instance, was that the percentage of our coursework that was education was what you expected out of an educated person. W was a higher percentage.

D 4-2

Um, I guess I didn't at the time I joined the task force and my knowledge of the old core at the time, I probably would have given it a rating of probably like a six or something like that. I didn't, I wasn't Tare of really serious problems with it and so that's my rationale of giving it a rating of at least five. Um, but I also knew that there were some relatively small things missing. And again with the idea of having a more well rounded kind of experience for the COS grads. So that's why I'd probably give it that rating.

J 8-7

DB So, on scale of one to ten with one being completely bad and ten being beyond expectation how would you rate the College of Science's core prior to 2007?

NS Probably about a seven, I'm sure students left here with a really good education it was just a lot of work. I'm not sure they were getting everything they needed so let's just give it a seven.

B 8-1

Oh I don't know, I mean, I think it was successful, I don't know what that really means, whether it's successful, I would say a six or seven.

S 19-1

I would have rated it as three

Reform (RM)

Reasons for Reform (RFR)

CS 5-1

We were getting, our accreditation was coming up, so you start thinking about what you're teaching and why you're teaching and what you are actually doing. We were also talking to employers, so there were things coming from employers, coming from those people, so you know, as you well know, the College of Science, we have science educators. Those faculty would talk to me and say, you know, what about this or what about that. So there was a community that was interested in curriculum reform or curriculum enhancement,

T 1-1

Um, well there were a couple of things as I recall. Uh, one was, what was, the feedback we were getting from alumni about our graduates, so it wasn't so much, it was education but it was sort of the applied education. What were they able to do and what weren't they able to do. And, um, was there something we could do about it. That was one aspect of it.

T 1-2

The other thing I think we looked at was just sort all those polls and rankings and everything that compared US students with students from other countries.

T 1-3

And, um, and I guess maybe a third component was, they hadn't looked at undergraduate education in over 40 years. In 40 years you probably should look at undergraduate education.

T 1-4

So those were probably the national components that were out there I know we did spend a lot of time looking at, I mean we did some benchmarking against what other peer institutions were doing but they weren't doing a lot different from what we were doing.

T 1-5

Well it certainly was a consideration for me. I never did get the faculty really excited about retention issues. Um, their perspective is more if they can't cut it they don't deserve to be here.

R 1-2

So it really led me to the conclusion that we need to just start over from square one and ask the questions what are we trying to do in our educational process, what do the students really need to succeed, what common aspects does every student need to have and that should be a college component.

R 1-4

DB So a question I kind of want to add to this, not on the sheet I sent you, but were retention issues in the School of Science, or nationally, an issue that you talked about?

R YeW. We wanted to make the curriculum more relevant. And that was definitely an issue that we were losing students. We were getting great students to come to Purdue and in fact we were a drT to Purdue. The recruitment office frankly would tell us that these students are not going to graduate from your college but they think they want to and they're going to find out for whatever reason they don't want to do that, um, and if we don't admit them to your college they won't come to Purdue. So we were kind of a, W, almost a mechanism to admit people to the university who weren't going to end up being science majors. A lot of those students really did want to be science majors and they just did not resonate with the curriculum. And I think a lot of that was the difficulty of the first year curriculum being kind of just thrown upon them. And not paying attention to these other important aspects that are going to help make them successful. That was definitely a part of it.

J 1-1

The administrators, DeaJ, and some of the faculty had been getting input from employers that said we want students that can work I teams, will understand the importance of group work.

J 1-2

The employers again were telling the University that they need students who could communicate scientific information to various groups. They needed people who had knowledge of other cultures and were Tare that we were a global economy, a global world, and not just Midwest or east coast or whatever that happeJ to be.

J 1-3

The other thing that was going on was, W, was a little bit more of a practical approach was, W, the curriculum had not been changed in over 40 years. It surely needed some updating.

J 2-1

I've brought up is the issue of attrition in the school of science. Was that an issue at all, both nationally and I know at Purdue as well how there was a high dropout rate out of the school of science?

Yes, um, that was one of the things that they were looking at.

J 3-1

Um, yes, there have been, um, fewer students finding success in science programs. So I'm sure that was part of the idea about listening to employers because we were not, we were kind of switching from an economy that said get your degree and you can go out and do anything.

J 3-2

But, um, yes, science was suffering, we have more students trying to go to college than in past years, like in the sixties it was somebody who's affluent, male, possibly white, who is coming to college, um, they didn't need much just here's a pencil, a slide rule, a class ring, go to it type of thing. But as we began to, um, realize that, um, more women needed to be in college, uh, we have more diverse, cultural diversity coming into college. There've been a lot of changes since the sixties in colleges. The COS said OK let's also try to make some changes that might be open to more students. Um, we have some students that might not make perfect grades but they are really good in a research lab, have entrepreneur skills, things like that they can take with them, whatever background they have, whatever focus they have, so I think it was looking to more ways to be inclusive but I don't think it was stated like that. But it was just understanding all the trends in college.

J 3-3

We need to address, um, enrollment, attracting, retaining students, and we also need for them to be able to leave here with the skills they need to be successful

J 3-4

, like surveys that president Jiscke did found out, and I don't remember at the time because these surveys are too long ago for me to give you the percentage, but I'm going to say it was over 60%, it might have been as high as 80 or 90% of the students, were addressing and coming to college to get a job. The philosophy of coming here to get an education as my only goal wasn't there. The students do want to get an education but they also want to get a job.

J 4-1

But I wonder on some level at least from an academic advisor perspective, if they weren't looking for ways to help students achieve their goals, even if they weren't the same goals, like the faculty may think you're here to get an education, you're here to learn as much science as you can, don't worry about the job because you'll find a job. And all this was way before 2008, 2009 when things really changed

Reform (RM)

M 8-4

DB Um, alright, I alluded to this before we started the official interview but I'm using the word reform. And I realize that the word reform is not used in any of the documentation. You said that was on purpose.

M Yes

M 8-5

Well we, since that core was developed by faculty and some of them are still there, you never want to get people against you from the beginning and tell them the impression that you think theirs' wasn't good.

M 9-4

DB Do you see the use of the word reform as kind of a pejorative term?

M Yes, I do. Especially when you dealing with faculty. Remember that.

M 9-6

Um, in some cases I think it's more saying this is what we were doing, this is like 40 years later, we hadn't changed it in 40 years. The world is different. Students are different. Employers are different. The graduate schools are different.

M 9-5

That you are telling them they are wrong. You're going to make it better.

M 9-7

Those places, those institutions, those people who want our students have different expectations. We need to meet them. I see it more as an updating.

M 9-8

In some cases, um, I see it as a reform in sense of less rigidity, more options. So that's where I see the reform.

M 9-9

I see it as a reform as we are talking about outcomes not just a language requirement, a math requirement, what are you trying to get at with that? So that's where I see the reforming.

M 10-1

DB So what I'm hearing you say is that you wouldn't really call it reform.

M Right.

M 10-2

When you deal with faculty who design something, change to what they've done is a bad thing.

M 10-3

So I like it now how the country is trying to go, I don't know if Purdue's going there, but this idea of the accreditors are not like, oh we are going to come every ten years and grill you, but continual assessment, I think that's the brain switch that we all need to assess what we do, and I can tell you

M 10-4

As the world changes, as the disciplines change, as science changes we need to be ready to help those students. Um, we're educators right? We can't be educating a 100 years ago style. We need to be constantly changing.

M 10-5

DB So I want to go back to the word reform again, uh, for the last time. Is there anything that could have been done that you would've called reform?

M I guess if we through out, if we threw it out and that's one of the things that several of the departments wanted us to throw out.

DB Just throw out the curriculum?

M The core.

DB Just the core?

M Yes, just the core and let the departments run it.

M 11-1

DB Oh, that would have been reform.

M Yep. Or either way. If we took over everything that's… I guess I see reform as big changes, where I see what we did was, um, assessment and evaluation to meet the needs. I don't see that as reform. That doesn't mean I see that as a non-significant change. Some of these were very significant changes. But they're not, they weren't, I guess if we said you don't need math any more, as a scientist you don't need calculus, I would not have survived that. That would have been reform.

W 7-1

DB Let's get to that in a second. But from your perspective was it a conscious effort not to use the word or…

W I don't remember whether Jeff ever spoke to that issue or not. I don't know. My guess is that reform may have over promised. I mean, they, promised too much or implied too big a change. W, I'd have to look up the…

DB To you. What does reform mean to you? Without a formal definition.

W I guess to me it would have implied more wide ranging changes rather than tweak here, tweak here, tweak here. Because I think what we did is nothing radical.

DB OK. By radical you mean big change?

W Big change, require every College of Science student to take physiM. MIT does that. Every MIT student takes physiM. That would have been reform.

DB Just one course? What if you did that, every science student had to take at least one course in every science discipline?

W I think that would have been a bit more radical. YeW.

W 7-2

DB OK, OK… Um, so the last formal question, at least. Um, so I'm going back to this word reform. Do you consider it to be a reform, however you define reform?

W No, I don't think so. I don't think so. I don't think so.

W 8-1

DB Do you think it required a reform?

W No, I think, W, I, I think it required some freshening. So we, we, have undertaken refreshing our own undergraduate curriculum in physiM. I don't know we reformed it but I know of examples where its been reformed. Oregon State, for example, they changed their upper division courses, W, by breaking down the barriers between the different topiM. So in the junior year here you'll take an advanced, W, typically an advanced electricity and magnetism course and an advanced, W, E&M course, a mechaniM course. What they did is they said let's break down the barriers between the courses. We're going to do, we're going to do topiM like waves. Waves in mechaniM, waves in E&M, waves in, in quantum mechaniM. They called it the paradigms. And to do that, and we looked at this when we were considering changing our curriculum, it required a lot of buy-in from the faculty because different faculty would teach different parts of this course. It was a, it was, it wasn't just a change of topiM it was sort of reshuffling the whole deck. That was a reform because it was, it was, radical. It's been very successful there.

W 8-2

DB So your opinion is that it's been successful.

W YeW, and it's been written about W, pretty extensively. But to me that's a reform. You haven't simply introduced a set of requirements or a single new course. They took topiM and integrated them in new ways. That's a reform.

W 8-3

YeW, yeW, so you could imagine an undergraduate curriculum or some part of it that is much more integrated across disciplines. Cause really what we've done is we've, you know, still parsed it into these separate categories and, I guess one of the things that attracted me to the great issues courses was that you could break down barriers. And you could mix students with different points of view and with different technical backgrounds. But for the most part, you know we got this statistiM requirement, we've got the lab requirement, we've got, you know, eh, eh, it's hardly radical.

J 8-3

Um, this was an effort at reform. We were changing what was going on in the light of a better understanding of the changing needs of our students. And to me that sounds like a piece of reform.

J 8-4

Reform I see has sounds like we did something wrong before. W, reform school or something. Um, and so the reason it's not used is probably simply because that community didn't intuitively know, it wasn't a good enough word to choose because no one really quite knew what it meant. Um, that people would have suspicions that it would have baggage associated with it or maybe it's one of those education words.

J 8-5

Um, so, so I guess I hadn't noticed that it hadn't been included but may in retrospect it doesn't necessarily surprise me. Because every community uses the words that seem to make sense. I mean, but one of the funny aspects of the multidisciplinary requirement. I was actively involved in that task force and I didn't like that word. I didn't want it called multidisciplinary.

J 9-2

DB Well, uh, a prior respondent to this, uh, interview, uh, I asked the same question and um. She replied that she felt that, uh, she knew the word reform had not been used and said on purpose. She said that her feeling was that it was a pejorative word. And I think you hit on this. Uh, she said that it, the use of the word sort of intimates that you were doing something wrong or bad. And so we're going to change that to something good. Would you agree with that?

J I would agree with that too and, you know, certainly in the discussions that, um, you know, we have an alumni advisory board and one of the ways you do change management in an organization like this is to help the faculty understand that in addition to their own knowledge about what's important to succeed as a graduate student, you know, there are external constituencies.

J 10-1

W, great issues is the one that surprised us all but the reason it doesn't fit the foundational core is not because it isn't science, technology in society, it fits that description beautifully, but it's too high a level. And the foundational core courses are meant to be things that first and second year students can get into. The great issues courses were purposefully designed to be courses that after you've taken several years of your major you know something about computer science, biology or whatever it is. And you bring that perspective to the discussions at the great issues. It's meant to be more of a capstone experience where the foundational core is meant to be sort of a beginning experience for students. So it's not the either of them is wrong, you can't count one for the other means that there's sort of an additional burden on our students.

J 10-2

DB So your future view potentially is that instead of maybe increasing in terms of effectiveness, the curriculum, it may decrease.

J It may decrease in terms of what we've been trying to do in the college. Now if a student is taking a science and technology in society course as a freshman or sophomore, you know, are they actually getting a lot of the outcome and experience associated with what we're trying to do in the great issues course. It's not that we're going to lose what we were trying to achieve we'll have different things, probably not as effective

T 10-3

DB Um, Alright, now this is kind of, we're getting near the end here, this is kind of interesting for me because, um, I've read through as much of the documentation as I could get my hands on. Uh, and something jumped right out at me. The word reform was never used. And, uh, so was that on purpose? Or did it just happen by accident?

T I don't remember any purposeful…

DB Well it was never used. So…

T What did they call it then?

T 10-4

Um, I, I would say it was more iterative than a reform. Reform I would have said, in my mind, when you reform something you sort of start over from scratch. You may, you may pull in good the components that are out there. You know if there is a block that's working, why tear it up and start over again? But you put all your blocks out on the table and then you pick up what you need. We didn't do that. We just, iteratively, we tinkered. I felt like we tinkered pretty extensively on some things.

T 10-5

I would have deconstructed our current curriculum into components and evaluated each of those components. I can't, first of all going back to that standard that we wanted to get our curriculum to. But, um, I would have looked and said, I would have gotten Tay from, well calculus is five credits so it has to be five credits. I would have gotten to what is it we want to accomplish and is it possible to create a course that's calculus and chemistry together? I don't know…

T 11-1

And, not only departmental courses but the engineering curriculum and the pharmacy curriculum because we weren't going to have our own courses to do this, we had to use the blocks that already existed. Now the thing that sort of irked me in all this was when engineering went through their change to curriculum or reform to their curriculum, whatever they called it, W, you know, our courses changed to what they wanted.

T 11-2

It's a political issue. So, W, and engineering was the bigger dog on campus so, so and they were going to populate courses, which is more money. So, so we had some blocks that we had to use no matter what.

T 12-1

The biggest problem with math was they had half or more of the science education students in science and they had no education faculty. So, uh, that was one of the reasons they were I think perceived as being more difficult to work with. Because they didn't understand, they didn't have somebody to go back to in their department that would advocate the education speak.

R 6-1

R Reform?

DB Yes.

R W, I don't, I don't remember that. I used to, um, I used to say when we were starting the process that, um, the curriculum dated back to, W, I think it was actually around forty years or so and it's always a good practice every forty years or so to look at how you are teaching what you teach and why you teach. And, um, I don't remember a conscious choice of using it or not using it.

R 6-2

I would say it's a major reform.

R 6-3

Yes, a major reform or really just starting from scratch, a total redesign. It was much more than a tinkering. Tinkering is sort of the process that happened over the preceding forty years.

R 6-4

DB OK, so if I can ask, how, and I think you just did, how would you define reform then? A major retooling?

R Yes, it's a, it's a new framework, a brand new framework that makes, it was significantly different from the old curriculum and, uh, I think moved the college forward in very significant ways.

D 4-4

Well reform is one of those terms that has multiple meanings. When I think of the term reform I think of something that's a pretty fundamental change. I don't think of something that's tinkering. I think of something that's more significant change, that is very carefully thought out, um, alternative approaches are consiDred and Dbated and usually a consensus is Dveloped of all the stakeholDrs involved. Um, and then careful thought is being put, should be put into how it's going to be implemented and then how it's going to be assessed, the success of the reform. How are we going to measure whether this is actually doing what we intenDd it to do or not. Um, to be perfectly honest I did not think that the change in the COS core requirements fell unDr that category of reform. I didn't think it was a fundamental change because many of the same kinds of thing reappeared in the new core requirements. Um, they were, I thought, given the audience, carefully thought out, however, I thought one of the real weaknesses of the whole plan was, it was all COS faculty who were discussing this. And when I said earlier, stakeholDrs who were involved, I didn't see any stuDnts on the panel, didn't see any employers on the panel, W, um, trying to remember if, um, Alan Welch was on the group, he was one of the leaDrs of the group, and rightfully so because he was representing the advising team from the COS too. At the time he was director of that. So it was good that that part of the population was incluDd. But I thought there were a lot of players who were not incluDd in that. And so, and then I thought a lot of this was implemented, it was phased in. There was a program that I thought it was Earth and Atmospheric Science that agreed to pilot several of the components. Um, but I wasn't really clear on how the success of the reforms was going to be assessed and evaluated.

D 5-1

Um, I did, I think I touched on a couple of things. One would be, would have been a broaDr representation of different stakeholDrs. From the beginning, throughout the entire process to ensure that perspectives from stuDnts, from employers, from faculty, those who are on the campus with stuDnt right here were well represented and became part of the consensus making process. That neeDd to take place. That was one of them. Um, and then the last part was, there was a lot of time, even in the couple of semester I was involved, there was a tremendous amount of time and effort that was Dvoted to changing the requirements, W, without any kind of a systematic way of asking the question ‘were we successful’ ‘does this make sense’ and again without having representation from the stakeholDrs and follow up with the stuDnts, with the employers, with the faculty, with the advisors and everybody else, without having something in place I don’t know how you could have said if it were successful or not.

D 5-2

No, they were very serious about what they were doing. I think they were fairly narrow minDd about what they were doing. And they weren’t consiDring, necessarily, um, the longer term consequences and how they would measure the longer term consequences of the changes they were planning to implement. Both on campus and off campus after the graduates left.

D 6-1

Absolutely. Absolutely. And so I don’t know if one individual, I mean I might have been able to throw some iDas out on the table. As I said before, there were parties on the task force who were from the get go seriously against a lot of these iDas. And so the compromise and the consensus that was reached is probably, um, in hindsight that’s probably, um, about as good as it could have been done given some of the parties involved. And again, I think, I got the impression, this was me personally, that you know a lot of time and energy was being put into this and a whole lot progress didn’t seem to be maD and so I think at a certain point people said OK we’ve come this far let’s make sure we get this new set of requirements advertise, get the word out to faculty, let’s think about how we’re going to phase it into the different majors in the college, um, and that’s about all we can do at this point.

J 9-1

To me reform is probably something huge. It’s big, it’s not oh let’s tweak it a little, let’s add this. Reform is big.

J 9-2

So reform would be, um, something that would, um, move mountaiJ as opposed to oh we’ll just add this course or something like that.

J 9-3

I think those, um, which we hadn’t had before maybe not huge reform but an important reform that would make our stuDnts better qualified for the next step, whatever it is.

J 10-1

DB OK, just to reiterate, your Dfinition of reform, this was a major reform then?

J OK, yeW.

DB I'm not putting words in your mouth, I'm just trying to clarify that.

J I, I, I think they were hoping for that yeW.

DB But what do you think?

J Um, yeW probably, um, yes because they really were trying to mold it a little bit to fit what the expectatioJ were today, so it wasn't something where they changed absolutely everything but, um, it was enough of a change in attituD that that could be reforming.

B 8-4

When I see, hear the word reform I'm think you're fixing something that is wrong or, or not working or there is just an inherent you now something bad about it. You know that's when I hear reform, um,…

B 9-1

But that's, yeW, but I wouldn't have said it neeDd reforming, I would say it neeDd some, some enhancements. Um, but I wouldn't say it neeDd reform.

B 9-2

And I can see where, you know, Purdue having all these different requirements, everyone doing their own thing doesn't seem cohesive and doesn't seem like we're working together. In some ways it seems like, you know, do they all know what they're doing? Um, and so I think to kind of have a general framework even though the core is going to have to be slightly different from engineering versus HTM or you know some of these Dpartments I'm like, certainly you can't force everybody to have the same level of math and sciences and blW, blW, blW. So I think kind of having a general framework is good, um, but I wouldn't say that, you know, we need reform. I probably wouldn't put that word on it.

S 26-1

Ok um I helped to create in chemistry discipline based educational research ok. It didn't exist when I got here. Uh true reform should have a theatrical framework.

S 26-2

It's it's like I won't be on an OP or a PhD dissertation DfeJe unless there's a theatrical framework. I I you know you know I happen to have written on theatrical frameworks but the the assumption is that there is a leJ through which you look. There otta be reform to me implies eviDnce based change.

S

DB How do ya measure whether it was successful

S No attempt, still the college has not attempted.

DB Why do you think?

S I have commented upon this uh in terms of the choice of associate DaJ. You've got an associate Dan whose job is research, ok fine. I know what he does. You've got an associate Dan for unDrgraduate iJtruction good. So put somebody into the office who knows how to do assessment.

S 27-2

And I'll tell you by the way I've read enough of these things to know. I know that individual using those words has no iDa what the mean. You can see it in the way in which the message is conveyed. Um if it was reform some eviDnce based some basis should be there for which you start and within the context of action research you know

Resistance (R)

Resistance (R)

M 4-5

Math didn't buy-in. Um, M was on the fence, I'm never sure that they bought-in. They were interested, but and this is a difficult, this is one of the difficulties, is they kept defining everything in terms of M and M students.

M 4-6

It was very difficult to get several of the faculty to move out of their discipline.

M 4-7

And there were several departments that weren't going to go there. They were trying to take things they already had in place and, and, really sort of push and shove them into meeting a requirement.

M 9-3

So I was at this math faculty meeting because the outcomes, we had to list them one to ten but there was no priority. I kept saying that. One to ten, we had ten outcomes or how many we were going to work on. But there's no priority in one to ten. OK? These are ones that all had a lot of votes for it. OK? And so I had these couple of mathematicians who are talking to me about why is this priority? I kept saying these are not in priority. They kept arguing me

M 11-2

One of the funniest things of the whole thing, was several of my colleagues, we always asked at every step, we send it back to the faculty to get input, OK? And several faculty they didn't give input. And now we are getting ready to vote and all of a sudden all of these people are coming out of the woodwork with complaints, right? Like you had all these chances, they were trying to delay. We had a big faculty meeting where everybody could speak up and we took notes and we could make amendments and we put the amendments up for vote. I thought that was a good process. And that was Jeff Vitter's idea. And then, um, and they would say things well we didn't think this was, I said you had and I would list, they would send me an irate email. We asked you on this date, on this date via email, then we had a public presentation and we asked for input. Amendments were offered, there were votes. At no time were you there or were you participating. Why? Why should I listen to you now? They said they didn't think it would get this far. There's this weird attitude out there about, we were trying to make this participatory, I still think it's the best way to do things. But we had people not participating and then they realize, oh, something is coming down that I may not like but I haven't participated. But they also think that there's no, like, rules. Like they are so important they could put their ideas out there at the last minute. When people had spent a whole year discussing this. And that was like the last strT. No vote, we are not starting over.

JH 5-6

Well so there was a, there are parts of the college where certainly advanced work in that field is not typically done, um, with, and I'm going to put multidiscipline and teamwork together because I was involved in both of those and there were similar controversies about it, um, so, and I'll pick math as an example because this was one of the departments that pushed hard against these things

J 5-7

So the vision of a mathematiM researcher that we all sort of vaguely, the misconception we have in our minds but probably not too far, is the individual sitting in a room with a pencil, you know, doing proofs. And that's not how math is done. That encapsulates the push that came from that department, say what's this teamwork thing, we don't need teamwork, this multidisciplinary won't produce the best mathematician, we don't want to, they don't need to spend their time learning how to do stuff with other people.

J 5-8

So there was some purists who would say, you know, this sounds fine but it isn't required by all science students because they're mathematicians and mathematicians don't need that piece. And so there was push back from some subsets of the College about multidisciplinary. Do our students really need, you know. And if you ask a senior faculty member and some will say all I ever did was that. We need students who are the best possible people in discipline X why do we want to sort of fritter Tay their time with the other things like work with people from other departments or working in teams?

J 6-1

DB OK, so was there a resolution to that?

J They lost (laughs). Again, this was something that it came down to a large open meeting and voting about these things so they were, the dominant feeling from the faculty who bothered to turn up and express opinions about these things was in fact it was important to have multidisciplinary experiences and to do teamwork. So there were minority opinions voiced very strongly because this is a college requirement if you were just one subunit of a department you're not going to win that.

T 7-4

In PhD mathematiM but very few of our students in mathematiM went on to a PhD. So from an undergraduate standpoint to be able to understand how, first of all how, how, I mean when I, one on one with some of the math faculty that I was talking to, they were, they were a little resistant to some of these things. And I had, coming out of the math department, I had a little bit of, you know I could talk their language a little bit, and so one of the things I just tried to point out to them was that they didn't want most of our undergraduate students in offices next to them some day down the road but they wanted, they understood, and the need to have undergraduate mathematiM majors from a job security standpoint and to, to again be that pipeline. And there has been some acceptance, for example the actuarial science program, which was already, it was getting a lot of traction, it clearly was something that wasn't purely mathematiM, but you needed a lot of mathematical abilities. But you also had a lot of other, you had to have economic capability, you had to have some computing abilities. And so while there was resistance from the math department they were also seeing the opportunities that were coming from the multidisciplinary research things for them. So, um, being able to talk to them about teamwork, because again even if they are going to do multidisciplinary work they're going to do it alone, as a pure mathematician. So, um, so yeW math wasn't that hard of a sell in the long run. It took a little prompting to get them to think about it but it wasn't that hard in the long run.

T 11-3

DB So, ok, you know I'm pretty near to the end of this now. Um, but since you've brought up math a number of times and you were act5ually in the math department, I think, and from prior respondents, everybody has said that math was a problem.

T And I probably thought they were less a problem than others thought.

T 12-1

The biggest problem with math was they had half or more of the science education students in science and they had no education faculty. So, uh, that was one of the reasons they were I think perceived as being more difficult to work with. Because they didn't understand, they didn't have somebody to go back to in their department that would advocate the education speak.

B 5-4

YeW, it's the personalities of the people how major in math. Um, and to some extent probably that is a discipline that is more solo, you know, than anything and so it's not like a regular lab science where you're definitely, you're working in the lab and you've got people around you that you're working with.

Science Education Trends (ST)

Attrition (A)

W 1-2

DB Were you Tare of, um, attrition issues in the school of science at the time?

W Yes, and I don't know they're any different today. Honestly, the statistics could bear that out. But the college has always been under scrutiny for having people start in one major and then move into another major. Even leaving the college of science. Many, many examples. I don't know that changing the core changed that at all. But you've got statistics.

T 1-6

yeW, we had a lot of students that shouldn't have been admitted to science. And I understood that and so I tried to focus on, I don't remember what the percentage was, just say the top half of our class

T 1-7

And we were still losing a significant percentage of those students, we were losing a larger percentage of those below the top half. I mean not top half 50 percentile of their high school graduating class, but top half of our class. Um, so we were still losing a significant number of those students, uh, we were losing more students in the low, lower section, but we were still losing a lot in the upper section.

T 1-8

And, again, I was fully ready to accept that we should be losing some of them. They didn't really understand from their high school science experience what being a scientist really meant. And we had some work to do to help them understand that. But we were losing too many in that category from my standpoint.

B 2-4

YeW, that was part of the problem (attrition). And this is always difficult to get the administration to really understand that at the time, and I don't know how this has changed, at the time we were, um, a feeder school

B 2-5

and you know it's bullshit.

B 3-1

YeW, I, you know I think it's not necessarily a misconception but it's just not understanding the full scope of what science is. Of what, really get in to upper levels. This stuff they've taken in high schools that's covered in the first semester of chemistry or biology or whatever. And then they're beyond and it gets, and it's really you know it's a whole new ballgame and they're not, I mean. You talk to the biology advisors cause that's where we have so much, there's a ton of attrition from the students that start from biology. Because they all think they're going to be premeds, that all think they're going to med school and then they realize how hard it is and shift.

National Trends (NT)

M 1-1

um, we thought about a number of things, um, one is that the trends is that science needed to be more rounded

M 1-5

There were also a lot of national trends in terms of communication that we wanted to make sure that science students got those skills

W 1-1

So, first question, "what national trends were considered?" I don't think I can answer that question. I think I'm much more in tune with the national trends today. I don't recall what the trends were then. I think there was a, the entire motivation, from my perspective, to revise the core that it had been stagnant for forty or fifty years. I don't know we were necessarily led by trends and other programs. I'm sure were but I can't pinpoint what those trends were.

J 1-1

So, so the core came about in part because of the national trends to look at more holistically at the sorts of skills and knowledge and experiences that students needed. So what are the crosscutting experiences, capabilities, knowledge that are important for our students? Above and beyond expertise in the particular major that they were doing. So, there some attempt to look across at other universities, the national literature, um, to identify those things that were important for all our students in addition to their content expertise.

J 1-2

It's been a while but things that I was particularly involved in and interested in were teamwork, um, the rise in importance in interdisciplinary work, um, variously described, um, communications, so the ability of students to not just write, writing is important, but also the ability to give presentations. So all communication. And then, you know, there was a lot of debate going on, as there is still today, about, um, the issue of a foreign language versus generally more global competency issues. So those are the ones that come to mind.

T 1-1

Um, well there were a couple of things as I recall. Uh, one was, what was, the feedback we were getting from alumni about our graduates, so it wasn't so much, it was education but it was sort of the applied education. What were they able to do and what weren't they able to do. And, um, was there something we could do about it. That was one aspect of it.

T 1-2

The other thing I think we looked at was just sort all those polls and rankings and everything that compared US students with students from other countries.

T 1-3

And, um, and I guess maybe a third component was, they hadn't looked at undergraduate education in over 40 years. In 40 years you probably should look at undergraduate education.

T 1-4

So those were probably the national components that were out there I know we did spend a lot of time looking at, I mean we did some benchmarking against what other peer institutions were doing but they weren't doing a lot different from what we were doing.

R 2-1

DB So, um, just to play on that a little bit more, the national data, I don't know if you looked at national data, W, but, uh, the national data is showing, uh, somewhere between 50% to 70% of the beginning science majors, nationally, dropped out of science curriculums. Was that a concern, an Tareness at the time?

R Uh, yea. It's even more so in engineering, yeW, it's Dfinitely a concern, um, and we were Tare of the importance of growing STEM graduates. That was a, that was Dfinitely an important component. Let me go run off, just to jog my memory of what the big goals were.

D 1-2

Uh, I'm not sure about national trends as far as other universities were concerned but, um, I do know that one of the driving forces that I kept hearing over and over again was employers were saying, those who employed College of Science graduates were saying Purdue's graduates were coming out inaDquately prepared in things like teamwork, inaDquately prepared in critical thinking, inaDquately prepared in a variety of different areas. Um, and so I think that in large part that's what motivated the committee to start looking at things like the composition, the communication types of skills that were there, teambuilding, um, the multidisciplinary experience and so on.

D 1-3

Yes, um, I knew for a long time and I think the biology Dpartment, although they didn't trumpet this, they acknowledged that they were having problems with, um, attrition for the biology majors. Um, and I know the College of Science as a whole was working on that too. So, yeW, that's a good point. I think that was another driving factor. So, ok, at the end point apparently the graduates of the College of Science were not meeting the needs of the employers once they graduated. But earlier on there were perceived to be some problems with we're not offering the right kinds of experiences to our stuDnts in orDr to, um, keep them in the College of Science. Have them graduate in the majors that they started in and so on.

J 1-1

The administrators, DaJ, and some of the faculty had been getting input from employers that said we want stuDnts that can work I teams, will unDrstand the importance of group work.

J 1-2

The employers again were telling the University that they need stuDnts who could communicate scientific information to various groups. They neeDd people who had knowledge of other cultures and were Tare that we were a global economy, a global world, and not just Midwest or east coast or whatever that happeJ to be.

S 1-1

S Nothing, complete and utter absence of coJiDration.

DB Of national trends

S Of national trends

S 2-2

So there was no discussion at the college level of any goals that we had of how this fit into any trends. Of how this fixed any problems other than the perception that we hadn't really looked at our curriculum.

S 3-1

Well I mean we knew what the problems were. One of the problems historically has been that the retention of people who come into the college of science for graduation um is as high as any college with the possible exception of engineering. We were very, very good at getting stuents to come here who then would eventually graduate but they didn't graduate in science

Retention (RT)

J 2-4

Um, not really. The long pause indicates that I have to think about that one. Um, as I think about the decisions we made in terms of what we put in place for this sort of science core, the one thing that maybe does address that is the great issues requirement. Not the other ones. Um, so when you think about, you know, teamwork, communication, you know it's possible that you could say that there were some students who were looking for that sort of team experience and, and, and if they perceived that science was all about individuals working individually that that wasn't a good fit for them therefore they left and they didn't realize that in fact most of us work in interdisciplinary teams. So one could make that argument, I don't remember that discussion happening though. That really wasn't the thinking.

J 3-1

DB OK, so the point wasn't really to address, as you said, retention per se, it was to, if I can, to make the science experience broader.

J To make the science experience one that equipped our graduates for their future careers in ways that some of us, but not all of us, thought were important.

DB But not specifically for retention.

J No.

T 1-5

Well it certainly was a consideration for me. I never did get the faculty really excited about retention issues. Um, their perspective is more if they can't cut it they don't deserve to be here.

T 1-6

yeW, we had a lot of students that shouldn't have been admitted to science. And I understood that and so I tried to focus on, I don't remember what the percentage was, just say the top half of our class

T 1-7

And we were still losing a significant percentage of those students, we were losing a larger percentage of those below the top half. I mean not top half 50 percentile of their high school graduating class, but top half of our class. Um, so we were still losing a significant number of those students, uh, we were losing more students in the low, lower section, but we were still losing a lot in the upper section.

T 1-8

And, again, I was fully ready to accept that we should be losing some of them. They didn't really understand from their high school science experience what being a scientist really meant. And we had some work to do to help them understand that. But we were losing too many in that category from my standpoint.

T 2-1

We have, we have a number of folks, probably still are a number of folks, who somewhat have their head in the sand about that. And, they're used, they get rewarded, they're used to dealing with PhD students. And all but the very best of our undergraduate students are not going to be PhD students. So there's a whole different mindset about a PhD student versus an undergraduate. And the results you want out of those kind of people. And that was the biggest challenge throughout was to get them to think about undergraduates and not just the science student.

S 9-1

Every institution is worried about it and the good news is we're finally getting two things to occur. I worked at the Indiana commission of higher education for quite some time. We finally convinced the commission stop worrying about retention at IPFW don't don't, collect the data and then ignore them. The question is not how what percentage of the freshmen at IPFW graduate from IPFW. The only piece of information you're interested in is what is the ratio of the number of people who are native Hoosiers who graduate at the end of four years relative to the number who entered. Don't assign them to an institution because that's not really where they, the problem is people moved from one institution to the other. Ok, we're not California where that happens three or four times but they do move.

S 9-2

And we were calculating retention the wrong way. Furthermore let's calculate retention by asking first of all did you really decide to come to campus to graduate. I use IPFW, they were graduating 17 percent of their freshmen but that's ok cuz a very significant fraction of those students did not come there with the intent to graduate.

S 9-3

Or then move to West Lafayette. Ok. The only really important question fundamentally is what percentage of the students who enter higher education graduate and there's nothing magically obviously about four years people have forgotten that five six. The chronicle of higher education had an article about two years ago arguing is ten years a viable time period for looking at graduation of people in the arts and humanities

S 9-4

Furthermore we've never really invested the resources that are necessary in doing exit interviews with enough people to really know what retention problems are. Less than five percent of the students who leave this institution leave it because of academic problems.

Task Force (TF)

Task Force (TF)

M 4-2

Yes, it was a Dean directive. But he knew many of us were interested in moving in that direction, but it was his directive

M 4-3

DB So did he, how did that come forward then? Did he give this task to you?

M It was assigned to me, I was the Associate Dean for Education

M 4-4

But he was the one who said this was going to happen. He convened the department heads and said this was going to happen.

M 6-4

There were also fights, and we do these town halls. We make sure we wouldn't debate people, we just write what they had to say. Because, and they get up and talk about all this fluff we were adding. I mean it was just rough

M 7-2

The other thing, then in retrospect I learned, right after we did that and got that, I learned a lot about politiM and I learned a lot about strategies. And it was, it was a faculty vote, one faculty, one vote. The entire faculty not just the task force. The task force had votes in between to see how we're going to put it all together and whether it all had to stand together or how we were going to have the whole college vote. We were going to have the vote on single things or all together. Those of us who wanted it all together prevailed.

W 1-3

How was the task force formed? Oh, I don't know, ha! I didn't form but I was asked to be part of it as were a huge number of other people. I do remember a series of meetings, one in particular was held at Jane's Deli. That's all I remember.

J 2-2

Um, the way it worked in the college is that there were, there were a couple of opened meetings and so all faculty were invited from all departments, from all departments were invited to discuss this and, um, that was part of the way that the Dean was trying to do business at the time. Um, that's the way strategic planning worked, how our decisions about. Coalesce these interdisciplinary areas we put a lot of new positions into. And so the mode of operation that was going on at that time was one that would very much have some ideas and some working groups initially put things together but then open it up to the entire faculty, invite everyone to come along and have a discussion and have a voting process to decide what we were to do. Um, I can't recall specific discussions you know at a faculty meeting or you know in some organized way within the department, um, around those things. There were discussions in the hallway and those types of things and there were sort of working groups. I can't recall a department wide discussion.

J 3-2

So as an Associate Dean, um, and someone who sort of knew the players in the college and someone who, because of my role in teaching, the fact I've won teaching Tards, I was often asked my opinion about things. YeW I was involved in that level and in selecting task force members, however each department was asked to nominate people for the task force. So it wasn't, um, it wasn't handpicked. I mean there was a task force that I belonged to that if I handpicked the members it would have been way easier, um, challenge

J 3-3

And so the departments did, the department heads picked individuals, each had their own process, I don't know how they did that, and this department you pretty much know who, the department knows people who had particular interests or strengths and sticks them on

J 3-4

I was involved in the multidisciplinary task force and that was one where, um, I guess from my perspective there were a couple of departments who chose people for that task force who didn't believe in the importance of multidisciplinary. And that made, I think, for a very rich discussion. I may have been frustrated at the time but it's actually good to have a full range of opinions in the task force rather than everyone signing the same tune. So they were diverse task force, the ones I was involved in.

J 3-5

So the task force was formed, so the departments were asked to nominate individuals on the task force and then, you know that's pretty how it happened.

J 4-1

Yes, Dean Vitter in discussion with obviously the Associate Deans. He was largely driving this sort of the vision for how the process would work. Um, he had a style for doing things that was one very much of driving things, but driving a process rather than saying you had to have this outcome. But his decisions about the process sort of encouraged certain things to happen.

J 4-2

Well he wanted all, he wanted all the departments represented. So he wanted to make sure all of the key voices were heard. Um, and his way of doing that was to ask each department to put someone on a committee. Um, that, that is egalitarian in a certain sense but it can lead to rather strange committees. Um, it doesn't guarantee that a committee will be diverse for example.

J 4-3

Yes. And those are tend to be made in a vacuum so as department head, which is what I am now, I said OK I need someone from multidisciplinary, OK Harbor sounds like the right person. I don't think well what would the makeup of the whole committee look like, you know, will it have the range of perspectives, will it bring junior faculty, senior faculty, men, women, majority, you know. And so, so there wasn't an attempt, if I remember it, to make sure those committees were balanced in that way. Whoever the department head sent that is what happened.

J 4-4

DB So are you saying there was a lack of diversity of different types on the task force?

J I would say the answer to that is yes. Because what tends to happen in, in some of our departments because of the fact that the departments, not all of them, many of them are overrepresented in males, especially at the more senior levels who tend not to choose struggling assistant professors to stick in. So even though we've been hiring in a more diverse way if you look at the mid and later career people, especially at that stage, um, many of them were more traditional, have more traditional views. So those opinions tended to be overrepresented on the task force.

T 3-6

Um, actually I was in quite a bit of those discussions early on. We, we wanted, we wanted as broad a representation from the faculty as we could get. We asked the departments heads to select, we wanted the undergraduate committee chairs from each department on the committee. And then we asked that the other faculty members, and I don't remember, even now I think it's like three from each department, if I remember right. We wanted, um, we wanted faculty members that would be open to undergraduate education ideas. Whether they had much practice in that themselves or not didn't seem to be as important. And we were looking for, I'm trying to remember, we had a few assistant professors but we wanted tenured professors as much as we could get it because we knew they weren't going to be rewarded for this work.

T 3-7

DB So, this was Jeff Vitter's idea or not?

T YeW, (long pause), I believe it came out of discussions that we had in staff meetings. I'm not sure it originated with Jeff but Jeff certainly championed it.

T 3-8

DB OK, I wouldn't know that but thank you. Um, so, in those initial days, uh, when this was coming to fruition, and set up the task force, uh, you were involved in that process kind of from the get go then.

T Pretty much, yeW. Because pretty early on I, looking back on it now I think it was a mistake, life has turned out fine but uh, Jeff pushed for me to be an assistant dean and I challenged him on that, I mean it was a great honor, but I challenged him on that knowing the culture in the College of Science. And, uh, I didn't have a doctorate. And I certainly, I didn't have faculty rank. Both those were issues. Both of those were definitely issues. So I, in some ways I probable didn't embrace that as fully as Jeff wanted me to. Again, it was sort of what got me in trouble. Um, but I think, I don't think I could have pushed any harder, Jeff got in trouble for as hard as he was pushing on things.

T 4-1

DB Alright, that's OK, um, so, uh, again we've kind of touched on this, how was the task force formed? Jeff says to you and other people I want to form a task force. What happened?

T And I as I recall, this is going to be speculation because I don't have notes to go back and look at. As I recall, um, we talked about it in the dean's staff meeting, we translated that over to the department heads meeting which happened regularly and, uh, it was sort of, I think the selling point that got everybody on board was we haven't looked at this in 40 years. So I think that was the selling point, well I mean it's worth looking at we haven't in 40 years. And, um, and then so basically each department head was to select their representatives to the task force. W we had me and the head of advising…

T 4-2

Well I didn't have, the voice I had was an administrative voice, try to keep things moving. I, I, I, again, I'm sure I shaped some of the discussion by how I presented things but I really took the role on of what are your ideas, let me organize them.

R 2-2

Well we, I mean we actually I would say had a miss that first year. We spent one year with the task force and then we had to restart basically after that year. Um, the reason is because I realized that a task force was really just a set of individuals and they weren't tasked as they, perhaps to the extent they should have been that they would represent departments. They were a set of individuals primarily. And you can't get the entire sense of the school at the time, now a college, from just that set of individuals. And so as much as they did interesting work, they came up with interesting ideas after a year, it became clear that if we were going to do something as major as changing the curriculum when changing the name of a course could be a life or death decision, there was just no way that was going to work. So we restarted and instead actually got every single faculty member involved. And the way we did that, we followed that approach here at KU, is that we asked every department to convene multiple faculty meetings and just discuss what are the key outcomes or goals that our curriculum should achieve? Um, things like communication or, um, multidisciplinary concerns. And, and then we consolidated the list so that we essentially eliminated duplicates and asked them to prioritize what those goals, and what came back was essentially consensus and that consensus was what these six outcomes are that are listed here that went forward. And if we hadn't done that I think what would happen is that every faculty member would be skeptical, skeptical that oh you know I don't really agree with this or that. The fact that they came out of the units themselves gave a lot of credibility to the whole effort and allowed it to go forward. People understood that we really sought their input and if they disagreed with one of the outcomes it was because the reason we went forward with what we did was because we had this overwhelming majority saying these are the important things. So individual disciplines had their own major requirements but as far as what should be common to everyone there was really remarkable consensus. And then it was filling in the details which still had brought forth a lot of potential contention such as should study abroad equate to taking language courses, that sort of thing. But the fact that the goal itself was listed there as a key one is, um, was really a driving force in how this got, um, ultimately approved. And it was approved something like 58% to, um, 42, or 60-40, something like that. So pretty good record.

R 3-1

YeW. Chris SWley led the efforts. She oversT the, um, task force and then there, uh, the new task force that resulted from that that kind of worked with the departments to get a hold of their input. W, she did a great job.

R 3-2

DB So she was the one responsible for contacting individual departments and getting faculty from each department or maybe the department heads?

R Well we collectively did that because we would meet with all the department heads on a regular basis. So, you know, that was their charge to do that, they organized that and Chris and Jon Harbor played a big role. They, they uh, they took the results in, um, that is how we determined, you know we did a statistical analysis to, W, look at what is, what are the correlations and it was pretty apparent that, W, I think five out of the six were like overwhelming everyone. Put them as the top priorities and then, um, the sixth one was also very high up. And I remember like which departments, I don't know which outcome that was.

J 5-1

Yes, they wanted all the departments represented, they wanted faculty, they wanted academic advisors, um, they wanted, um a good representation of people who were working with undergraduates, things like that.

J 5-2

That would have been back in 2003 when it started and our department was actually the lead. We, actually we ran it first, we had a sample core that we did. We implemented that, I think, in 2005 or 2006, so it was our majors

S 11-2

it was basically formed by getting volunteers from various departments and the attempt was to get the people who either were knowledgeable or were interested in the question. I mean Buster Dunsmore you know being a perfect example, I mean he was both knowledgeable about what was happening and he was interested in change. And Gabriella Weaver was in there because she was interested in seeing what could be done. Chris Mesena (?) was on that committee for the same reason. Um so you look for volunteers, uh you load the committee with people who want to change. Now that gets you into a problem.

S 12-1

And the problem is you now have a committee full of people who want to make changes not necessarily because they understand the problem being solved. If you wanted to get the system solved based on the people who knew what the problems were then you would start it with Chris Saley. Uh you'd bring in Bob Wilde from my department. Ok associate head of the department, you know. Uh Bill from M um (?) but again you know. You would bring together those people who had been working with undergraduates exclusively the advisor kind of thing. By the way I don't know if there were advisors on that task force. If there were they weren't in a large enough to be critical mass.

Task Force Member (TFM)

M 3-3

because the core curriculum is designed by all of the faculty and is required by all of the students it's very key to have stakeholders from all the departments. So on the task force we had membership from every department.

M 3-5

We try not to hit new professors too hard because they are so burdened with other things.

M 3-6

We tried to select faculty, um, who were, um, interested in education.

M 4-1

We also included several key staff members including the director of advising and one other person. At that time we had an assistant Dean who was a staff member, he was included. Um, I think the director of advising, an additional advisor, and the assistant Dean were the staff members.

D 1-1

Uh, I was actually kind of in the middle. I was not there from the very beginning. Um, I was asked actually to replace, I'm trying to remember who's spot I was asked to fill on a temporary basis. I think it was Ken Robinson from the biology department. Um, and I ended up also staying on longer than I expected or longer than I thought I was going to be asked to participate. So it was pretty much in the middle. And, uh, I did that I think maybe for two semester and then I left the committee, um, and I know the committee's work continued on after I was there. So it was for a brief period in the middle as things were going on.

B 1-1
Not specifically (Tare of national trends) as we talked before. The advisor's were not

really part of the decision making proces

Faculty Arguments for Reform (FAR)

M 7-3

So to get faculty to think about outcomes, which was all about the accreditation, that's how we started the curriculum work. We talked about what learning outcomes we wanted for the students in the College of Science. So we didn't throw out anything, we said what learning outcomes do we want. Now let's look at what we have them do and where are the gaps? First of all, is what we do, where does what we do fit into these outcomes and second where are the gaps? And that's how we finessed it into things like teambuilding and critical thinking.

Team Work (TW)

Groups (G)

M 1-3

Um, and third, the ability to work in groups, the benefit in terms of the thinking process, in terms of the ability to get along with each other, the ability to discuss ideas from different viewpoints is so critical for these science students whether they are going into industry or other professions like IT or even into science or med school.

M 2-5

So, we were concerned about the lack of these other skills, the critical thinking, the ability to work in a group, um, no computer science was in our original core.

Teamwork (TW)

M 7-3

So to get faculty to think about outcomes, which was all about the accreditation, that's how we started the curriculum work. We talked about what learning outcomes we wanted for the students in the College of Science. So we didn't throw out anything, we said what learning outcomes do we want. Now let's look at what we have them do and where are the gaps? First of all, is what we do, where does what we do fit into these outcomes and second where are the gaps? And that's how we finessed it into things like teambuilding and critical thinking.

M 5-2

Many of us wanted to, um, do more with groups, um, teamwork

M 6-7

And for me teambuilding. (successful attributes)

M 6-8

And I used my colleagues in engineering help me. Because engineering, first-year engineering, they do a lot of teambuilding.

M 7-4

Um, it's been, the teamwork has been difficult. Partly because now they've taken Tay the hands-on first part of it.

M 7-5

The second thing is that certain departments insisted on, they said, well lab is teamwork. It's not unless you do it appropriately

W 5-1

On line…YeW, it's not clear how seriously people take the online stuff. And I don't know what it's like. If it's anything like the, W, FERPA training…

J 2-1

Part of my personal baggage that I bring to this is that, um, I used to work in a company and as someone who used to recruit undergraduate students to work in a company. Um, you know I've interviewed a lot of students and these are the same things I identified in those. That they were often very good at their discipline but couldn't do anything useful because they didn't know how to work in teams, didn't work with people with other expertise, and their writing skills were pretty poor. So all of these things in my mind started to come together.

J 5-2

Um, we implemented a requirement in teamwork that had two pieces. So an initial training program to understand how do teams work, the theory behind it, the practice and philosophy behind it. And then to take a course on an experience that included teamwork. So that was a change that hadn't been explicitly included before.

J 5-6

Well so there was a, there are parts of the college where certainly advanced work in that field is not typically done, um, with, and I'm going to put multidiscipline and teamwork together because I was involved in both of those and there were similar controversies about it, um, so, and I'll pick math as an example because this was one of the departments that pushed hard against these things

J 5-7

So the vision of a mathematiM researcher that we all sort of vaguely, the misconception we have in our minds but probably not too far, is the individual sitting in a room with a pencil, you know, doing proofs. And that's not how math is done. That encapsulates the push that came from that department, say what's this teamwork thing, we don't need teamwork, this multidisciplinary won't produce the best mathematician, we don't want to, they don't need to spend their time learning how to do stuff with other people.

J 5-8

So there was some purists who would say, you know, this sounds fine but it isn't required by all science students because they're mathematicians and mathematicians don't need that piece. And so there was push back from some subsets of the College about multidisciplinary. Do our students really need, you know. And if you ask a senior faculty member and some will say all I ever did was that. We need students who are the best possible people in discipline X why do we want to sort of fritter Tay their time with the other things like work with people from other departments or working in teams?

J 6-1

DB OK, so was there a resolution to that?

J They lost (laughs). Again, this was something that it came down to a large open meeting and voting about these things so they were, the dominant feeling from the faculty who bothered to turn up and express opinions about these things was in fact it was important to have multidisciplinary experiences and to do teamwork. So there were minority opinions voiced very strongly because this is a college requirement if you were just one subunit of a department you're not going to win that.

J 6-2

Um, the, the teamwork, um, requirement had some challenges associated with it. Didn't have many people who were actually trained to do anything with that. Our faculty are wonderful people but most of us aren't trained in many of these areas. We, we may think they are important and we may sort of know something about but we don't, uh, know that from training. So we have to come up with some ways to train students in teamwork and so that was done with a, you know, small groups, staff, and there was an online process and so, you know, how well that worked, I think the juries out on that. Um, but that, over time, that's sort of how we do that.

J 6-6

YeW. I don't think, so I would agree that on its own the training doesn't give students experience in teamwork. And so absolutely I think it would be better it was done in an environment where they are not only learning about the theory of teamwork but they're also immediately implementing it. They're learning in a team. So that would be my stronger, logistically it just turned out to be a nightmare for the college to do that.

J 7-1

So you end up hiring people to do it and, you know, that's one of the tricks of implementation. How do you do this without spending huge amounts of money. Um, and so, the online solution was one that's, that's low cost replicable. Um, if that's the only thing we did it would be completely ridiculous. Wouldn't meet the intent at all. But that's meant to be coupled with students then taking a course where they implement what they've learned.

T 7-3

Teamwork, teamwork, yeW. And again clearly in the world that we're in hardly anything happeJ with a person in a room by themselves.

T 8-2

Well, science faculty don't have a long history with teamwork. And, and I would think that it might be difficult to get the faculty to accept that people like us could serve a valuable role by fostering a teamwork environment, you know, how to, how to work as a team. So they aren't used to doing it themselves, it doesn't surprise me.

J 7-2

The other thing they did was the teamwork, they weren't quite sure what to do with that. They decide that you needed principles and experience.

J 7-3

That you had to understand teamwork from I think it was Meyers-Briggs. If you didn't know those terminologies and you couldn't look at your group member and say that you're this or that, you didn't know teamwork. OK, so, from the beginning the principles

J 7-4

the teamwork thing, was just, they offered it on Saturdays, football weekends to get people in. The course times conflicted, they tried to offer it three times during the semester.

J 7-5

They had a Dean and a grad student trying to teach it, they had an administrator trying to teach it. It was just all over the place. And some of the things they would have them do in there were not science related. So it was kind of tough.

J 7-6

So it's, um, oh you had to have teamwork your freshman year and then they backed off and then they said you have to have the teamwork module within a semester of your teamwork experience. They just didn't know what to do with it. And it was just, it's been exhausting. All these years trying to work with that and it's kind of up for a vote about whether or not they'll keep it.

J 7-7

So I don't know, I think the students do need to understand that when you are in a chemistry lab or a physiM lab or something like that, there is going to be somebody who doesn't pull their weight, so how do you do that? You're going to have somebody with lots of energy in the beginning but not at the end. Somebody's going to come along at the end and sparkle and shine but they kind of dragged their feet the whole time. So yeW, it's OK but, I think the online has been OK because they were, the goal was for people to recognize terminology, understand concepts, and recognize yourself. You can do that in an online module. I think that makes seJe.

J 7-8

I think the online part is OK because they are actually doing the teamwork in their computer science class or physiM lab. The physiM lab is set up, it won't function unless you work in teams.

J 8-6

Um, the teamwork was like maybe we need to rethink this. I thought the teamwork should come in through Boiler Gold Rush. I thought that would have been a good time to teach everybody, every program about teamwork.

B 5-1

The teamwork piece was, has been the most problematic.

B 5-2

So I think I theory teamwork, um, is a good idea although I don't know that we have ever done that great of a job in implementing it.

B 5-3

Well I don't know maybe it's part of the culture of that department, um, I don't know, and I know who was on the committee at that time, and that was Kenji Matsuki, um, he didn't like the whole teamwork idea. Um, he W, just in general math doesn't like anybody telling them what they're supposed to do…

B 5-7

And it was kind of this one that why teamwork became a bit of a boondoggle to implement and there all kinds of you know work arounds that the students would come up with.

B 7-4

I think teamwork was not successful. I don't think teamwork was successful, I think it was just so, um, it had so many problems and issues and students already had a, you know, every student coming out of high school has got an opinion about teamwork and most of them are not good.

S 16-1

And in engineering it's there. And in pharmacy, I've got a bunch of students in my pre-chem class from pharmacy, they have a team. They learned that, we don't have it. One of the problems that came in to the thinking was the assumption that a modular approach can be taken and we don't have any evidence to support that. I have evidence that doesn't support it cuz I was a coJultant in the U. K.

S 17-1

it's integrated through the field. Ok, it was 1980 in which I introduced teamwork in the chemistry labs where students would do lab reports in groups of three. I knew why, I had theoretical basis for doing this uh but to be honest just let me admit I wanted a lab report from the students but I didn't want them to be spending all of their time writing up lab reports. Ok the lab report was important we've shown that it was essential in their evolution but that doesn't necessarily mean that I wouldn't rather have them spend time studying the content of the course.

VITA

VITA

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DOCTORAL STUDENT

Department: Curriculum and Instruction
Specialization: Science Education
Chairman: Professor Gerald Krockover

CURRENT POSITION

Continuing Lecturer
Earth, Atmospheric, and Planetary Sciences Department
Curriculum and Instruction Department
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EDUCATION

Ph.D., College of Education, Curriculum and Instruction, Purdue University, West Lafayette, 2014.

Thesis: A Qualitative Analysis of the Impact of the Reform of the College of Science Undergraduate Core Curriculum at State University

Master of Science in Geophysics, Purdue University, West Lafayette, 1988.

Thesis: Permeability of Young Oceanic Crust

Bachelor of Science in Civil Engineering, Purdue University, West Lafayette, 1977.

Passed Engineer-In-Training (EIT) Exam, 1977.

EXPERIENCE

Continuing Lecturer, Purdue University, August 2014 to present

Visiting Lecturer, August 2010 to August 2014

College of Science, Earth and Atmospheric Sciences Department, and College of Education, Curriculum and Instruction Department, Purdue University, West Lafayette, Indiana.

Instructor, EAPS 102, Earth Science for Elementary Teachers, August 2010 to August 2014

- Responsible for developing, coordinating and teaching EAS 102, Earth Science for Elementary Teachers. This course is required for all elementary education majors and is a content course concerning solid earth science, atmospheric science and planetary science. It is taught primarily from an inquiry point of view and incorporates a Problem Based Learning (PBL) component. Students are asked to discover central components of those three areas through a series of guided activities.
- Supervising three lab TA's.

Instructor, EAPS 312, Capstone Environmental Science, January 2009 to present

- Primary lecturer for Earth and Atmospheric Science 312, Capstone Environmental Science for Elementary Education majors. This course is required for all elementary education majors and is generally taken a semester or two before student teaching. The course is inquiry based and examines environmental science with an emphasis on biodiversity and sustainability. Students are required to read a number of case studies and discuss their views and write reflections. There is also a group research project and presentation due at the end of the semester.
- Supervise three laboratory instructors.

Instructor, EDCI 424, Secondary Science Teaching Methods, August 2013 to present

- Responsible for developing and teaching science methods for secondary school.

Instructor, EDCI 428, Teaching Science in Middle School and Junior High School, January 2013 to present

- Responsible for developing and teaching science teaching methods appropriate for middle and junior high school students.

Secondary Student Teacher Supervisor, August 2010 to present

- University supervisor for secondary science student teachers.

Assistant Dean of Students, January 2000 to August, 2011, Purdue University, West Lafayette, Indiana

Director, HORIZONS Student Support Program, April 1998 to August, 2011, Purdue University, West Lafayette, Indiana

- Ensure that all program goals and objectives are met.
- Supervise the administrative and clerical staff.
- Monitor the budget keeping system and interact with University Business Office personnel.
- Monitor the student selection process and maintain liaison with the Admissions Office.
- Ensure the provision and proper disbursement of financial aid sufficient to meet the needs of HORIZONS students.
- Develop and monitor orientation and in-service training for staff.
- Develop long-range goals and a mission statement for the program.
- Articulate goals, objectives, and services of the HORIZONS Student Support Program to the University community and significant others within the state and the region.
- Develop, implement, and monitor an evaluation system for the daily activities of the program and for measuring the achievement of long range goals and objectives.
- Secure federal funding for the continued operation of the program; submit proposals and required reports to the U.S. Department of Education.
- Develop educational materials and teach courses, seminars, and workshops.

Adjunct Faculty, Math and Physics, 1993 to 2006
IVY Tech State College
Lafayette, Indiana

Coordinator of Science and Technology, September 1997 to April 1998, HORIZONS Student Support Program, Purdue University, West Lafayette, Indiana

Coordinator of Math and Physics Tutoring 1993 - 1997, HORIZONS Student Support Program, Purdue University, West Lafayette, Indiana

Graduate Assistant to the Director of Alumni and Development 1992 - 1993
School of Education
Purdue University, West Lafayette, Indiana

Research Assistant, 1989 – 1992
High Pressure Geophysics Laboratory
Purdue University, West Lafayette, Indiana

Staff Scientist, 1989
Ocean Drilling Program (ODP)
Rosenstiel School of Marine and Atmospheric Science
University of Miami
Miami, Florida

Staff Engineer, 1977 – 1979
Dames and Moore Consulting Engineers
Chicago, Illinois

TEACHING EXPERIENCE

Purdue University, West Lafayette, Indiana

EDCI 424, Science Methods for Secondary Science Teachers. This is a required course for secondary science education majors about to begin their student teaching experience. It is a science teaching methods course specifically for the secondary school environments.

EDCI 428, Teaching Science in Middle School and Junior High School. This is a required course for secondary science education majors about to begin their student teaching experience. It is a science teaching methods course specifically for the middle school and junior high school environments.

EAS 102, Earth Science for Elementary Teachers. This is a required course for elementary education majors as part of their sequence of science content courses. It is an inquiry based exploration of solid earth science, atmospheric science and planetary science.

EAS 312, Capstone Environmental Science for Elementary Education Majors. This is a required course for seniors in elementary education. It is intended as a content course in environmental science to assist beginning teachers approach teaching environmental science in their own classrooms.

GS 199, Strategies for a Successful First Semester. A program developed course divided into three sections; basic college study skills, the Community Development laboratory that focuses on personal and career development, and Supplemental Instruction in math. This course is intended for beginning students at Purdue and is designed to help students be successful at Purdue.

EDPS 301A, Peer Mentor Training. A program developed peer mentor training course. The successful student will then enroll in EDPS 301B and become peer mentors in HORIZONS and be used as class helpers in GS 199.

EDPS 301B, Peer Mentor Practicum. Student successfully completing EDPS 301A will enroll in this course and will become official peer mentors in HORIZONS and be used as class helpers in GS 199.

GS 490F, Second Semester Seminar. A program developed reading course that allows participants to further explore options in college.

IVY Tech State College, Lafayette, Indiana

MAT 111, Beginning Algebra

MAT 131, Intermediate Algebra

MAT 132, Trigonometry

MAT 220, Introduction to Calculus

SCA 111, Physical Science

PHYS 101, First Semester College Physics, Mechanics, Energy, Work, Heat

PHYS 102, Second Semester College Physics, Waves Theory, Thermodynamics, Optics, Modern

CURRICULAR DEVELOPMENT

Purdue University

GS 199, Strategies for a Successful First Year

Co-designed this course to meet three distinct needs of beginning first-generation and low-income students at Purdue University. Those needs, divided into three sections, include basic college study skills, career development and acculturation to the University, and Supplemental Instruction in math. Unique elements incorporated into the curriculum include library research techniques, financial management, goal setting reports, and faculty mentoring.

IVY Tech State College

PHYS 101 and 102

Developed and implemented these first and second semester college physics courses. This included development of a laboratory manual and associated experiments.

PROFESSIONAL AFFILIATIONS

National Association of Research in Science Teaching (NARST) 2006 to present

National Science Teachers Association (NSTA), 2006 to present

Hoosier Association of Science Teachers, 2006 to present

Counsel for Opportunity in Education (COE), 1996 to 2010

MidAmerica Association of Educational Opportunity Program Personnel (MAEOPP), 1996 to 2010

Indiana MidAmerica Association of Educational Opportunity Program Personnel, 1996 to 2010

Student Leadership Conference Chairman, 2004 to 2008

Chapter Treasurer, 2002 to 2007

Chapter President, 2001 to 2002

GRANTS AWARDED

Grant Period:	September 2010 to August 2015
Grantor:	U.S. Department of Education
Project Title:	HORIZONS Student Support Program
Principle Investigator:	Dean Ballotti
Grant Period Funding:	$1,900,000

Grant Period:	September 2005 to August 2009
Grantor:	U.S. Department of Education
Project Title:	HORIZONS Student Support Program

Principle Investigator:	Dean Ballotti
Grant Period Funding:	$1,402,484
Grant Period:	September 2001 to August 2005
Grantor:	U.S. Department of Education
Project Title:	HORIZONS Student Support Program
Principle Investigator:	Dean Ballotti
Grant Period Funding:	$1,242,338

PUBLICATIONS

Dale, P., Ballotti, D.,Handa, S., and Zych, T., (1996). An Approach to Teaching Problem Solving in the Classroom, *College Student Journal*, Mobile, AL.

Ballotti, D. M., Christianson, N. I., and Becker, K., (1992). Seismic properties of serpentinized peridotite from the Mariana Forearc - Leg 125. *Proc. ODP, Sci. Results, 125*: College Station, TX (Ocean Drilling Program), 581-584.

PRESENTATIONS

Ballotti, D. (2008, February). *Retention of HORIZONS' Students.* Presentation to Purdue President Cordova's strategic committee on retention.

Ballotti, D. (2003, April), *Access Denied*. Presentation to the Office of the Dean of Students concerning the congressional report.

Ballotti, D. (2003, April). *Community Involvement and Leadership.* Presentation at Purdue North Central Leadership Conference.

Ballotti, D. (2003, February). *The Dynamic Planet.* Regional Science Olympiad, Purdue University.

Ballotti, D. (2003, January). *Life After College*. Presentation at the Mortar Board Leadership Conference, Purdue University.

Ballotti, D. (2002, October). *Collaboration Between Indiana TRIO and 21st Century Scholars*. 21st Century Scholars/Gear Up Conference, Indianapolis.

Ballotti, D. (2002, March). *All About TRIO*. Presentation to the Indiana Student Financial Aid Association (ISFAA) Conference, French Lick, Indiana.

Ballotti, D. (2001, November). *First Generation and Low Income College Students: A Study of the First and Second Semester Academic Progress.* Presentation at the MAEOPP Annual Conference, Fontana, Wisconsin.

Ballotti, D. (2000, November). *Program Assessment and Evaluation One Year Later*. Presentation at the MAEOPP Annual Conference, Washington DC.

Ballotti, D. (1999, November). *Program Assessment and Evaluation*. Presentation at the MAEOPP Annual Conference, Fontana, Wisconsin.

Ballotti, D. (1998, March). *Best Practices in Student Retention.* Presentation at the Department of Education Conference, Washington DC.

Ballotti, D. (1997). *HORIZONS Student Support Program.* Presentation to the Indiana State High School Vocational Counselors.

Ballotti, D. (1997). *HORIZONS Student Support Program*. Presentation to the Commissioner of Higher Education for the State of Indiana Gwendolyn Lee-Thomas.

HONORS AND AWARDS

Wilson Doctorate Science Education Award, 2012. Purdue University, College of Education's award for the best doctoral student in science education.

Golden Acorn Award, 2008. Awarded by Purdue University in recognition of being one of 19 grant recipients in excess of $1M in the 2007 academic year.

Laverta Terry Outstanding Service Award, 2002. This award recognizes the commitment, loyalty and unselfish service to TRiO students, state and regional associations and the community.