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Assessment of case-based integrated learning as a part of dental curriculum reform

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ASSESSMENT OF CASE-BASED INTEGRATED LEARNING AS A PART OF DENTAL CURRICULUM REFORM

by

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Abstract

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There has been a growing call for change in the management of dental education programs, and, in response to this call, the faculty and staff at the University of the Pacific Arthur A. Dugoni School of Dentistry developed the Pacific Dental Helix Curriculum management model. The first major component of this curriculum was the development of the Integrated Clinical Science Strand of the Helix focused on multidisciplinary and case-based andragogies.

The mixed method research design was used to identify common aspects of Case-Based Learning and multi-disciplinary teaching through a qualitative analysis of curricular materials and to analyze their impact on selected student outcomes of pre and post-change through statistical analysis. The outcomes chosen for the quantitative portion were surrogate measures of National Board Scores and grade

point averages to represent knowledge and skills. The overall analysis of the quantitative data shows negligible impact on the outcomes being measured.

We know from the literature that active learning models motivate and engage students at a higher level in their learning and better prepare them to solve problems creatively versus a traditional educational model, so it is significant to see that there were no decreases in performance with a move to a more engaging curriculum. This study offers foundational information for future curriculum design, pedagogy, and assessment.

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CHAPTER: INTRODUCTION

Background

In the Early 1900s, the Carnegie Foundation for the Advancement of Teaching funded a series of reports on professional education. The fourth report, the Flexner Report, released in 1910 upon the urging of the medical community, was a landmark in medical education (Flexner, 1910).

> Over the course of 18 months, Flexner visited all 155 US medical schools. He examined five principle areas at each school: entrance requirements, size and training of the faculty, size of endowment and tuition, quality of laboratories, and availability of a teaching hospital whose physicians and surgeons would serve as clinical teachers. Flexner's report showed that, although most of the nation's medical schools claimed to adhere to progressive, scientific principles of medical education, only a very few had the financial resources, laboratory and hospital facilities, and highly skilled teaching staff necessary to apply this demanding form of education. (Beck, 2004, p. 2139).

The Flexner Report was the stimulus for the last change in medical education since the more recent move in the last thirty years toward a problem-based curriculum (Donner & Bickley, 1993).

After its investigation into the state of medical education, the Carnegie Foundation decided that there was a need to look at the current state of dental

education and to provide some suggestions to create a vision for the future of dentistry, similar to those provided by the Flexner Report.

> When the Carnegie Foundation issued its report on medical education, in 1910... it did not seem possible to deal with the question of dental education without larger knowledge than was then available. In particular it was not then clear whether dentistry ought to become a specialty of the conventional medical practice, or whether it should remain a field of practice for a separate body of practitioners (Gies, 1926, p. xv).

The Foundation selected William Gies to lead its review of dental education. William John Gies was a biochemist born in Reisterstown, Maryland. He earned his Bachelor of Science degree from Gettysburg College in 1893 and his Ph.D. from Yale University in 1897. He began teaching at Columbia University in 1898, co-founded the School of Dentistry, and helped establish the American Association of Dental Schools (AADS), now known as the American Dental Education Association (ADEA). Gies was charged with the research and development of the report on dental education for the Carnegie Foundation. In five years, he completed his comprehensive and influential review of dental education by 1926. The Gies report, *Dental Education in the United States and Canada*, illustrated the flaws of dental education at that time. Dental education had loose standards for admissions, was not scientifically based, used apprenticeship as the signature pedagogy, was not university-based, and had no formal accreditation process (Gies, 1926). After the Gies report, some changes occurred in dental education with the connection of dental schools to a university, the development of stronger scholarship in biomedical and clinical sciences, and formal accreditation processes

to ensure that students were being provided the type of education promised upon admissions. In spite of these and many other changes in the science and technology of dentistry, very little has changed in the curriculum and structure of dental education since the publication of the Gies report (Donoff, 2006).

Bruce Donoff (2006), Dean of the Harvard School of Dental Medicine, described the challenges facing dental education as we move into a period characterized by rapid internal and external change. These changes share some similarities and differences from the ones which prompted the Gies report. This current rapid change has spawned much attention to the topic of reform in the dental curricula across North America (Donoff, 2006; Kassebaum, Hendricson, Taft, & Haden, 2004). Two entire meetings of the Council of Deans, a group of dental school deans and other leaders from North America, organized and supported by the ADEA, have been dedicated to the deconstruction and reconstruction of the dental curriculum (ADEA Council of Deans Proceedings, 2005, 2006).

The interest in reform of dental education is not limited to dental school deans. As a collective, dental educators have begun to look at new forms of learning within the dental curriculum (Kassebaum, et al., 2004). The ADEA has dedicated large portions of its annual sessions to the scholarship of teaching and learning (SoTL) to support the transition that is needed to reform dental education. This movement in ADEA builds on the work of Ernest Boyer (1990), who described the scholarship of teaching in an effort to expand our understanding and the value

of teaching as a scholarly enterprise. The focus has been on reviewing what exists and on examining new pedagogies to support the curriculum reform efforts occurring within each dental school (Kassebaum, et al., 2004).

In 1995, The Institute of Medicine (IOM) supported the publishing of the pivotal report by M. J. Field titled *Dental Education at the Crossroads, Challenges and Change*. In the fourth recommendation, the authors of this report describe the need for modernizing courses, eliminating redundancy, and, most importantly, designing "an integrated basic and clinical science curriculum that provides clinically relevant education in the basic sciences and scientifically based education in clinical care" (p. 141).

In 2005 the ADEA formed the Commission on Change and Innovation (ADEA CCI) in order to support the growing interest by dental educators in curricular reform. This CCI collaborative group of faculty was charged with supporting change through development of programs, such as CCI conferences, curriculum guidelines, competencies for dental education, and a series of white papers distributed separately and bound in a 2009 book that served as a follow up to the 1995 IOM report by Field. This book, titled *Beyond the Crossroads, Change and Innovation in Dental Education,* contained a series of white papers organized around the following topics: background, visions of the future, assessment of students' progress toward competence, leadership in academic dentistry, and reflections (ADEA CCI, 2009).

One reform discussed in *Beyond the Crossroads* that is prominent in dental education is case-based learning (CBL), sometimes referred to as case-related learning. This adult learning model consists mainly of patient cases that are reviewed in small groups, with faculty members serving as facilitators for student learning. Students engage in data gathering, discussion, and decision-making to make the exercise more relevant to clinical care (Garvey, O'Sullivan & Blake, 2000; Jamkar, Yemul & Singh, 2006). CBL has been used in other fields like as medicine and law for some time. However, dentistry has been slow to adopt the concept because of the strong emphasis on surgical procedures (Garvey, et al., 2000; LaVere, Sarka, Marcroft, Smith & Holloway, 1996). This emphasis has led dental education and dentistry to focus on surgical treatment of disease and to ensure that students mastered techniques supported by established approaches to treat oral health problems like as decay and loss of tooth structure.

One curricular structure related to the use of CBL is the use of multi-disciplinary courses in the dental curriculum. These efforts usually focus on opportunities to integrate the clinical with the biomedical and behavioral sciences (Prystowsky, DaRosa & Thompson, 2001; Richards, Inglehart & Habil, 2006). As the profession of dentistry moves toward the combination of medical and surgical models of treatment, this multidisciplinary approach is designed to prepare graduates for their evolving practice. As an example, the development of discussions around caries management by risk assessment, greater use of

diagnostic codes, and evidence-based practice all require the practitioner to integrate multiple areas of dentistry into the diagnosis and treatment process.

With this backdrop of a changing dental education environment, the issue of curriculum reform is particularly salient at the University of the Pacific's Arthur A. Dugoni School of Dentistry (Pacific Dugoni). In 2005, at the same time that ADEA was forming the Commission on Change and Innovation, Pacific Dugoni began looking at reform with a group of internal and external stakeholders. The first step included a survey of faculty members as part of a values clarification exercise. Survey results and other relevant information were then reviewed at multiple levels within the school to create some understanding of and buy-in to the process. The analysis of this information, along with a review of the changes being proposed in dental education, became a launching point for reform efforts.

The Pacific Dugoni faculty developed the overarching vision for curricular reform. The vision centers on a commitment to "graduating lifelong learners and critical thinkers able to integrate the science and technology of dentistry." Members of the community decided that our curricular reform would focus on promoting active integrated learning and critical thinking through the use of multidisciplinary courses that use small group CBL as a signature andragogy. The goal of the reform was to ensure a learning environment that allows students to integrate and synthesize material they are learning at a higher level than what has been done in the past. The traditional dental school curriculum delivered topics in lecture and laboratory sessions independently, and students were more or less

expected to fit the classroom foundations into their clinical practice. The reformed curriculum was designed to allow faculty experts to help learners integrate the information in a more prescribed and predictable manner. One part of this reform included the complete change of the curriculum hours to allow for larger blocks of time to be used for smaller group CBL. Another part included the integration of content to create multidisciplinary courses that were larger and separate from the traditional departmental structure of the school of dentistry. The intent was to have a program that is more learner-centered and matched the pace of learning with the professional development of the student.

Some of the anticipated benefits from the proposed change include the following:

- additional CBL opportunities;
- better timing of what the students learn in a classroom relative to their clinical training experiences;
- flexibility in curriculum timing to fit content with learning needs;
- efficient use of instructional / laboratory time;
- better use of visiting Instructors with the development of two hour blocks;
- completing foundational concepts before the third year;
- opening the third year curriculum for seminars, CBL, and clinical rotations;
- more faculty members available to attend / present cross-training and meetings during non-clinic hours;
- time for faculty cross training;

- enhanced creativity for integrated assessment techniques and assessments scheduled outside of finals week rigidity such as comprehensive examinations and Objective Structured Clinical Examinations (OSCE);
- seminar time in courses that were previously taught by traditional lecture;
- re-evaluating current curricular content; and
- involving students in personalized programs such as scholarly activities.

As the vision for curriculum reform began to develop, faculty realized that a change in the curriculum would need to follow a series of steps in both concept and practice. The first step would be to bring the "siloed" stand-alone courses together in a way that allowed for collaboration and integration of similar content. Visually, the separate blocks of courses were put together in a series of five strands, as depicted in the following diagram of primary integration (Figure 1). In the diagram, Q shows the twelve quarters of the academic program. The strands are labeled as follows

PIP = Personalized Instructional Program

IPT = Integrated Preclinical Technique

IBS = Integrated Biomedical Sciences

ICS = Integrated Clinical Sciences

CP = Clinical Practice

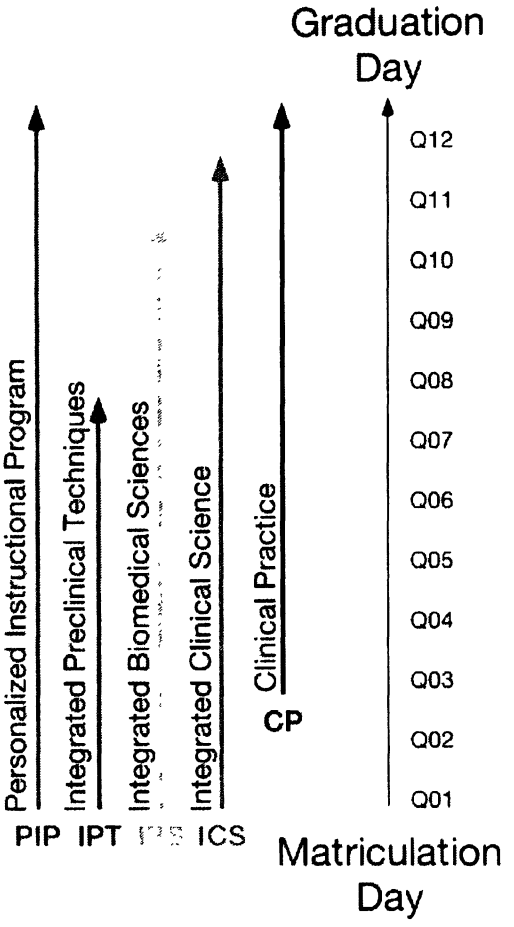

Figure 1. Primary Integration, Faculty Perspective

This first step required that faculty come together to collaborate and review their courses, content, learning objectives/student learning outcomes, instructional and assessment methodologies, timing, and other factors. After this review, faculty realized that the students were experiencing all of these courses in real time throughout the curriculum and that they would not see the clear separation of strands that faculty members were developing so the progression of the image was depicted as follows (Figure 2).

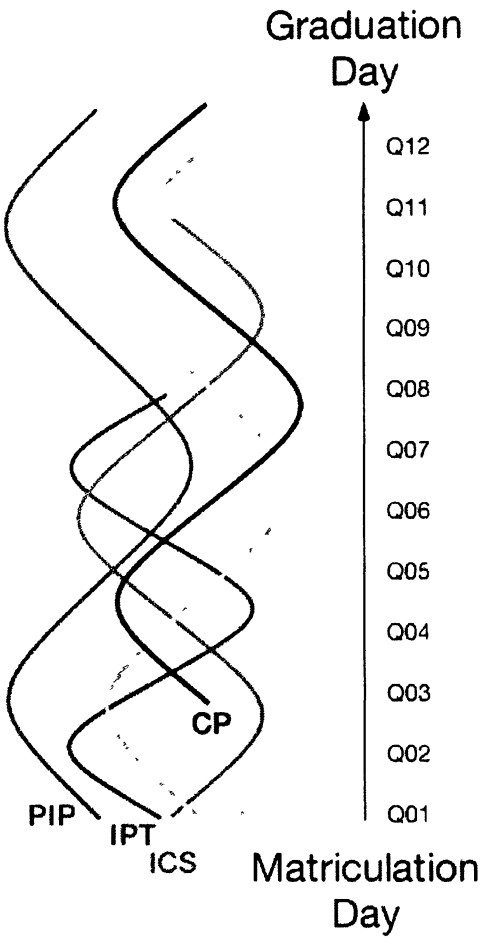

Figure 2. Primary Integration, Student Perspective

Finally, to create a strong relationship between the various multidisciplinary strands of the curriculum, the faculty perceived that links among the learning experiences were needed to help students. These links were created through timing of experiences, specific content areas being delivered in multiple strands, and faculty spanning multiple areas of the curriculum. The links in the following figure are shown in the final image, Figure 3, which depicts the

relationships created by having faculty intentionally coordinate the various content areas within the curriculum using a more case-based delivery program.

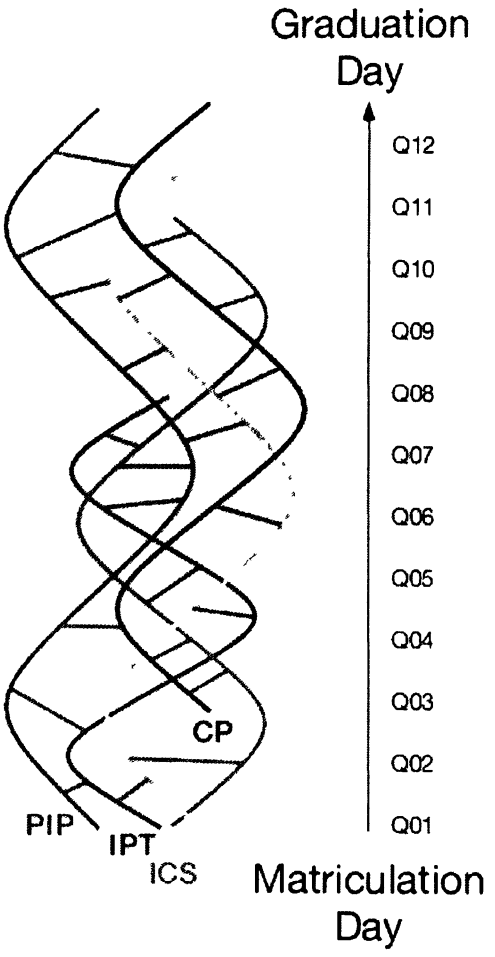

Figure 3. Secondary Integration

The Pacific Dugoni mission states that we will prepare oral healthcare providers for scientifically based practice and define new standards for education (Appendix 1). To that end, the curriculum model discussed above became known as the Pacific Dental Helix Curriculum. This curriculum places a strong

focus on active learning and critical thinking by integrating across multiple disciplinary areas and using small group CBL as a signature andragogy.

The design and photography staff at Pacific Dugoni developed a logo for faculty, students, and staff to assist in understanding the Pacific Dental Helix Curriculum as they continue to formulate the future of the school's instructional program (Figure 4)

Figure 4. Pacific Dental Helix Curriculum Logo

Figure 1 shows the titles given to the five strands of the proposed curriculum. The first strand that was phased in was the Integrated Clinical Sciences. This three-year continuum includes material from multiple disciplines, departments, and faculty. The curriculum is organized as follows.

First -Year Simple Integration

The first-year Integrated Clinical Sciences, Orientation to the Clinical Practice of General Dentistry, primarily covers how a student addresses a patient,

collects information, and prepares to treat the patient in our general dentistry clinic. There are lecture, seminar, and clinical exercises on diagnostic sciences, periodontology, clinic business systems, and community health. Behavioral science topics cover communication, professionalism, and ethics. Active learning is introduced in small seminar case-based format. Students, with the encouragement of faculty, work toward answers to problems and dilemmas in the presented cases.

Second-Year Transitional Integration

The second year Integrated Clinical Sciences, "Application of Foundational Knowledge, begins directing learning to comprehensive treatment planning and delivery of dental care. Students are provided enriched multidisciplinary diagnostic and technical content beyond the fundamentals of first-year studies. Second-year students begin treating their own patients in clinic, and the lecture and seminar content in the integrated second-year course is sequenced to be aligned with the clinical situations those second-year students are experiencing. Instruction in the second-year integrated clinical sciences course is provided by faculty from a broad spectrum of basic science, clinical departments, and practice backgrounds. Students increasingly find themselves focusing on clinical dentistry as a whole, rather than the individual disciplines that comprise much of their first-year dental school experience. The active learning format of the first year of Integrated Clinical Sciences is expanded in seminar settings. Students are encouraged to think beyond the "ideal" skills and protocols of first year to the application of these

skills to their patients in clinic. Students also work one-on-one with a faculty mentor learning to search the dental literature on a selected topic and then evaluate and write a critical review of their reading.

Third-Year Comprehensive Integration

The third-year Integrated Clinical Sciences, Multidisciplinary Case-Based Seminars, is, as its name suggests, a fully case-based presentation of clinical situations. There are themes involving all aspects of clinical dentistry, with faculty facilitators from all departments leading the seminars. Students must actively participate in small group bi-monthly seminars demonstrating an understanding of the assigned dental literature as it applies to the seminar theme. Each student formally presents one of his or her own cases during third year at an assigned seminar illustrating the theme being discussed. (Pacific Dugoni School Catalog, 2009)

The curricular structure was developed to allow for more multidisciplinary and small group case-based discussion. In order to measure the results of our change, we wanted to ensure that we were measuring the difference, if any, between students before and after this curriculum change to inform us in future planning exercises.

Problem Statement

Reform in the curriculum and structure of dental education is a relatively recent occurrence, and, to date, there has been limited research on the impact of specific reforms. Data on the impact of specific reforms are needed to evaluate and improve instruction and assessment in dental education.

Purpose of the Study

The purpose of this study was to examine the initial outcomes in student learning of case-based and multidisciplinary modes of learning in a dental educational program by exploring relationships between and among curricular changes and selected measures of student learning.

Value of the Study

This study has proven valuable in at least two different ways. The study has given us a greater understanding of pedagogies (andragogies) that are emerging as prominent parts of the current curriculum reform process in dental education throughout the United States, which is intended to create a stronger basis of understanding as we move forward. This study also offered foundational information for future curriculum design, pedagogy/andragogy, and assessment.

The study also supports the Pacific Dugoni in developing a plan and structure to measure outcomes of any curricular change in an effort to maintain continuous quality improvement. A strong component of measuring the outcomes of the school's strategic plan and preparation for accreditation through the

American Dental Association Commission on Dental Accreditation includes the continuous evaluation of such outcomes data to assess program performance.

Research Questions

This study addressed the following research questions.

1. What are the common aspects of case-based learning as implemented at the Pacific Dugoni?
2. What are the common aspects of multidisciplinary teaching as implemented at the Pacific Dugoni?
3. What are the differences in **knowledge**, as assessed by national board part one performances and didactic GPA, when dental students experience a curriculum that devotes significant time to case-based, multidisciplinary approaches?
4. What are the differences in **skills**, as assessed by national board part two performances and lab/clinic GPA, when dental students experience a curriculum that devotes significant time to case-based, multidisciplinary approaches?

Definitions

Andragogy: Theory of adult learning popularized by Malcolm Knowles in 1984 distinguishing itself from pedagogy or "child leading", whereas andragogy is "man-leading". Andragogy assumes that adults are ready to learn because of life experiences, self-directed, solution centered, and interested in active learning experiences (Knoles, 1984).

Case-Based Learning (CBL): An educational method that is very closely related to the more common Problem-Based Learning (PBL) described below. Small groups will work together to solve cases while drawing upon foundational learning and preparation for each session. The faculty facilitator takes a more active role in CBL than in PBL (Richards, 2005; Williams, 2005).

Grade Point Average (GPA) Didactic (D): An average student grade calculated from performance on a four point scale, with no modifiers, in all lecture and seminar based didactic courses given at Pacific Dugoni.

Grade Point Average (GPA) Laboratory and Clinical (LC): An average student grade calculated from performance on a four point scale, with no modifiers, in all laboratory and clinical courses given at Pacific Dugoni.

Integrated: Management of the teaching and learning program in a way that brings traditionally separate and distinct disciplines in basic and clinical sciences together in an effort to parallel how the knowledge will be used in practice.

National Board Exams I and II: "The purpose of the National Board Dental Examinations is to assist state boards in determining the qualifications of dentists who seek licensure to practice dentistry. These qualifications include the ability to understand important information from the basic biomedical, dental, and clinical dental sciences and also the ability to apply such information in a problem solving context" (Joint Commission on National Dental Examinations, 2008, p. 2).

Pre-clinical training: The surgical training of dental students in a laboratory using simulated patients and simulated treatment cases.

Problem Based Learning (PBL): "A form of education in which information is mastered in the same context in which it will be used. " In addition, "in most recent medical forms, PBL is seen as a student-driven process in which the student sets the pace and the role of the teacher becomes one of guide, facilitator, and resource" (Donner & Bickley,1993, p. 294).

Strand: One curricular management theme that spans the entire dental curriculum and ties together content from multiple disciplines. Each strand is a vital part of the whole educational program to prepare graduates for the future of dental practice.

CHAPTER II: REVIEW OF THE LITERATURE

Introduction

The review of the literature has been separated into the following sections in an effort to provide a clear roadmap and progression of ideas:

- Historical overview of curriculum and structures of dental education in the United States;
- An overview of emerging trends in dental education; and
- A brief discussion of literature that clarifies distinctions between Case-Based Learning (CBL) and Problem Based Learning (PBL) as components of andragogy and their impact on student outcomes and performance.

Historical Overview

Gies, in his seminal report on dental education (1926) noted,

> A large amount of time is now consumed in teaching ... students redundant details of anatomy, of physiology, of chemistry, which they quickly forget and which the teachers do not long remember. These details ought to come to ... students as matters of illustration and experience in the course of their ... study. This is a problem of education... It is the most important problem, which confronts the modern ... school (p. xiv).

Donoff (2006) points out that the Gies report did, in fact, have an impact on practices in dental education, but that little has changed for many years. Indeed, since the time of the reforms based on the Gies recommendations, the curriculum has been steadily managed and maintained until the institute of Medicine (IOM)

report of 1995, *Dental Education at the Crossroads: Challenges and Change,* by Field. This report describes challenges in dental education. Kalkwarf, Haden and Valachovic (2005) describe the challenges with these words:

> Individual courses and curriculum reflect past dental practice rather than current and emerging practice and knowledge; clinical education does not sufficiently incorporate the goal of comprehensive care, with instruction focusing too heavily on procedures; linkages between medicine and dentistry are weak; and the curriculum is crowded with redundant material, often taught in disciplinary silos...basic and clinical sciences teaching do not stress the basic sciences as a relevant foundation for clinical practice (p.1085).

In 2004, the American Dental Education Association (ADEA) board of directors identified curriculum reform in dental education as a major strategic direction. The ADEA Commission on Change and Innovation in Dental Education (ADEA CCI) was created to coordinate with the dental education community and to develop programs and models for training the oral health care practitioner of the future. The ADEA holds annual session programs for educators, mainly those from North America and some scattered faculty from other parts of the world. The theme for the ADEA's 85th annual session held in March of 2008 was "Curricular Change: It's Time." The program "included a focus on curriculum reform to meet the educational needs of the new millennial learner" (Howard, Stewart, Woodall, Kingsley & Ditmyer, 2009, p.962). These efforts ultimately led to the call for changes discussed in the various commissioned papers included in the ADEA CCI book titled *Beyond the Crossroads: Change and Innovation in Dental Education* (ADEA CCI, 2009).

There is a general consensus in the dental profession about the need to review curricula and make changes as appropriate to meet the changing needs of the dental profession and dental education (Donoff, 2006; Kassebaum, et al., 2004; ADEA COD Proceedings, 2005, 2006). With this historical framework, let us turn our attention to one of the promising adult learning methods being used in professional education and, more specifically, in healthcare.

Case-Based Learning

Any discussion of case-based learning (CBL) must include some background on adult learning and problem-based learning (PBL). Discussion of the literature will begin with those topics.

Adult learning theory is salient in the proposed research study as the students attending dental school all enter the program as adults, having completed the undergraduate college or university phase of their education. Many theories describe the learning process for adults under the umbrella term of "adult learning" (Abela, 2009; Merriam, 2001; Trivette, 2009; Trotter, 2006; and Yang, 2003). In a 2009 publication, Abela used Knowles' (1984) term *andragogy* to describe the adult learning theory that assumes adults

- are independent and self directing;
- have (various degrees of) experience;
- integrate learning into the demands of their everyday life;
- are more interested in immediate problem-centered approaches; and
- are motivated more by internal than external drives (Abela, p. 11)

The literature on adult learning supports the use of a real world authentic problem to guide an open small group discussion that will enhance the learning process. This fits the PBL/CBL model (Abela, 2009; Trivette, et al., 2009).

> The use of adult learning tools such as PBL or CBL is based on the criticism of the traditional curricula in which background knowledge in areas such as basic or clinical sciences was presented in a more passive lecture format.
>
> Traditional instruction, such as the typical lecture-based session that developed before textbooks were mass-produced, often involves delivering as much information as possible as quickly as possible. The lecture method was one of the most effective and efficient ways to disseminate information and has often been used for this end. Because many faculty members are poor lecturers, and because students are often poor participants in the lecture, this type of instruction has often allowed students to be passive in the classroom. Students, not knowing how to be active participants in the lecture, have relied on transcription, memorization, and repetition for learning. (Major & Palmer, 2001, p. 1).

The criticism of the traditional curriculum delivery in health education is described by Finucane, Johnson, and Prideaux (1998), who note that

- It [traditional curriculum] creates an artificial divide between the basic and clinical sciences;
- Time is wasted in acquiring knowledge that is subsequently forgotten or found to be irrelevant;
- Application of the acquired knowledge can be difficult;
- The acquisition and retention of information that has no apparent relevance can be boring and even demoralizing for students. (p. 445)
-

Matching the criticisms of traditional curricular structures and buttressing the reasons for using PBL or CBL in higher education are several important research efforts that have generated theories of adult learning. For example, several researchers claim that the use of more active adult learning techniques can aid in retention of information, interest in subject matter, and retention of what has been learned (Abela, 2009; Finucane, et al., 1998; Trivette, 2009). And in many

professional programs, apparently there is, a move toward learning that uses stronger signature pedagogies to emphasize learning over teaching, such as "project-based learning, inquiry-based learning, case-based learning, research-based learning, situation-based learning, action learning, and PBL" (Major & Palmer, 2001, p. 1).

Before entering into the discussion of problem-based learning, it is appropriate to briefly discuss project-based learning. In this dissertation, all references to PBL indicate problem-based learning, which is the more common discussion in literature geared toward healthcare education. According to Thomas, project-based learning has emerged from three traditions that include outward bound wilderness expeditions, problem-based learning, and research in cognitive science applications and cognition (Thomas, 2000). Project-based learning uses projects to organize student learning by actively engaging them in the development of a solution for the project over an extended period of time. The learning in PBL is of a higher order and is more appropriate for dental education. as opposed to project-based learning that is appropriate for foundational learning

In 1993, Donner and Bickley described PBL as

> "a form of education in which information is mastered in the same context in which it will be used. In medical/health education, PBL is seen as a student-driven process in which the student sets the pace and the role of the teacher becomes one of guide, facilitator, and resource" (p. 294).

Finucane and colleagues in 1998, described PBL as "an educational method characterized by the use of patient problems as a context for students to

learn problem-solving skills and acquire knowledge about the basic and clinical sciences" (p. 445).

The objectives of PBL include the adult learning goals of gaining the knowledge, skills, attitudes, and habits to perform competently in a chosen field (Abela, 2009; Donner & Bickley, 1993; Finucane, et al., 1998; Trivette, et al., 2009; Wang, Tai, Huang, Bian, Shang, Wang & Song, 2008). In health education,

> . . . the PBL student must acquire a body of basic biomedical knowledge equivalent to that learned in a traditional curriculum, the student must learn to apply this basic knowledge in patient care, and the student must acquire the attitudes, habits, and techniques of a lifelong leaner (Donner & Bickley, 1993, p. 295).

Problem-Based Learning started gaining popularity in medical education after it began in North American medical education with the transition of McMaster University to a full PBL curriculum in 1969. After that initial start, PBL grew in medical programs throughout the world. The first United States program was at the University of New Mexico in 1979, followed by many other medical schools, including Harvard University School of Medicine. By the mid 1990s PBL had been well established in hundreds of medical schools around the world and endorsed by World Federation of Medical Education and the World Health Organization (Donner & Bickley, 1993; Finucane, et al., 1998; Wang, et al., 2008).

Donner and Bickley (1993) describe the structure of the PBL curriculum as including the following components;

1. Review of the problem;
2. Small-group tutorial session with students and faculty facilitator;

3. Student-directed learning as students identify and rank issues that will be researched and reviewed in a future session;
4. Tutorial learning with students and faculty; and
5. Reciprocal student-faculty evaluations.

Problem-based learning programs have shown mixed reviews over the years in the outcomes that have been achieved (Albanese 1993, 2000; Koh, Khoo, Wong & Koh, 2008; Lewis, Menezes, McDermott, Hibbert, Brennan, Ross & Jones, 2009; Major & Palmer, 2001). Students and faculty appear to enjoy the active participation, and there is evidence that PBL fosters lifelong learning skills (Finucane, et al., 1998; Major & Palmer, 2001). There is, however, little evidence that PBL curricula are better than traditional ones outside of limited studies with small groups. There is some evidence that

> PBL curricula cover about 80% of what might be accomplished in a conventional curriculum in the same period. In medical settings, there are particular concerns about students' grounding in the basic sciences, with some evidence (although confounded by uncontrolled variables, including the effects of admissions policies) that students from PBL-based schools do less well than those from traditional schools in the basic science component of the US National Board Examinations (Albanese, 1993; Berkson, 1993; Finucane, et al., p. 6, 1998).

Finucane and his colleagues, (1998) state that "PBL and traditional curricula are far from incompatible, and Berkson (1993) argues that the two will gradually merge. "As commitment to the principles of adult learning and the creation of a more stimulating and supportive learning environment become more common goals for both students and teachers, traditional curricula will face pressure to become more integrated and interactive" (Finucane, et al., p. 6).

A study by Lohman and Finkelstein (2002) attempts to show that PBL is most effective when the problems are clearly formatted and broken into smaller segments. This allows students the ability to integrate information and solve problems highly similar to the one presented. This may be appropriate in dentistry as it is possible to segment the activities of a dental practitioner and present smaller segments of problems through a case.

Problem-based learning has key learning principles that say learning should be constructive, self-directed, collaborative, and contextual (Dolmans, DeGrave, Wolfhagen & VanDerVleuten, 2005). It uses problems to stimulate learning, the group for interaction, and the instructor as the facilitator (Roberts, Lawson, Newble, Self & Chan, 2005). In 2001, Fincham and Shuler described the challenges and relevance of PBL in dental education. Their work shows that it is a promising pedagogy but that there may be other more effective ways of providing dental education. Building on our earlier discussion, Roberts and colleagues (2005) show that there is not a significant difference in outcomes measured between students engaged in a PBL program and those engaged in a large class integrated learning activity that could be patient-, case-, or problem-based.

According to Donner and Bickley (1993), out of 100 medical schools claiming the use of PBL in their curriculum, most were actually using case-enhanced teaching, which appears to be closer to what will be discussed as case-based learning (CBL). One promising benefit of PBL, which is also a major component of CBL, is that.

> . . .students who acquired knowledge in the context of solving problems have been shown to be more likely to use it spontaneously to solve new problems than individuals who acquire the same information under more traditional methods of learning facts and concepts through lectures" (Major & Palmer, 2001, p. 3).

Williams, in his 2005 article, argues that CBL is similar to, but slightly different from PBL. Problem-based learning is primarily student driven whereas CBL uses cases to enhance the learning experience, although the faculty member is more involved in the development of the learning experience and outcomes. Richards and co-authors (2005) describe CBL as an important way to combine and distill all of the knowledge acquired by students in lectures and textbooks in order to apply it to patient care.

The above information suggests that CBL may be as appropriate in adult professional education as PBL. Williams uses a diagram (Figure 5) to point out that PBL and CBL have some similarities, but he also states that they are different in focus with CBL, as they are geared toward students using previously learned foundational knowledge to solve real clinical cases (Williams, 2005).

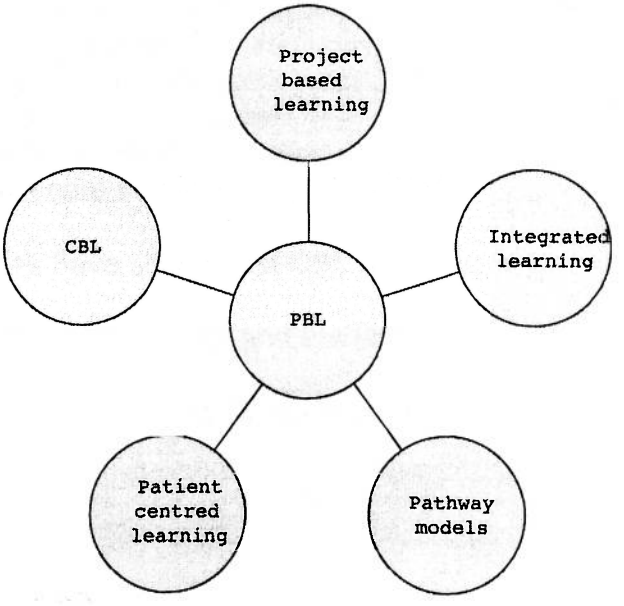

Figure 5. Educational Fusions of Problem-Based Learning (Williams, p. 578)

Williams argues that there are many synonyms for PBL with similar educational characteristics. Case-base learning is one of them, as shown in his diagram above. A fundamental difference between PBL and CBL is that PBL does not require the student to do any prior study of the subject matter, whereas CBL requires that students draw upon previously learned foundation to solve the clinical problem presented in the discussion (Williams, 2005).

In an attempt to distinguish problem versus case-based learning in dental education, Richards (2005) and his colleagues note the following:

> Although problem-based learning and case-based learning share common goals and are often described as similar entities, these approaches are actually different techniques that have unique characteristics. In problem-based learning, the problem drives the learning. In some instances, the problem-based approach dominates the educational process from the beginning to the end of a student's professional education. Case-based learning, on the other hand, can take many forms. At its most basic, instructors may use a clinical case to raise awareness about a specific issue, dramatize the importance of a particular health problem or treatment strategy, or introduce a topic. At the other end of the spectrum, students can document their clinical care of patient and present it to other students and clinicians in case-based comprehensive care seminars. (2005, p. 284)

Several studies have shown that CBL is a good adjunct to traditional lectures. Students enjoy this format and are better prepared to engage in conversation during class sessions by asking questions or making appropriate

topical comments (Hansen, Ferguson, Sipe, & Sorosky, 2005; Kassebaum, et al., 1991; Pearson, Barker, Fisher & Tafton, 2003). There is also some discussion in the literature about the use of computer-aided learning,, noting that a web-based approach may meet some of the challenges of CBL, such as this being a resource-intensive style of teaching (Abbey, Arnold, Halunko, Huneke & Lee, 2003). Another reform also taking place within dental education has the potential to make the use of CBL even more powerful and relevant. This is the move away from a curriculum that separates the basic sciences courses from the rest of the curriculum toward a multi-disciplinary approach that integrates basic science with instruction focused on clinical practice.

Dentistry, as a surgical field in healthcare, requires higher order learning, and students must be able to function at high levels where they synthesize and apply knowledge to solve new and novel problems. In educational terms, students must achieve a level of synthesis as described in Bloom's taxonomy (Bloom, 1968). A multidisciplinary case-based approach lends itself to the synthesis of information and evaluation of outcomes and is one method for delivering the type of learning opportunity necessary in dentistry (Garvey, et al., 2000; LaVere, et al., 1996; Prystowsky, et al., 2001).

Movement toward integrating and teaching the biomedical sciences in larger multidisciplinary courses, specifically in dental schools, is also occurring and supports the use of CBL as an instructional strategy (Lantz & Chavez, 1997). Multidisciplinary teaching promotes collaboration and the inclusion of individuals

from different fields, such as the behavioral and biomedical sciences, in the clinical education of professional students (Prystowsky, et al., 2001; Richards, et al., 2005). Richards and co-authors also show that multidisciplinary approaches to teaching provide students with a deeper appreciation of the complexities of treatment planning and diagnosis. This style of teaching also helps students understand the importance of topics like cultural sensitivity when they are speaking and working with their patients.

Case-based learning, as a part of a multidisciplinary approach, has received positive evaluations from learners and facilitators. This mode of teaching is characterized as positive in the development of clinical skill s(Jamkar, et al., 2006). However, if CBL is to be effective, certain issues must be addressed. For instance, faculty and residents should be trained to lead discussion groups. Evidence shows that expert discussion leaders are necessary for providing students with a deeper understanding of the foundation when taking on CBL as a learning modality (Hay & Katsikitis, 2001). As noted above, CBL relies on students having a foundation of understanding from their previous study of the disciplines involved in order to fully understand and solve the issues and problems presented in the case. Faculty must also be aware of the problems of CBL and the need to work intentionally on developing the students' capacity to take advantage of this kind of learning. For example, Hay and Katsikitis (2001) note the following:

> . . . students need to be brought up to speed on what the expectation is for their preparation and participation. Without this assistance, they may have difficulty in following through and really integrating the material if they are left on their own to gather and synthesize the material (p.23).

According to Howard and colleagues (2009), the curricular changes include the premise that "dental school curricula [will hopefully] inherently incorporate a multiple-discipline [multidisciplinary] theme leading to one common goal: to graduate knowledgeable and competent dentists" (p.963). Other authors, including Richards, Inglehart, and Habil (2005), have claimed that multidisciplinary learning may be more successful than traditional teaching in preparing students for higher order cognitive skills like critical thinking and problem solving. "In particular, treatment planning may be most effectively taught using an interdisciplinary approach and not merely within the confines of specialty departments" (p. 286). The competencies for the new general dentist, developed in collaboration with ADEA CCI, includes a much stronger focus on higher order cognitive skills, so the hope is that the focus on multidisciplinary learning will support students in reaching those competencies. The curricular reform movement in dental education is continuing to swell, and schools across North America and throughout the world are reporting movement toward a more integrated, multidisciplinary model that creates linkages between the basic and clinical sciences (Bohay, et al., 2009; Wang, et al., 2008).

Historical Background: National Board Dental Examinations

The quantitative analyses that were reviewed in this study include a review of student performance on the National Board Dental Examinations (NBDE or

NB), so it would be appropriate to review some background and history on these examinations to place them in perspective as they exist currently in dentistry.

Currently a great difference exists in perspective about board examinations among members of dental practice, education, organized dentistry, and licensing boards. In 2007, Neumann and MacNeil begin the article on revisiting of NBDE with the following statement: "National Boards stifle curricular innovation...force students to memorize useless facts that they never use in practice...test outdated irrelevant information...should be testing knowledge for future dental practice" (p. 1281). This represents one perspective on the NBDE and how it should or should not relate to the curricula in dental education. "The diversity of thought and commentary on the National Board exams reveals a mixture of interest, misinformation, misunderstanding, misperception, and skepticism tempered by respect for this rite of passage from dental school to professional practice" (p. 1281).

A good place to begin discussion of the NBDE is with the history of the boards. The purpose of the NBDE has been consistent since their development following the Gies report in the late 1920s. The National Board of Dental Examiners was created as a standing committee of the American Dental Association (ADA) in 1929. This committee provided the oversight in developing and conducting the different parts of the NBDE. The purpose of the board is to provide one of the pieces of evidence used by state boards of dentistry in confirming the qualifications of candidates seeking state licensure to practice the

profession (Neumann & MacNeil, 2007). Originally the ADA plan included a three-part examination, with the first two sections as written examinations (NBI and NBII) and the third as a practical examination. Due to political and other forces, the management of the practical examination was relegated to the state dental boards.

Part I of the NBI boards was first administered in 1933 and Part II in 1934. Most states did not begin recognizing the certification of passage of NBI and NBII until the mid 1950s; however, by 1990 all U.S. jurisdictions that provided a license to practice dentistry recognized the boards as a requirement for licensure. In 1980, the Joint Commission on National Dental Examinations (JCNDE) became the agency of the ADA responsible for oversight and administration of the NBDE through an agreement between the ADA and the American Association of Dental Examiners (AADE).

According to the *Candidates' Guide to the NBDE*, published in 2005, and referenced by Neumann and MacNeil, the examination is intended to assess a candidate's ability to understand and apply, through problem solving, the basic biomedical and clinical sciences. Part I of NBDE includes knowledge of mostly basic biomedical and some clinical sciences, and the case-based Part II includes mostly a case-based review of clinical skills. The description above leads us to the use of the National Boards as one way to measure knowledge (NBI) and skills (NBII) acquired during the educational process.

The JCNDE creates and maintains an exam based on a list of competencies for the new dentist, as established by the ADEA. The NBDE is designed to achieve validity with enough confidence in the information gained to assess if a candidate obtains the knowledge and skills identified in the various domains of the ADEA competencies to allow the new dentist to practice independently as an entry level dentist. The test construction committee (Table 1) of the JCNDE also uses data from a practice analysis that is a periodic survey of a randomized sample of roughly 7000 practicing dentists who share their perception of the importance of the various competencies. Once the test questions and their balance of questions between the various competency areas are developed, an expert panel is asked to review the questions, and a pilot of new test items is conducted. The piloted questions are assessed statistically for difficulty and discrimination before becoming scored items in future tests. The NBDE is organized as a criterion referenced test as the candidates are evaluated in comparison to a standard and not in relationship to one another or normative measures. The score is reported as a mathematical conversion of the raw score to a standard score that compares with all other candidates over time. The pass-fail point is determined by a group of content experts, and the JCNDE sets the standard score of 75 as the passing point or minimum acceptable performance level (Neumann & MacNeil, 2007).

Table 1. National Board Dental Examination Test Construction Committee Membership

National Board Part	Test Construction Committee
NBI	
	Anatomical Sciences
	Biochemistry/Physiology
	Microbiology/Pathology
	Dental Anatomy/Occlusion
	Testlet Development
NBII	
	Endodontics
	Operative Dentistry
	Oral and Maxillofacial Surgery - Pain Control
	Oral Diagnosis
	Orthodontics/Pediatric Dentistry
	Patient Management
	Periodontics
	Pharmacology
	Prosthodontics
	Component B-Case Composition and Case Selection
	Consultant Review

Summary

In summary, there a significant body of work throughout the professions, including dentistry, shows that it is time to look at our curriculum in dental education and that multidisciplinary CBL offers a promising pedagogy/andragogy for teaching dental knowledge, skills, and attitudes. This literature serves as the backdrop for the curriculum reform movement at the Pacific Dugoni as faculty members realize the Pacific Dental Helix Curriculum. The literature also provides the foundation of understanding necessary to interpret the current study and outcomes with the use of the NBDE as one measure for the attainment of dental knowledge and skills.

CHAPTER III: METHODOLOGY

General Design

This research employed a mixed method design. Questions related to identifying common aspects of CBL and multidisciplinary teaching were addressed through a qualitative analysis of curricular materials. Questions related to analyzing the impact of CBL and multidisciplinary teaching on select outcome measure were addressed through quantitative statistical analysis.

Qualitative Methodology

The first two research questions in this study were addressed through qualitative content analysis.

1. What are the common aspects of case-based learning as implemented at the Pacific Dugoni?
2. What are the common aspects of multidisciplinary teaching as implemented at the Pacific Dugoni?

Data Sources and Analytical Approach

Data that were examined included minutes from the Pacific Dugoni's curriculum committee between 2005 and 2009, the strategic plan "Advancing Greatness," (Appendix 1), course syllabi, and formal and informal reports from faculty. These materials were analyzed through a process of "inductive category

development" (Mayring, 2000, p. 38). T his process is somewhat similar to Glaser's (1965) "constant comparative method" in that the researcher notes themes and patterns related to content, as well as structure within and across courses and phases (years) as they emerge from reviews of the materials. These themes and patterns lead to the development of preliminary conceptual categories. Subsequent analyses of data led to revision of original categories and, ultimately, to an identification of common (and uncommon) features of CBL and multidisciplinary teaching at the Pacific Dugoni. This identification, in turn, helped to frame the interpretation of the results of the quantitative portion of this study.

The following research questions were addressed using a quantitative approach.

3. Are there differences in knowledge, as measured by NBI scores and didactic GPA at the end of year three when dental students experience a curriculum that devotes significant time to case-based, multidisciplinary approaches?
4. Are there differences in skills, as measured by NBII scores and lab/clinic GPA at the end of year three when dental students experience a curriculum that devotes significant time to case-based, multidisciplinary approaches?

In the book *Research Methods in Education*, Wiersma and Jurs (2004) describe ex post facto non-experimental quantitative research. This research design is appropriate for the study of the impact resulting from the introduction of

multidisciplinary CBL on knowledge and skills of dental school students, as measured by performance on National Boards Examinations and GPAs. The changes in the curriculum toward more multidisciplinary CBL have been planned and implemented, and data are maintained on scores on NBDEs and GPAs of similar size groups of students. This structure suggested that we could analyze if and how curricular changes affected Board scores and GPAs. According to Wiersma and Jurs, this type of research is also called after-the-fact or causal-comparative. The basic premise is that the research is evaluating data that occurs in a natural non-experimental setting.

Selection of the Population and Sample

The Pacific Dugoni is the only three-year accredited dental school in the United States. The average class size for the Doctoral of Dental Surgery program is 142 students per class. Candidates are selected from a very large applicant pool of roughly 3200 applicants annually. This large applicant pool allows for very high selectivity, and the entering classes tend to be similar in their characteristics at entry.

The change in the curriculum toward more case-based and multidisciplinary learning was fully implemented for the graduating class of 2007. Because of the relative similarity in class characteristics and size, a sample of three years pre-change and three years post-change was chosen for this ex post facto study. The number of students in each group was as follows

Table 2. Description of Comparison Groups

Pre change group			*Post change group*		
Graduating Class	Applicants	Students	Graduating Class	Applicants	Students
2004	2236	140	2007	3043	144
2005	2581	142	2008	3115	143
2006	2944	144	2009	3201	144
Total	7761	426	Total	9359	431

Comparison of Experimental and Control Groups

The students whose data is described above for the pre- and post-change groups have the following basic demographic characteristics. Overall, all of the students in the graduating classes of 2004-2009 share the following similarities in ethnicity as shown in Table 3.

Table 3. Ethnicity Overall

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	8	.9	.9	.9
	Asian/Pacific Islander	246	28.7	28.7	29.7
	American Indian/Native American	4	.5	.5	30.1
	Black/African American	16	1.9	1.9	32.0
	Caucasian	416	48.6	48.6	80.6
	Hispanic/Latino	56	6.5	6.5	87.1
	Do not Wish to Report	12	1.4	1.4	88.6
	Other	74	8.6	8.6	97.2
	Unknown	24	2.8	2.8	100.0
	Total	856	100.0	100.0	

This data for the pre-change group including the classes of 2004-2006 (Table 4) and post-change group including the classes of 2007-2009 (Table 5) are very similar in makeup with the largest number of students from the "Caucasian" and "Asian/Pacific Islander" categories.

Table 4. Ethnicity Pre-change

Pre-change Ethnicity[a]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	.9	.9	.9
	Asian/Pacific Islander	121	28.5	28.5	29.4
	American Indian-Native American	2	.5	.5	29.9
	Black/African American	8	1.9	1.9	31.8
	Caucasian	210	49.4	49.4	81.2
	Hispanic/Latino	23	5.4	5.4	86.6
	Other	38	8.9	8.9	95.5
	Unknown	19	4.5	4.5	100.0
	Total	425	100.0	100.0	

a. Cohort = 1

Table 5. Ethnicity Post-change

		Post-change Ethnicity[a]			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	.9	.9	.9
	Asian/Pacific Islander	125	29.0	29.0	29.9
	American Indian-Native American	2	.5	.5	30.4
	Black/African American	8	1.9	1.9	32.3
	Caucasian	206	47.8	47.8	80.0
	Hispanic/Latino	33	7.7	7.7	87.7
	Do not Wish to Report	12	2.8	2.8	90.5
	Other	36	8.4	8.4	98.8
	Unknown	5	1.2	1.2	100.0
	Total	431	100.0	100.0	

a. Cohort = 2

Figure 6 shows an equally similar distribution of gender between the total student population included in the study and the pre- and post-change three-year cohorts.

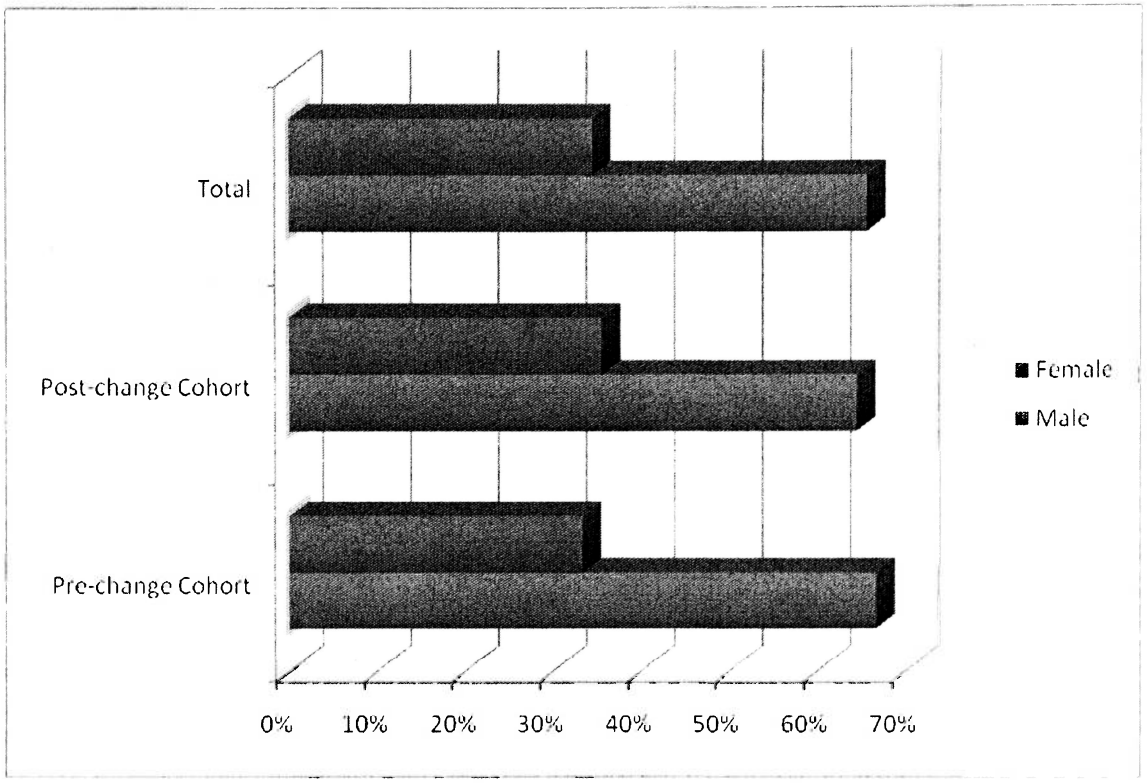

Figure 6. Gender Full Cohort and Pre and Post-change Groups

In addition to the gender and ethnicity information, it is also important to confirm that the two cohorts were similar in academic performance upon matriculation. Figure 7 is a graphical depiction of entry academic data for the two cohorts. In order to ensure similarity, we compared entry GPA overall (GPA Total), in the sciences (GPA Science), and in biology, chemistry and physics (GPA Bio/Chem/Phys). We also reviewed highlighted portions of the standardized dental admissions test (DAT) in the areas of total science (DAT Total Science), reading comprehension (DAT RC), perceptual ability (DAT PAT), and overall academic average (DAT AA). These data showed great homogeneity between the

entry characteristics of the pre and post-change cohorts in the quantitative portion of this study.

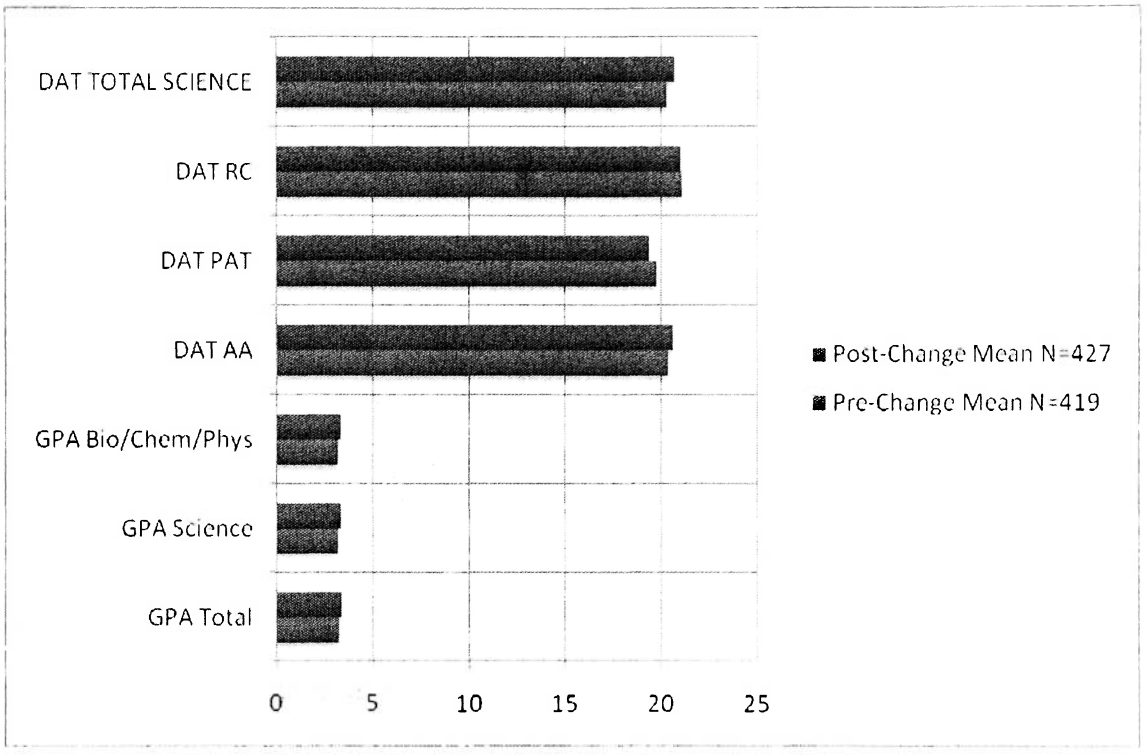

Figure 7 Academic Data for Pre and Post-change Groups

Independent and Dependent Variables

The independent variable was change in curriculum that was fully implemented for the class of 2007, and the dependent variables were relevant data for the pre- and post-curriculum change cohorts.

Data Collection Procedures

Prior to data collection, approval to work with these data was obtained from the appropriate Institutional Review Board at the University of the Pacific. For the qualitative content analysis portion of this study, the strategic plan implementation

documentation was gathered, along with minutes of the curriculum committee. The department chairs were also asked to provide information on how case-based multidisciplinary learning has been incorporated into their courses to allow for a description of the common aspects of how the University of the Pacific Arthur A. Dugoni School of Dentistry has implemented multidisciplinary and case-based learning.

For the quantitative ex post facto portion of the study, we combined student data from multiple locations into one single comprehensive dataset. For example, entry characteristic data collected by the Office of Admissions and Student Services and performance data held in the Office of Academic Affairs were brought together to allow for comparisons. In addition, performance on NBDE and practical licensing examinations data, which in the past were reported and maintained separately, were collapsed into a single data management system.

Data Analysis

The qualitative data, including minutes from the curriculum committee, reports from departments, and syllabi, were analyzed using the constant comparative method. The goal of this analysis was to identify themes and patterns within and between courses and within and between phases (years) of the program of study. These themes were noted and provided a framework for interpreting the results of the quantitative analysis portion of this research.

As noted above, the quantitative data was gathered in the newly developed data management system in the Office of Academic Affairs. The data for the

classes of 2004-2009 were transferred to the software program Statistical Package for the Social Sciences (SPSS) for further statistical analysis.

The analysis of the data began with a look at the entire dataset for general trends and overall description of the full dataset. The data were subsequently split into two cohorts. Year zero was the pre-change group, including the classes of 2004-2006. Year one was the post-change group, including the classes of 2007-2009. Descriptive statistics were calculated on each of the two cohorts to provide a basic understanding of the similarities and/or dissimilarities that may exist between the two cohorts. Sample T-tests were completed; and a 95% confidence interval was reported.

Reporting the Data

The data have been reported with a narrative description of the content analysis information broken down into two sections: multidisciplinary and case-based learning. A description is also provided that explains how they have been included in the dental curriculum at Pacific Dugoni.

The quantitative data from the SPSS analysis of the six classes were reported in aggregate and then separated by cohort, with a description of any differences, similarities, and significance of the findings. The data analysis focused on answering the research questions related to differences between cohorts in knowledge, as measured by student performance on NBI and didactic GPA, and skills, as measured by performance in NBII and laboratory and clinical

GPA. Potentially confounding factors such as gender, ethnicity, entry grade point average, and dental admissions testing results were noted and reviewed.

Assumptions of the Study

One assumption underlying this study was that the new curriculum in the integrated clinical sciences strand, with a move toward more case-based and multidisciplinary learning, was implemented. A second assumption was that this change would affect student performance. A third assumption related to the recognition that students bring with them factors that influence performance. However, since Pacific Dugoni enjoys such a large and selective applicant pool, we assumed that the skill level and experience levels of the students would be similar upon entry to the program.

Limitations of the Study

One limitation of the study is the author's role as Associate Dean for Academic Affairs of the program that implemented the change. This might have influenced the information that the faculty members and department chairpersons provided in discussions about the use of case-based and multidisciplinary learning. There may also be a bias because of the strong connection and role that the author has played in the development of the Pacific Dental Helix Curriculum reform and the development of the integrated clinical sciences strand of courses.

Another limitation could be the range-restricted student population. Higher-level students create less variance, therefore, less power to determine significant differences between pre and post curricula change.

A third possible limitation of the study was that the NBDE is a third-party external assessment that uses multiple choice questions in a case-based format, so the questions may be testing at a lower level than the intent of the learning experience. Multiple-choice examinations test for recognition, and skillful guessing may provide the correct answer without a deeper understanding of the material. Thus, the curricula may only detect significance in certain type of assessment and may not be generalizable

A fourth limitation of this study is that the study is completed with information from only one dental school, resulting in low external validity.

A fifth limitation is the reality that this research was not designed to take into account the entire range of factors that influence GPA and NBDE Scores.

CHAPTER IV: FINDINGS

Summary of Findings

The summary of findings will be divided into two sections. The first section will cover the first two research questions in this study:

1. What are the common aspects of case-based learning as implemented at the Pacific Dugoni?

   What are the common aspects of multidisciplinary teaching as implemented at the Pacific Dugoni?

These questions were addressed through qualitative content analysis.

The second section will cover the last two research questions:

3. Are there differences in knowledge, as measured by NBI scores and didactic GPA, at the end of year three when dental students experience a curriculum that devotes significant time to case-based, multidisciplinary approaches?
4. Are there differences in skills, as measured by NBII scores and lab/clinic GPA, at the end of year three when dental students experience a curriculum that devotes significant time to case-based, multidisciplinary approaches?

These questions were addressed using a quantitative approach.

Qualitative Analysis

The qualitative review, as described in Chapter III, looked at information from three primary sources. Documentation of the strategic plan implementtation was gathered, along with minutes of the curriculum committee. The department chairs were also asked to provide information on how case-based multidisciplinary learning had been incorporated into their courses to allow for a description of the common aspects of how Pacific Dugoni has implemented multidisciplinary and CBL.

We will begin our discussion of the environment in which these curricular reforms occurred with a description of the strategic planning process that was underway during the period covered by this study. Dean Patrick J. Ferrillo formed and charged the strategic plan writing committee to create a strategic plan that took into consideration input from a broad array of stakeholders connected to the Pacific Dugoni. This committee collected information from the dental school community through the activities of 65 students, staff, and faculty serving on 22 teams. They finished their work in June of 2007 with a comprehensive strategic plan. (See Appendix 1 for the complete strategic plan.) After this plan was shared broadly with the dental school community, a new committee was tasked with creating the implementation plan, again, using a broad level of involvement from the entire community. The strategic plan implementation task force completed its work in May of 2008 and, from the 109 action items, a short, prioritized list of 22 action items was created for the school to pursue. (The action items can be viewed in Appendix 2.)

Appendix 3 shows some of the data gathered for this project to illustrate the strategic plan implementation themes, specifically those related to leading educational innovation as a strategic direction for the Pacific Dugoni School of Dentistry. These themes show that this inclusive strategic planning process focused on curricular changes with the following main characteristics;

1. Integration, both inter and intra-disciplinary (multidisciplinary);
2. Active learning opportunities with more student engagement;
3. Case-based learning.

Next, the minutes of the curriculum committee of Pacific Dugoni were reviewed from July 2005 to January 2010 for any discussion of CBL or multidisciplinary programs. This timeframe was chosen based on discussions with members of the committee regarding the best potential for commentary on the development of the ICS strand of the Pacific Dental Helix Curriculum and the development of the Helix model overall as a curriculum management idea. Minutes from the following meetings were found to have relevant excerpts, which were condensed into one document for review.

1. October 25, 2005
2. November 30, 2005
3. March 3, 2006
4. August 29, 2006
5. February 7, 2007
6. April 24, 2007

7. August 5, 2008
8. September 3, 2008
9. January 12, 2009
10. April 12, 2009
11. August 5, 2009
12. September 2, 2009
13. October 12, 2009

A review of this documentation revealed that the first discussions of case-based teaching or learning and comprehensive multidisciplinary examinations began in the October 25, 2005, meeting. The discussions concentrated on the development of the Integrated Clinical Sciences Course, defining and deploying CBL, and comprehensive examinations. According to the April 24, 2007, minutes, one student member of the curriculum committee was quoted as characterizing the first attempt at the integrated multidisciplinary ICS course as a course "the students are proud of."

In September of 2008, there was an extensive discussion about curriculum integration and the goals of such an effort. These goals include tying foundational knowledge to clinical practice using a case-based teaching model and growing the interdisciplinary competence of faculty. The discussions continued in January 2009, with the idea of adjusting the structure of several committees, including the curriculum committee, to reflect the future model of the Pacific Dental Helix Curriculum.

The remaining documents present the refinement and adjustment of the curriculum. These documents reveal that the changes in the curriculum were geared toward pulling content from multiple disciplines together in a more logical way to fit the needs of the learner. Content was integrated both vertically and horizontally across the three-year DDS curriculum. They also focused on the development of CBL as a standard common andragogy to support the application of knowledge to the practice of dentistry. The discussions of the curriculum committee that were reviewed for this study were centered on the following main areas.

1. Development of the Pacific Dental Helix Curriculum Model;
2. Development of the support needed for the success of the curricular changes, including graduate characteristics and competencies, structure of support and committees, faculty numbers and development, facilities, and student characteristics;
3. Case-based learning across all strands of the curriculum;
4. Multidisciplinary collaboration in the development and delivery of the curriculum; and
5. Mapping content and measuring outcomes.

Finally, the different departments were surveyed about how they were implementing CBL and multidisciplinary teaching across the curriculum at Pacific Dugoni. The following describes some of the themes that arose during the constant comparative analysis of the materials gathered from this survey.

Almost every class at Pacific Dugoni incorporated CBL in some way. The following common themes arose from the responses to the question about how CBL is incorporated into the coursework:

1. Clinical and biomedical courses use patient cases as a central focus to provide relevance to the topic being covered in lecture or seminar.
2. Students are given patient cases during clinical rotation to evaluate and provide diagnosis, alternatives, and a treatment plan based on evidence.
3. Case presentations are completed by students in a seminar format. Each student presents an interesting/challenging case that is discussed with faculty and peers and draws in material from course work in different disciplines.
4. Treatment planning seminars are based on actual patient cases from the case database and include charting, models, photos, and radiographs. All of the clinical disciplines are addressed in the cases overall.
5. Case-based assessments are used in lecture and seminar courses to determine student ability to apply knowledge in context.
6. Case-based tests assess students' ability to diagnose and develop treatment plan, including self-assessment and identification for remediation.

Multidisciplinary teaching ranges from very little multidisciplinary teaching in some courses to other courses that are one hundred percent multidisciplinary in development, delivery, and assessment. The following are some general themes that arose about how multidisciplinary teaching is deployed at Pacific Dugoni:

1. Case presentations are completed by students in seminar formats. Each student presents an interesting/challenging case that is discussed with faculty from different departments and peers and draws from course content in multiple disciplinary areas.
2. Treatment planning seminars are based on actual patient cases from the case database including all of the clinical disciplines.
3. Lectures and seminars are conducted, with faculty from different disciplines (clinical, biomedical, and behavioral) collaborating on the development and delivery of the lecture and the facilitation of discussions.
4. Many courses include lecturers from different disciplines to deliver content as part of a course.

The review of qualitative data gathered for this project suggested a widespread focus on multidisciplinary and CBL at Pacific Dugoni. Further, the data suggest the following responses to the two qualitative research questions.

What are the common aspects of case-based learning as implemented at Pacific Dugoni?

The common aspects of case-based learning as implemented at Pacific Dugoni include the following:

1. Use of a patient case as a central focus to provide relevance to the topic being covered in lecture, seminar, or laboratory courses;
2. Student case presentations in a seminar format to faculty and students;
3. Treatment planning seminars that are based on actual patient cases facilitated by faculty;
4. Case-based testing as a formative process in seminar, laboratory, and clinical courses; and
5. Case-based assessments in lecture, seminar, lab, and clinical courses as a summative measure.

The second question asks what are the common aspects of multidisciplinary teaching as implemented at Pacific Dugoni?

The common aspects of multidisciplinary teaching at Pacific Dugoni may be narrowed down to the following main approaches:

1. Multidisciplinary student case presentations in the format of a seminar for faculty and students;
2. Multidisciplinary treatment planning seminars that are based on actual patient cases, facilitated by faculty;
3. Collaborative lectures and seminars conducted with faculty from different disciplines (clinical, biomedical, and behavioral);

4. Inclusion of lecturers from different disciplines to deliver content as part of a course; and
5. Multidisciplinary student assessments.

Quantitative Analysis

As described above, the quantitative analysis of the data began with a review of the entire dataset in order to identify general trends. This resulted in an overall description of the full dataset using SPSS. The first series of tables describe the general entry demographics of the students included in the dataset. Two thirds of the students in the entire dataset were male, with the largest numbers reporting that they were Caucasian (48.9%) and Asian/Pacific Islander (28.7%). The data also showed that 8.9% of the 856 students included in this data reported that they were under-represented minorities (Black/African American, Hispanic/Latino, or American Indian/Native American). Seventy-seven percent of all students had undergraduate degrees upon matriculation. (Tables 6-9) The dental school accepts some students in an accelerated program coordinated with the University of the Pacific undergraduate program that requires maintenance of a 3.05 science GPA and a minimum of 18 on the DAT sections.

Table 6. Gender Distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	562	65.7	65.7	65.7
	Female	294	34.3	34.3	100.0
	Total	856	100.0	100.0	

Table 7. Ethnicity Distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	8	.9	.9	.9
	Asian/Pacific Islander	246	28.7	28.7	29.7
	American Indian/Native American	4	.5	.5	30.1
	Black/African American	16	1.9	1.9	32.0
	Caucasian	416	48.6	48.6	80.6
	Hispanic/Latino	56	6.5	6.5	87.1
	Do not Wish to Report	12	1.4	1.4	88.6
	Other	74	8.6	8.6	97.2
	Unknown	24	2.8	2.8	100.0
	Total	856	100.0	100.0	

Table 8. Under-represented Minority Distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Non-URM	780	91.1	91.1	91.1
	URM (BLA/HIS/AMI)	76	8.9	8.9	100.0
	Total	856	100.0	100.0	

Table 9. Undergraduate Degree Earned

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	194	22.7	22.7	22.7
	Yes	662	77.3	77.3	100.0
	Total	856	100.0	100.0	

Further analysis of students upon entry into the program included their academic (GPA) and standardized test data (Dental Admissions Test - DAT). The DAT is a multiple-choice computer-based standardized exam taken by students before application to dental school. The United States DAT exam is scored on a scale of 1-30, and the mean score for any section is set at 17 (AA=Academic Average; PAT=Perceptual Ability Test; and RC=Reading Comprehension). Tables 10 and 11 describe the high academic capacity of the students in the entire dataset; students demonstrated a mean total entry grade point average of 3.33 and strong DAT scores, including an academic average mean of 20.53. Table 11 includes a representation of the quartiles. Histograms

with a normal curve overlay for each of the categories may be found in the Appendix (Appendix D, Figures D1-D7).

Table 10. Mean and Standard Deviation for All Students in Study

	N	Mean	Standard Deviation
Entry GPA Total	846	3.3264	.40946
Entry GPA Science	846	3.2453	.45681
Entry GPA BCP	846	3.2389	.47489
DAT AA	845	20.53	1.775
DAT PAT	845	19.61	1.996
DAT RC	845	21.07	2.577
DAT TOTAL SCIENCE	845	20.51	1.922
Valid N (listwise)	844		

Table 11. Entry Percentiles for All Student in Study

		DAT AA	DAT PAT	DAT RC	DAT TOTAL SCIENCE	Entry GPA Total	Entry GPA Sci	Entry GPA BCP
N	Valid	845	845	845	845	846	846	846
	Missing	11	11	11	11	10	10	10
Percentiles	25	19.00	18.00	19.00	19.00	3.0675	2.9400	2.9300
	50	20.00	19.00	21.00	20.00	3.3500	3.2700	3.2600
	75	22.00	21.00	23.00	22.00	3.6200	3.5800	3.5800

To facilitate the quantitative exploration of the entry data, as described in Table 2, the data were split into two cohorts. One cohort included students from classes enrolled in the dental school before the curriculum change (2004-2006); the second included students from the post-change years (2007-2009). The entry demographics of these cohorts were analyzed to identify any significant differences between the comparison groups.

First, the groups were analyzed for any significance related to gender. As seen in Appendix D, Tables D1 and D2, the chi-square value was greater than 0.10 at .474, indicating that any difference in gender between the groups was **not** significant. An additional layer was added to the data analysis including the question of whether or not the student had earned an undergraduate degree. (Some applicants are allowed to matriculate having completed all pre-requisites without having completed all work necessary to earn a degree.) As displayed in Appendix D, Tables D3 and D4, there was no significant difference between the two cohorts in gender, taking this additional data into account.

A cross tabular analysis was also performed between groups to determine any difference between cohorts in the number of under-represented minorities, defined as individuals indicating that they are Black/African American, Hispanic/Latino, or American Indian during the application process. As seen in Appendix D, Tables D5 and D6, a significant difference was not observed between cohorts. Appendix D, Tables D7 and D8, also suggest that there was no

significant difference in the numbers of students entering with an undergraduate degree and those entering through an accelerated program.

Next is a discussion of the analysis of performance differences, if any, observed in the results of National Boards Parts I and II, dental school grade point averages, and ranks for the two cohorts: (1) pre and (2) post- curricula change.

Table 12 is a review of the independent sample t-tests, which showed that the only one of the differences noted above that is significant and beyond the realm of normal variance was the performance on Part I of the National Boards. All of the other changes were not in the range of a significant difference.

As seen in Table 13, there are some differences noted in the mean scores between the two groups. Cohort 2's mean scores were slightly lower in both NBI and NBII. On average, Cohort 2's mean scores were also slightly elevated in first-, second-, and third-year didactic and cumulative GPA and slightly lower in the corresponding laboratory and clinical GPAs.

Table 12: Statistical Analysis of Study Variables

	Equal variances	F	Sig.	t	Df	Sig. 2-tailed	Mean Difference	Std. Error Difference	95% Confidence Interval of Difference Lower	Upper
NBI Score	assumed	20.197	.000	2.686	824	.007	.874	.326	.236	1.513
	not assumed			2.689	801.249	.007	.874	.325	.236	1.513
NBII Score	assumed	2.137	.144	1.461	820	.144	.428	.293	-.147	1.003
	not assumed			1.461	814.366	.144	.428	.293	-.147	1.002
2.587	assumed		.108	-.827	821	.068	-.06989	.03824	-.14495	.00518
	not assumed			-.828	819.574	.068	-.06989	.03822	-.14492	.00514
1st Yr GPA Lab Clinic	assumed	1.586	.208	2.395	821	.017	.08066	.03368	.01456	.14677
	not assumed			2.394	817.781	.017	.08066	.03369	.01453	.14680
2nd Yr GPA Didactic	assumed	.106	.745	-.792	821	.073	-.05988	.03341	-.12546	.00570
	not assumed			-1.792	820.736	.073	-.05988	.03341	- 12546	.00570
2nd Yr PA Lab Clinic	assumed	1.169	.280	2.355	821	.019	.06548	.02781	.01089	.12006
	not assumed			2.354	818.458	.019	.06548	.02782	.01088	.12008
3rd Yr. GPA Didactic	assumed	.000	.998	-.236	819	.217	-.03936	.03183	-.10184	.02313
	not assumed			-.236	819.000	.217	-.03936	.03183	-.10184	.02313
3rd Yr GPA Lab Clinic	assumed	1.290	.256	1.195	819	.232	.03144	.02631	-.02019	.08308
	not assumed			1.195	813.669	.233	.03144			

Table 13. Simple Statistics of Group Variables

	Cohort	N	Mean	Std. Deviation	Std. Error Mean
NBI Score	1	411	85.22	4.239	.209
	2	415	84.35	5.075	.249
NBII Score	1	410	81.62	4.009	.198
	2	412	81.19	4.379	.216
1st Year GPA Didactic	1	408	3.0081	.53206	.02634
	2	415	3.0780	.56428	.02770
1st Year GPA Lab	1	408	2.9679	.49408	.02446
Clinic	2	415	2.8873	.47198	.02317
1st Year GPA	1	408	2.9924	.46271	.02291
Cumulative	2	415	3.0067	.48235	.02368
2nd Year GPA	1	409	3.0918	.48062	.02377
Didactic	2	414	3.1516	.47786	.02349
2nd Year GPA Lab	1	409	3.0876	.40754	.02015
Clinic	2	414	3.0221	.39015	.01917
2nd Year GPA	1	409	3.0903	.41352	.02045
Cumulative	2	414	3.1028	.40633	.01997
3rd Year GPA Didactic	1	408	3.0792	.45322	.02244
	2	413	3.1185	.45888	.02258
3rd Year GPA Lab	1	408	3.1012	.38971	.01929
Clinic	2	413	3.0698	.36376	.01790
3rd Year GPA	1	408	3.0908	.37989	.01881
Cumulative	2	413	3.0933	.36631	.01802

In regard to the quantitative research questions, the data show mixed results for any differences in knowledge, as assessed by National Board Part I performances and didactic GPA when dental students experienced a curriculum that devotes significant time to case-based, multidisciplinary approaches. There was a slight but significant decrease in National Board Part I examination score

averages when comparing the post-change to the pre-change group. However, the data also show a slight yet insignificant increase in didactic GPA in all three years for the post-change group.

The evidence is even less conclusive for the second of the quantitative questions about any differences in skills, as assessed by National Board Part II performances and lab/clinic GPA when dental students experienced a curriculum that devotes significant time to case-based, multidisciplinary approaches. In this case, the data showed a slight, and in all cases insignificant, drop in average National Board Part II, and laboratory and clinical GPA scores for the post-change group as compared with the pre-change group.

To reinforce the reliability of these results, independent sample t-tests were conducted to compare means for the same dependent variables of National Board scores for Parts I and II, in addition to the didactic and lab/clinic grade point averages of the first, second, and third years. The t-tests were conducted to compare the data for individual graduating classes Year 1 vs 2; Year 2 vs 3; Year 3 vs 4; Year 4 vs 5; Year 5 vs 6; Year 1 vs 6; and Year 2 vs 5.

Upon review of the results from the tests that were completed, there were no clear patterns that emerged between any of the above pairings of classes. More importantly, none of the tests comparing GPAs and NB scores for the above pairings resulted in a level of significance. (See Appendix D, Table D9 to D22)

Overall, there was no major change in GPA and National Board Part II scores between the pre- and post-curricula change cohorts once the new multidisciplinary case-based curriculum was implemented.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

As discussed in Chapter I, reform in the curriculum and structure of dental education is a relatively recent occurrence, and, to date, there has been very little research on the impact of specific reforms. Data on the impact of such reforms are needed to evaluate and improve instruction and assessment in dental education.

Change has been recommended in dental school education with the intent of improving the knowledge and skills of dental graduates in meeting the growing oral healthcare needs of the population. Dental education has been challenged to integrate biomedical knowledge with clinical sciences and to create a more engaging curriculum for graduates (Field, 1995).

As discussed earlier, some criticisms of the traditional curriculum delivery in health education are that it (traditional curriculum) divides the clinical and biomedical sciences; creates an environment where time is wasted in learning and then forgetting material that may seem boring and irrelevant to the learner; and the application of knowledge may be difficult (Finucane, Johnson & Prideaux, 1998).

This study gives us more understanding of pedagogies (andragogies) that are emerging as prominent parts of the current curriculum reform process in dental education throughout the United States. Additionally, it creates a stronger basis of understanding of the role of CBL in an integrated dental and multidisciplinary

curriculum. This study offers foundational information for future curriculum design, pedagogy/andragogy and assessment.

As part of overall curricular reform, Pacific Dugoni has undergone changes through the development and implementation of an integrated clinical sciences curriculum. This has been accomplished with a focus on case-based instruction and support from current literature. (Garvey, O'Sullivan & Blake, 2000; Jamkar, Yemul & Singh, 2006). The other signature component of the change in the development of the ICS curriculum is the involvement of multiple disciplines to support collaboration and encourage the linking of biomedical with the various clinical sciences (Prystowsky, et al., 2001; Richards, et al., 2005).

One goal in undertaking this study was to support Pacific Dugoni in developing a plan and structure to measure outcomes of any curricular change in an effort to maintain continuous quality improvement. A strong component of measuring the outcomes of the school's strategic plan and, preparation for accreditation through the American Dental Association Commission on Dental Accreditation, includes the continuous evaluation of outcome data to assess program performance. A positive outcome of the development and completion of this study has been to bring data that was previously housed in several different departments into one location. The database used in the quantitative components of this study has already served as a useful instrument for curriculum development, admissions, and promotion decision-making in committees of faculty and administrators. The faculty members now have the evidence and ability to

closely track the outcomes of any changes by seeing the effect on student performance.

The main purpose of this study was to examine the impact of case-based and multidisciplinary modes of learning on selected measures of student learning in a dental educational program by exploring relationships between, and among, curricular changes and these measures. Below, we present a summary of answers to the research questions that guided this study.

1. What are the common aspects of CBL as implemented at Pacific Dugoni? Qualitative analysis of records related to curricular design and implementation revealed that the following are common aspects of case-based learning at Pacific Dugoni:
    a. Use of a patient case as a central focus to provide relevance to the topic being covered in lecture, seminar, or laboratory courses;
    b. Student case presentations in a seminar format to faculty and students;
    c. Treatment planning seminars that are based on actual patient cases facilitated by faculty;
    d. Case-based test cases as a formative process in seminar, laboratory, and clinical courses; and
    e. Case-based assessments in lecture, seminar, lab, and clinical courses as a summative measure.

2. What are the common aspects of multidisciplinary teaching as implemented at Pacific Dugoni?

Reports from department chairs and analyses of academic records indicate that the following are common aspects of multidisciplinary teaching at Pacific Dugoni:

a. Multidisciplinary student case presentations in a seminar format to faculty and students;
b. Multidisciplinary treatment planning seminars that are based on actual patient cases facilitated by faculty;
c. Collaborative lectures and seminars conducted with faculty from different disciplines (clinical, biomedical, and behavioral);
d. Inclusion of lecturers from different disciplines to deliver content as part of a course; and
e. Multidisciplinary student assessments.

These findings support the literature in the development of a more stimulating and supportive learning environment. Commitments to adult learning principles provide the pressure for a movement toward a more interactive and integrated learning environment that will support the students and teachers (Finucane, et al., 1998).

What are the differences in knowledge, as assessed by National Board part one performances and didactic GPA, when dental students experience a curriculum that devotes significant time to case-based, multidisciplinary approaches. Comparisons of National Board Part I scores and students' didactic

GPAs from cohorts of students before and after curricular changes to incorporated case-based, multidisciplinary approaches showed mixed results. Analysis revealed a slight but significant decrease in National Board Part I examination score averages when comparing the post-change to the pre-change group. However, the data also show a slight yet insignificant increase in didactic GPA in all three years for the post-change group.

What are the differences in skills, as assessed by National Board Part II performances and lab/clinic GPA, when dental students experience a curriculum that devotes significant time to case-based, multidisciplinary approaches? Analysis of pre- and post-change data revealed slight and insignificant decreases in National Board Part II performances and laboratory and clinic GPAs.

The overall analysis of the quantitative data showed **negligible impact on the outcomes being measured**. However, we know from the literature that active learning models like CBL can motivate and engage students at a higher level in their learning and better prepare them to solve problems creatively versus a traditional educational model (Jamkar, et al., 2006; Major & Palmer, 2001). This is a useful finding because a program with high student success in passage of national boards, licensure. and graduation outcomes, all in the high 90% range, was able to incorporate a more active and engaging curriculum without a drop or change in student performance on the selected measures.

Reasons for the inconclusive results of the data analysis could include the possibility that the curriculum change did not have results as intended to improve

student achievement of competency. Another possibility is that the students in the program would do well on outcome measures regardless of curriculum change. The highly selective admissions process and the high quality of students could support the finding of a negligible change in the measures of knowledge and skills chosen in this study. A third option is that unaccounted-for variables are possible reasons for the findings.

Unaccounted-for Variables

This research has attempted to take into consideration the different variables that could affect student performance, such as entry performance on standardized tests and, grade point averages overall, more specifically in the sciences. There has also been an attempt to rule out any significant differences due to demographics of the two student groups, such as racial identify and gender. However, after all of this has been taken into consideration, accountability for all variables has not been achieved. As an example, it is difficult to re-assess if there are any micro-generational differences between the two cohorts that would create a difference in their performance. There may be other variables, such as the effect of the undergraduate school that each student attended, which we were not able to address in this project. As Major and Palmer (2001) suggest, some of these students may be socialized as passive learners through the many years of schooling leading up to matriculation at dental school.

There may also be some programmatic variables that were not considered in this project. The Pacific Dugoni has normal turnover of faculty, as compared to

any other academic program, and we were not able to assess any differences that may have arisen because of the different faculty member cohorts during the matriculation time of the six classes covered in this study. Faculty may have an effect on grades in the different disciplines that would affect the didactic, lab / clinic, and cumulative grade point averages. Faculty and administrative changes may also affect the way that a curriculum is managed and deployed. Although our qualitative review has given a description of how reforms were incorporated into the curriculum at Pacific Dugoni, there still may have been differences in the use of case-based learning and multidisciplinary teaching between faculty members over the six years of this study.

Finally, there are a host of macro environmental factors occurring outside of the Pacific Dugoni that may have affected the results of this study. There are changes in dental education being discussed on a national level, new dental schools being developed, and increasing discussions of global collaboration. All of these factors may affect the applicant pools, faculty, and goals of a dental education.

Curriculum Design

Curriculum design is a high-stakes operation for any educational program. One responsibility given to the faculty by the school dean is to manage an effective curriculum that will facilitate the necessary learning opportunities for students so that they achieve stated programmatic goals.

Because of this great responsibility in shaping the future of each learner, change is often delayed or feared by the professorate. However, the world continues to change with new knowledge, technology, and need, so a curriculum must be developed that allows for some flexibility to adapt.

Any curricular redesign requires visionary and dedicated faculty and staff who will work with the students and the community to move forward with a holistic plan in support of the school mission.

Recommendations for Additional Research

There are alternative assessments that may be more appropriate for this more active approach to adult learning. Formative and summative assessments, such as essays, writing samples, oral presentations, portfolios, practicals, and project-based studies, . have been shown in the literature to more accurately assess outcomes of a CBL approach used with small groups in a multidisciplinary setting. (Major, 2001)

Upon reflection, this study suggests a need for the development of an assessment program or instrument that will allow the dental school to evaluate the impact of changes in the curriculum that are not readily assessed by traditional measures like National Board exams. Such an assessment program should be created with rich input and study so that it is valid and reliable in determining overall student knowledge and skills to practice dentistry. This foundation should include critical thinking and problem-solving abilities necessary to cope with the ever-evolving nature of the art and science of a profession such as oral healthcare.

The author recommends a collaborative research project with other schools of dentistry in the development of appropriate internal assessment tools for dental schools. These tools would enable us to monitor student progress along the road to becoming a competent practitioner and professional.

Summary and Implications

This is an exciting and challenging time for professional higher education and more specifically, dental education. We are in a period of rebirth as practitioners of the profession of dentistry and educators come collaborate to develop best practices in the organization and management of a dental curriculum. This study is one small step in evaluating the many changes that are occurring in the global dental education arena, which we hope will encourage others to reflect on their programs and begin to assess whether or not the desired outcomes are being met.

Although the findings of this study were not conclusive, we know that higher education requires higher-order learning, and students must be able to function at high levels to synthesize and apply knowledge to solve new and unusual problems. In educational terms, students must achieve a level of synthesis as described in Bloom's taxonomy (Bloom, 1968). A multidisciplinary case-based approach lends itself to the synthesis of information and evaluation of outcomes. It provides one method for delivering the type of learning opportunity necessary in dentistry (Garvey, et al., 2000; LaVere, et al., 1996; Prystowsky, et al., 2001).

The full implementation of this curriculum model is estimated to take five years to phase in by the faculty and administration of the school of dentistry. Planning for the overall curriculum has included several key components:

1. Review of the desired outputs from this curricular reform; and
2. Input variables that are a vital component of any curriculum.

Figure 8 depicts a brief listing of the outputs that would include student competencies for practicing dentistry and the achievement of the school mission. The figure also depicts some inputs, such as applicant characteristic and the right number of faculty and development programs that will allow for successful implementation of the curriculum.

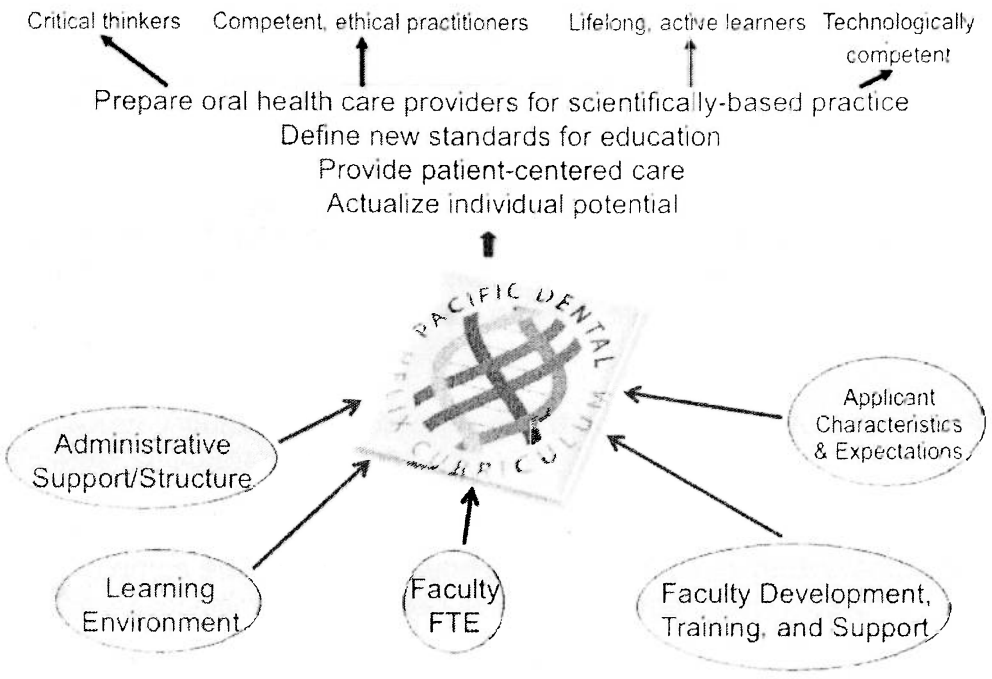

Figure 8. Curriculum Support Model

This study shows that there is a great need for the development of assessment instruments to measure change in the development and implementation of dental curricula around the globe, thus ensuring that the intended outcomes are being achieved. This information should then be shared as a part of a collaborative effort to communicate the design and content of what is done at each dental school, raising raise the bar for dental education and ultimately dental care throughout the world.

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APPENDIX A

Advancing Greatness

UNIVERSITY OF THE
PACIFIC
Arthur A. Dugoni
School of Dentistry

Strategic Plan

June 12, 2007

Strategy is about what our School does, what we want to become, and most important, how we plan to get there. The University of the Pacific Arthur A. Dugoni School of Dentistry has a rich tradition on which to create a bold and dynamic strategic plan to advance our School to a new level of greatness. Our School has many unique attributes, but among its most distinguishing features are the following:

- Leadership and innovation
- The humanistic model of education
- Clinical excellence
- Three-year curriculum
- Alumni allegiance
- Family-like culture
- Life-long passion for Pacific

These features are central to both the past and future success of the Arthur A. Dugoni School of Dentistry. They are ***distinctive core competencies*** that constitute the "Dugoni Brand." It is what makes us unique within our University, to the profession and our alumni.

There are many significant issues facing dental education and our School. In choosing those issues that form the structure of the strategic plan, the following questions were carefully considered:

1. In addressing this issue, do we ***advance*** the vision, mission, and values of the Arthur A. Dugoni School of Dentistry and the University of the Pacific?
2. Does this issue provide ***opportunities*** to take the School in new and exceptional directions?
3. If not addressed, does this issue ***threaten*** the future of the School?

4. Do our stakeholders—faculty, students, staff, alumni, patients, and others—consider this issue ***important***?
5. Does this issue build on our ***distinctive core competencies***?
6. Is there ***evidence*** that the School should make this issue a priority?

Using these questions as criteria to ascertain the most critical issues facing the Arthur A. Dugoni School of Dentistry, this plan is organized around six strategic directions and 34 goals.

The Arthur A. Dugoni School of Dentistry

"Leading the improvement of health by advancing oral health"

Our Mission is to:

- Prepare oral healthcare providers for scientifically based practice
- Define new standards for education
- Provide patient centered care
- Discover and disseminate knowledge
- Actualize individual potential
- Develop and promote policies addressing the needs of society

The Core Values that characterize our School and define our distinctive identity are:

- Humanism—dignity, integrity, and responsibility
- Innovation—willingness to take calculated risks
- Leadership—modeling, inspiring, and mobilizing
- Reflection—using facts and outcomes for continuous improvement
- Stewardship—responsible use and management of resources
- Collaboration—partnering for the common good
- Philanthropy—investing time, talent and assets

Strategic Directions and Goals

Strategic directions summarize the major initiatives driving the plan. The goals that correspond to each strategic direction state what the School wishes to accomplish over the next approximately five years.

Pacific has enjoyed a rich tradition of leadership in teaching and the scholarship of learning. Dental education is experiencing a surge of change globally that focuses on the development of new signature pedagogies and the application of novel educational technologies. The School of Dentistry must continue its leadership as an innovator by

developing and implementing opportunities for learners to become outstanding oral healthcare practitioners who are critical thinkers invested in lifelong learning.

Strategic Direction 1: Lead educational innovation

Goals:

1.1 Advance the scholarship of teaching and learning
1.2 Develop faculty and staff to lead curricular change
1.3 Identify and implement best practices in curricular management
1.4 Harness technology to maximize learning
1.5 Nurture critical thinkers and lifelong learners
1.6 Promote the School's unique identity through the Dugoni brand to become an international leader in educational innovation and professional development

The Arthur A. Dugoni School of Dentistry must become a leader in formulating new and creative ways to face the health care challenges present in the local community, the nation, and the world. The School must not only educate oral health care providers in the delivery of dental services, but also in understanding the importance of oral health to overall health. It is our responsibility to develop professionals committed to improving the health of the public by nurturing future leaders, implementing innovative curricula including service learning, collaborating in private and public partnerships, and enhancing clinical care through cultural understanding and international collaborations.

Strategic Direction 2: Develop professionals committed to improving the health of all people

Goals:

2.1 Develop and enhance leadership skills to address societal needs
2.2 Integrate knowledge and experience about public health systems
2.3 Integrate oral to systemic health applications throughout the curriculum
2.4 Expand opportunities for service learning experiences in community sites
2.5 Collaborate with external entities to improve the oral health of the public both nationally and internationally
2.6 Enhance patient care and clinical education by increasing cultural understanding

Discovery and dissemination of new knowledge are essential to dental education. Those who are engaged in research and scholarship carry their creativity into the classroom to enhance teaching and learning, and through research opportunities students develop the ingrained habit of critical thinking and life-long learning. Enhancing research at Pacific requires the School of Dentistry to do a select number of things very well, rather than many things with mediocrity. Because one of our most distinguishing features is clinical excellence, we should also be committed to excellence in clinical and applied research. Our research efforts should be a source of pride internally and recognized as both meritorious and significant externally. The School must continue to develop partnerships

to achieve and maintain sufficient people, expertise and facilities to build research initiatives.

Strategic Direction 3: Build focused and valued research initiatives

Goals:

3.1 Identify unifying research themes focused on clinical, applied biomedical, educational and community-based research
3.2 Establish organizational structures to support research
3.3 Obtain resources to initiate and sustain research and scholarship efforts
3.4 Integrate discovery into the curriculum
3.5 Create collaborations to advance research

Realizing ambitious goals takes initiative and resources. The School of Dentistry, as an organization, possesses special qualities that make us a world leader in dental education. Using our strengths and expertise to provide progressive care for our patients and the professional development of our colleagues world-wide will define our position as a leader in oral health education, and will create new revenue streams to advance our goals.

Strategic Direction 4: Build upon the School's unique strengths to create and enhance revenue streams

Goals:

4.1 Create a professional development center
4.2 Develop high end dental service clinics
4.3 Utilize the Dugoni Brand to provide educational management services worldwide
4.4 Strengthen relationships with alumni and external stakeholders

People are Pacific's greatest asset. The success of the Arthur A. Dugoni School of Dentistry depends on a robust support structure that provides the necessary resources for individuals to develop and succeed. Resources include many things, from finances to opportunities to learn and grow professionally and personally. The development of people is fundamental to keeping them as members of the Pacific family. Pacific will reach new levels of excellence by enriching its culture so that the School of Dentistry continues to be a source of pride and inspiration and a fulfilling place to learn and work.

Strategic Direction 5: Create a resource rich, supportive and diverse culture to develop, retain, and recruit outstanding individuals

Goals:

5.1 Foster two-way communication and collaboration among faculty, students, staff and administration

5.2 Increase the diversity of faculty, students, staff, and administration
5.3 Provide opportunities to faculty and staff for professional and personal growth
5.4 Hold administrators, managers, and department chairs accountable for developing, evaluating, recognizing and promoting staff and faculty
5.5 Improve the organizational structure to strengthen operational efficiency
5.6 Enhance compensation for faculty and staff
5.7 Create a coordinated effort in describing, marketing, and filling all open positions
5.8 Develop an innovative recruitment plan geared toward creating future faculty from our current student body

The location of the Arthur A. Dugoni School of Dentistry in one of the world's most beautiful cities creates both challenges and opportunities. The cost of living and working in San Francisco, coupled with the increasing cost of higher education in general, means that the School must be innovative in maximizing its assets to insure its financial vitality. As its infrastructure evolves to meet changing needs, the School must renovate and build state-of-the-art multi-use facilities. Operational efficiency might also involve using additional facilities, both within and outside the city. Everything that the School of Dentistry does is affected by technology. Because technological advancements also come with increasing costs, the School must utilize its existing technology resources to their fullest. Emerging applications mean that the School must invest wisely in new technologies to improve education, research, patient care, and ways in which the members of the Pacific team work together.

Strategic Direction 6: Optimize our facility assets and technology investments

Goals:

6.1 Design contemporary, flexible facilities
6.2 Leverage the value of real estate assets
6.3 Improve the application of information technology
6.4 Explore the possibility of updated or additional facilities to enhance operational efficiency
6.5 Create the infrastructure to ensure business continuity in emergency situations

APPENDIX B

Implementation Plan

Action Agenda

June 1, 2008 – May 31, 2009

The agenda below is divided into four sections: (1) items for **Immediate Action**; (2) items that have high priority requiring **Significant Resources**; (3) items that have high priority requiring **Moderate Resources**; (4) items that have high priority with **Low Resource** requirements The **strategic direction and goal** from the strategic plan that corresponds to each item is referenced in parenthesis. Items presented in each section below do not reflect any particular order. A brief description of the management process follows the items. In addition, three documents are attached:

1. Updated summary tables of goal rankings and action step rankings colored coded to reflect the 12 month action agenda (from the May 4, 2008 report on the survey of the Deans' Cabinet and the Implementation Task Force);
2. Implementation Plan showing all goals, action steps, and actions steps color-coded to reflect the 12 month agenda, and linkages to strategic directions;
3. Example of a template for Progress Reports.

Immediate Action

1. Invite the Director of the Pacific Center for Teaching and Learning (CTL) to provide an active learning workshop at Faculty Development Day in June 2008 and on a monthly basis to provide assistance as identified in the Faculty Needs Survey. (1.2)
2. Develop formal evaluation system for Chairs, Associate and Assistant Deans. (5.4)
3. Establish formalized, comprehensive peer evaluation system. (5.4)
4. Improve the current evaluation system for Faculty and Staff. (5.4)
5. Retain the "scholarship of learning" in the portfolio of the Associate Dean for Academic Affairs to ensure representation at the Dean's cabinet level. (1.1)
6. Hire an innovative Academic Dean to review/revamp the curriculum. (3.4)
7. Combine the Basic Science Department into a Department of Biomedical Sciences. (1.5) Implementation Plan Page 2 Action Agenda for: June 1-2008 - May 31, 2009

8. Conduct bi-Annual Staff/Administration/Faculty Meetings. (5.1)
9. Post all positions internally within the school; including Faculty and Administrative Appointments - Consider: development of new process, posting sites/length, application forms, and search committees. (5.7)
10. Review and develop new action items corresponding to Mission Statement Item 6 (Develop and promote policies addressing the needs of society) and Strategic Direction 2 (Develop professionals committed to improving the health of all people).
11. Acknowledge, encourage and reward students and residents for volunteerism and service-learning projects. (2.1)

Action Items Requiring Significant Resources

1. Acquire and implement a comprehensive electronic patient record system. (1.4)
2. Complete a facility master plan to include: teaching (all learning spaces), research, faculty practice, labs, continuing education, and technology needs. The plan should recognize the priority of the clinics and maximize space utilization throughout the School. (6.1)

Action Items Requiring Moderate Resources

1. More clearly define "scholarship of teaching and learning" (SoTL) to maximize the benefit of this activity for faculty promotion and tenure. (1.1)
2. Align IT, Instructional Development and Classroom Services support functions and staff to assist faculty with adopting current developments in technology; make greater use of existing educational technology and learning materials; create a training program for faculty and staff in optimal use of educational technology. (1.4)
3. Conduct a competitive salary review and develop an implementation plan. (5.6)
4. Create integrated biomedical science courses (Internal Medicine for Dentist and Infectious Diseases) that dovetail with the Integrated Clinical Sciences course; develop a curriculum integration plan that is customized to Pacific's three-year program with vertical integration (3.4); expand the use of case-based learning and format across the curriculum for evidence-based decisions (2.3)

Action Items with Low Resource Requirements

1. Conduct a comprehensive review of current curriculum management with recommendations for comprehensive curriculum management. (1.3)

Implementation Plan Page 3 Action Agenda for: June 1-2008 - May 31, 2009

2. Evaluate extramural rotation blocks for opportunities to improve the educational experience via an Advising Council of students, staff and rotation faculty, chairs and community health professionals. (2.4)
3. Establish relationship with the Center for Teaching and Learning (Stockton Campus) to promote research on teaching and learning. (3.5)
4. Develop standing committee for all diversity issues. (Gender, Race, Ethnicity, Age, Religion, Sexual Orientation, Cultural, etc.) (5.2)
5. Raise the faculty's awareness of the Commission on Change and Innovation (CCI), as well as of innovations being adopted by other schools. (1.3)

Management of the Action Agenda

1. The Dean will assign oversight to each action item to a member of the Dean's Cabinet.
2. The Dean's Cabinet will review the action agenda each quarter to determine process, identify items completed, and add additional items to the agenda as warranted.
3. Annually, the Dean's Cabinet will conduct an extensive review of the Implementation Plan and through a collaborative process involving faculty, staff, and student input; establish an action agenda for subsequent 12-month periods.

APPENDIX C

STRATEGIC PLAN IMPLEMENTATION THEMES RELATED TO LEADING EDUCATIONAL INNOVATION

Prepare oral health care providers for scientifically base practice :

Integrate Biomedical, Clinical, and Professional studies

1) Expand prevention and public health curriculum themes across all 3 years.
2) Create integrated biomedical science courses (Internal Medicine for Dentist and Infectious Diseases) that dovetail with the Integrated Clinical Sciences course.
3) Expand the use of case-based learning format across the curriculum (Evidence Based Decisions).
4) Develop a curriculum innovation plan that is customized to Pacific's three year program with integration as a main theme.

Advance Learner-centered approaches to dental education

Educational Innovation

1) Create a "Laboratory (Center) for the Development, Implementation and Evaluation of Innovations in Teaching and Learning".
2) Develop and implement new paradigms in teaching and learning with the emphasis placed on active/independent learning, case-based and case-assisted learning and greater use of emerging educational technologies.
3) Re-evaluate the "purpose of a lecture." Determine what concept is appropriate for lectures and minimize their use as the instructional method of choice. Limit lecture time to topics where the lecture is deemed the most appropriate format.
4) Provide 2nd and 3rd year students with research time blocks built into the curriculum.

Infrastructure

5) Combine the Basic Science Department into a Department of Biomedical Sciences.
6) Explore the possibility of converting underutilized space into places that will match our plan for future teaching and learning. Review current learning spaces, clinic, lecture, lab, etc. to ensure optimal fit for future educational program.
7) Create small, informal spaces for collaborative learning within the School.
8) Make greater use of existing web-based learning materials.
9) Facilitate collaborative learning by adopting appropriate technologies (e.g. the concept of a virtual coffee shop)

APPENDIX D

QUANTITATIVE DATA ANALYSIS

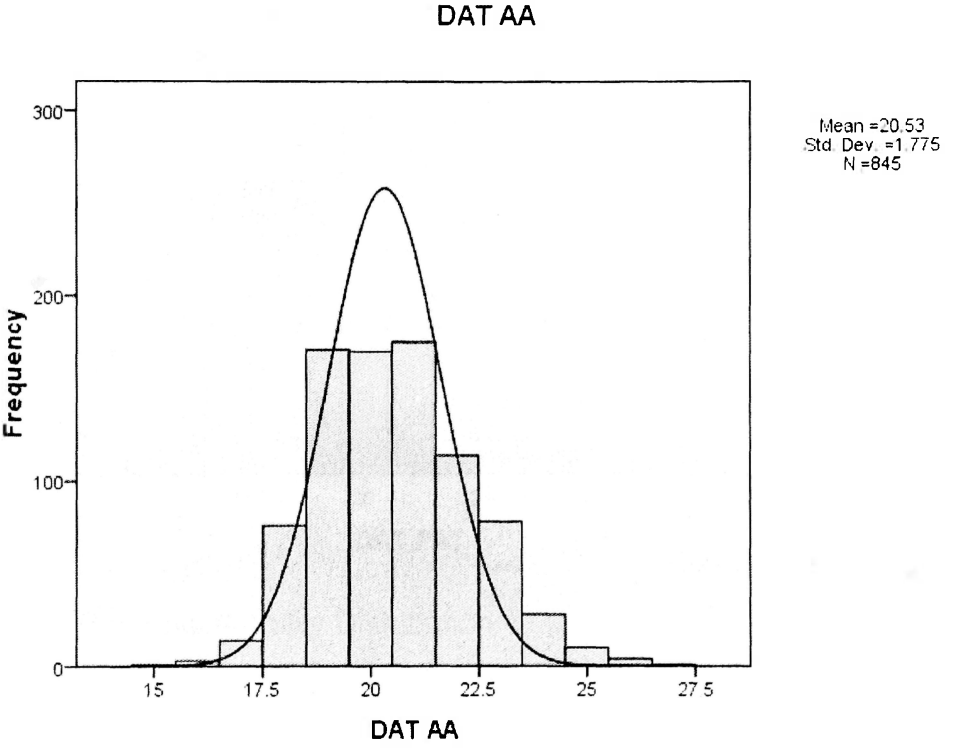

Figure D1: Academic Average Distribution

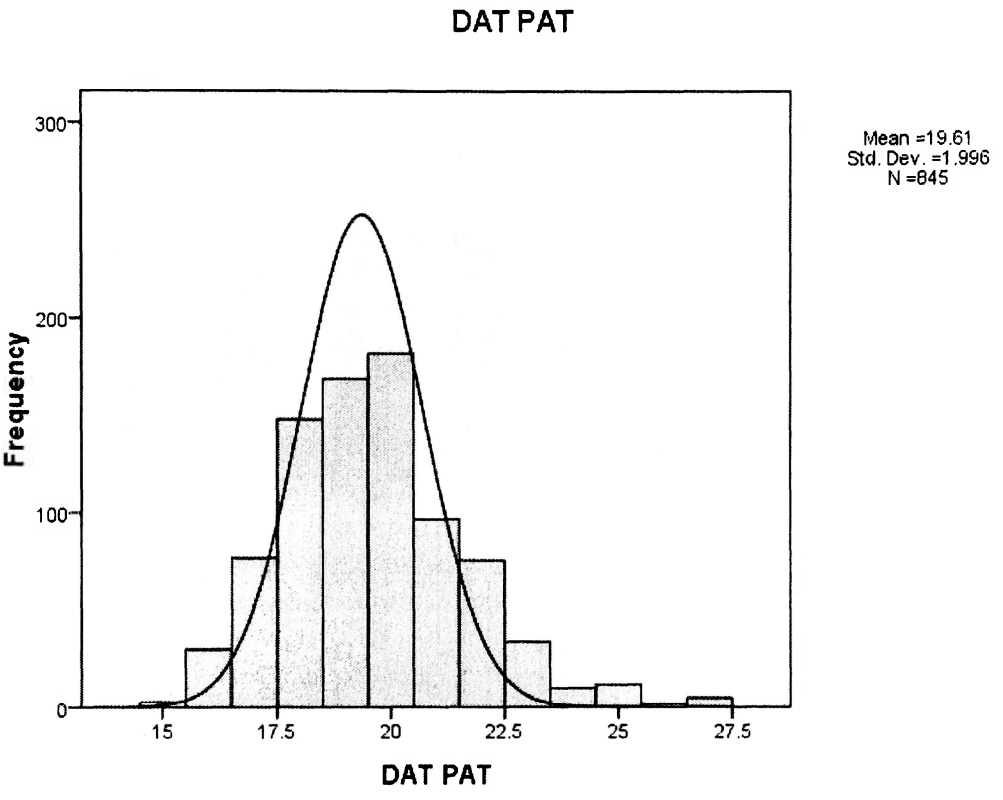

Figure D2:. Perceptual Ability Distribution

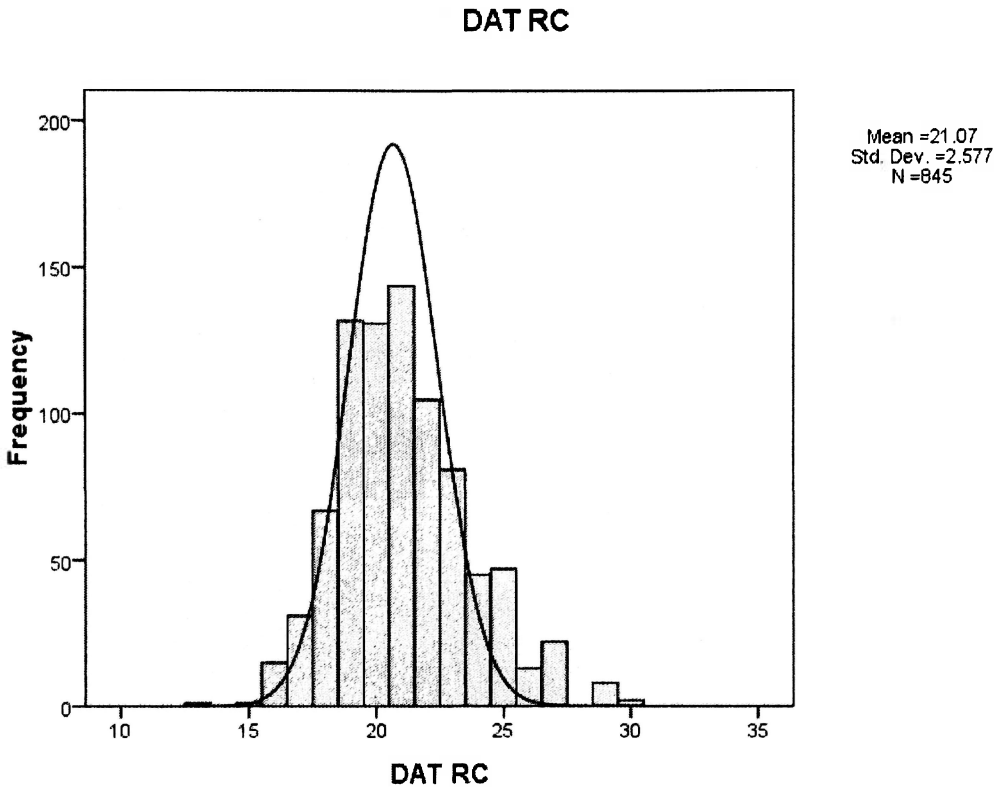

Figure D3:. Reading Comprehension Distribution

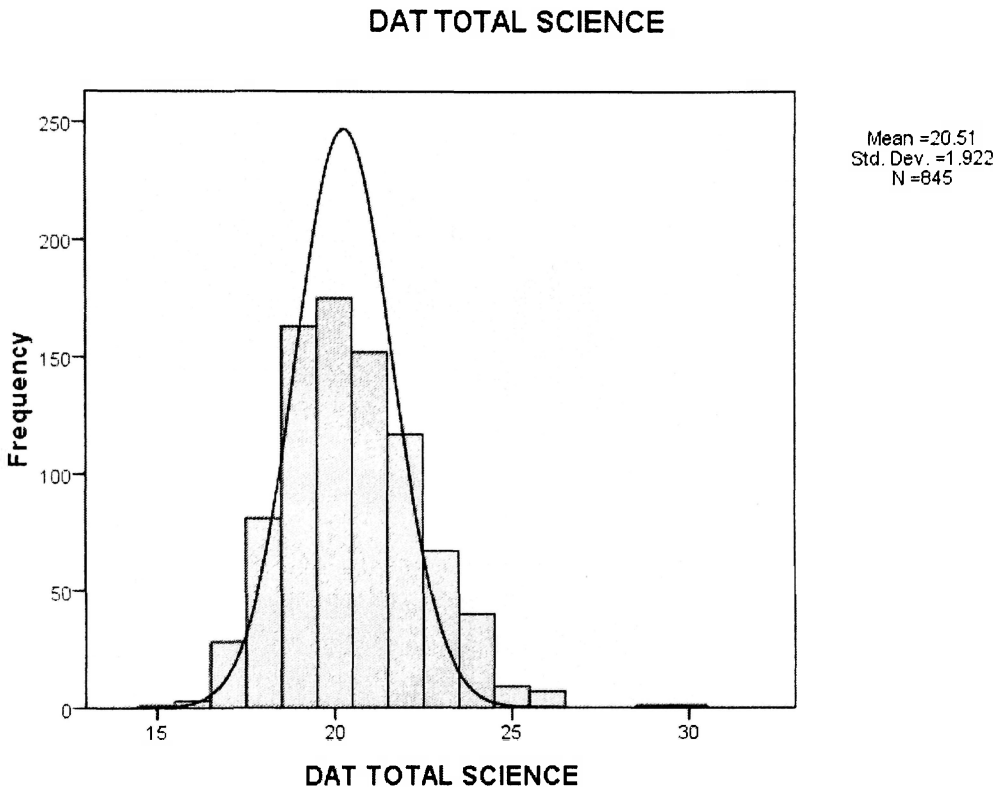

Figure D4:. Total Science Distribution

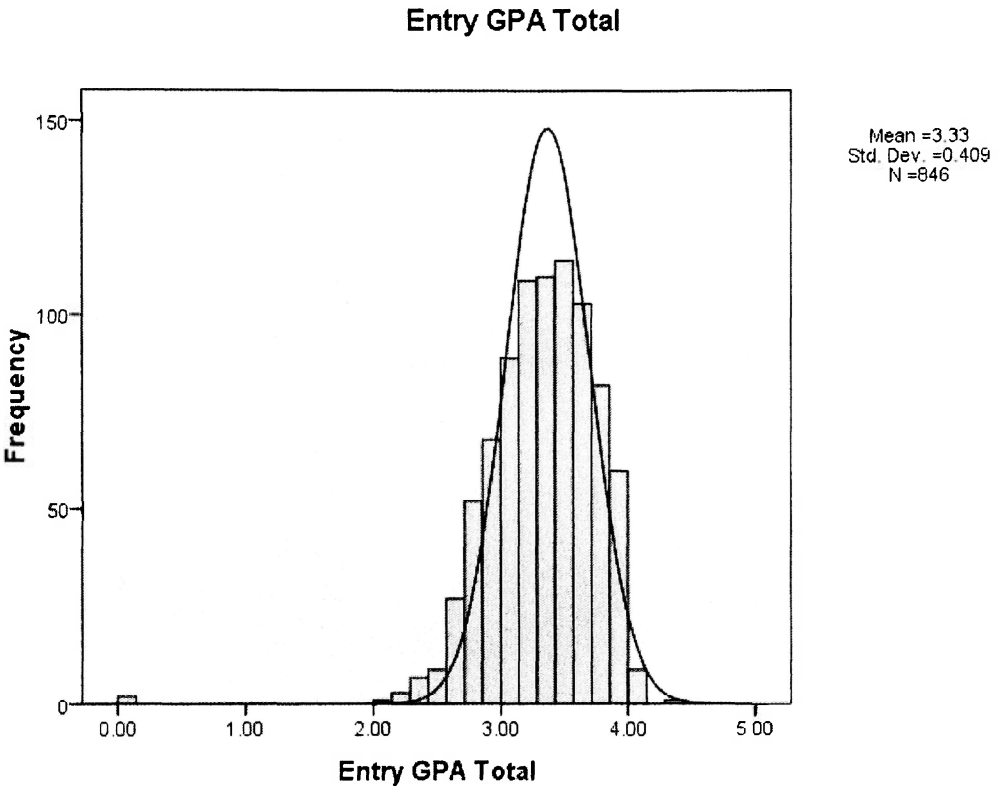

Figure D5: . GPA Distribution

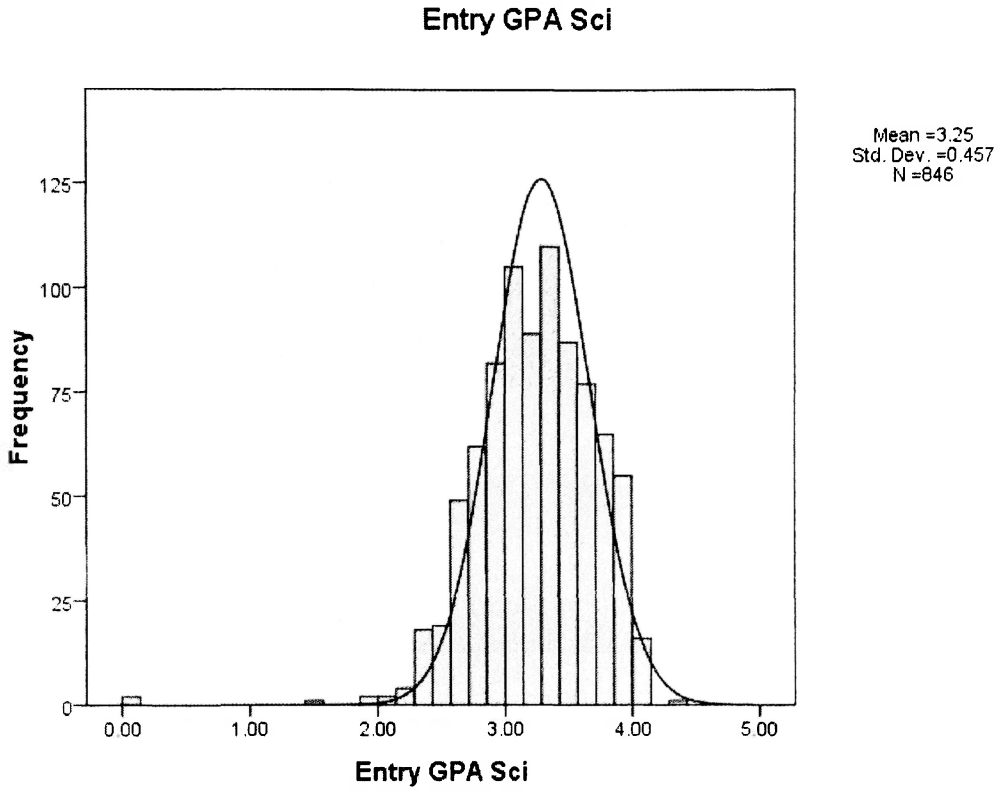

Figure D6: . GPA Science Distribution

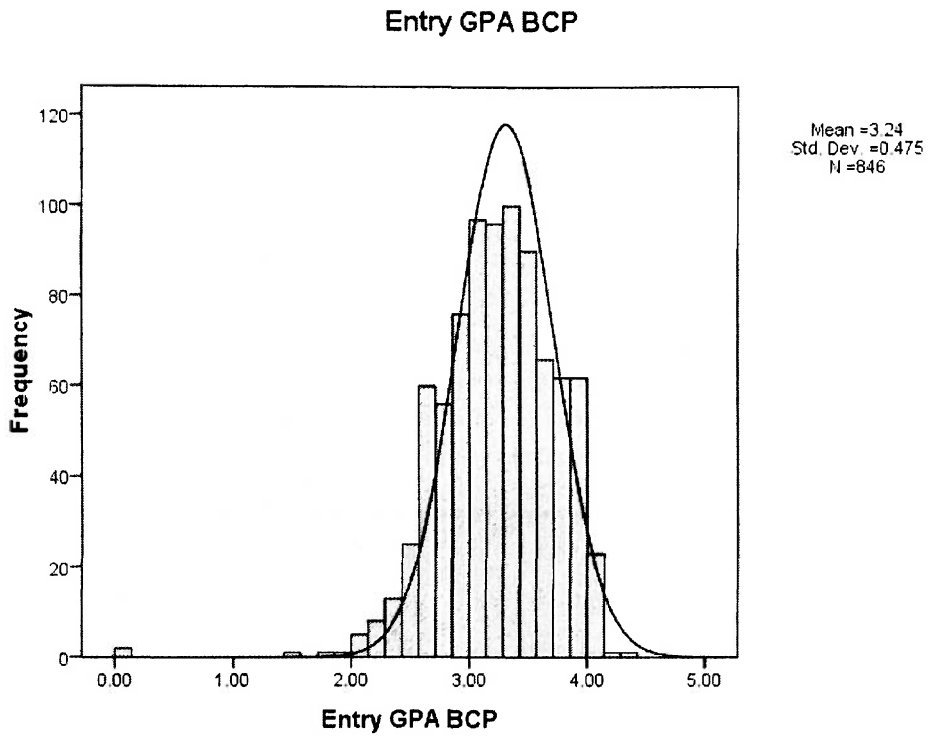

Figure D7: GPA Biology, Chemistry, Physics Distribution

Table D1: Gender Cross Tabulation

		Gender		Total
		Male	Female	
Cohort	1	284	141	425
	2	278	153	431
Total		562	294	856

Table D2: Gender Chi-square Test

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.512[a]	1	474		
Continuity Correction[b]	414	1	.520		
Likelihood Ratio	.512	1	474		
Fisher's Exact Test				.517	.260
Linear-by-Linear Association	.511	1	.475		
N of Valid Cases	856				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 145.97.

b. Computed only for a 2x2 table

Table D3 : Gender and Degree Earned Cross Tabulation

Degree			Gender		Total
			Male	Female	
No	Cohort	1	68	28	96
		2	68	30	98
	Total		136	58	194
Yes	Cohort	1	216	113	329
		2	210	123	333
	Total		426	236	662

Table D4: Gender and Degree Earned Chi-Square

Degree		Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
No	Pearson Chi-Square	.048[a]	1	.826		
	Continuity Correction[b]	.004	1	.950		
	Likelihood Ratio	.048	1	.826		
	Fisher's Exact Test				.876	.475
	Linear-by-Linear Association	.048	1	.826		
	N of Valid Cases	194				
Yes	Pearson Chi-Square	.484[c]	1	.487		
	Continuity Correction[b]	.378	1	.539		
	Likelihood Ratio	.484	1	.487		
	Fisher's Exact Test				.517	.269
	Linear-by-Linear Association	.483	1	.487		
	N of Valid Cases	662				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 28.70.

b. Computed only for a 2x2 table

c. 0 cells (.0%) have expected count less than 5. The minimum expected count is 117.29.

Table D5: Under-represented Minority Cross Tabulation

		URM		Total
		Non-URM	URM (BLA/HIS/AMI)	
Cohort	1	392	33	425
	2	388	43	431
Total		780	76	856

Table D6: Under-represented Minority Chi Square

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.294[a]	1	.255		
Continuity Correction[b]	1.035	1	.309		
Likelihood Ratio	1.298	1	.255		
Fisher's Exact Test				.280	.154
Linear-by-Linear Association	1.293	1	.256		
N of Valid Cases	856				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 37.73.

b. Computed only for a 2x2 table

Table D7: Under-represented Minority and Degree Earned Cross Tabulation

Degree			URM		Total
			Non-URM	URM (BLA/HIS/AMI)	
No	Cohort	1	88	8	96
		2	87	11	98
	Total		175	19	194
Yes	Cohort	1	304	25	329
		2	301	32	333
	Total		605	57	662

Table D8: Under-represented Minority and Degree Earned Chi-square

Degree		Value	df	Asymp Sig (2-sided)	Exact Sig (2-sided)	Exact Sig (1-sided)
No	Pearson Chi-Square	459[a]	1	498		
	Continuity Correction[b]	190	1	663		
	Likelihood Ratio	461	1	497		
	Fisher's Exact Test				630	332
	Linear-by-Linear Association	456	1	499		
	N of Valid Cases	194				
Yes	Pearson Chi-Square	850[c]	1	356		
	Continuity Correction[b]	614	1	433		
	Likelihood Ratio	853	1	356		
	Fisher's Exact Test				407	217
	Linear-by-Linear Association	849	1	357		
	N of Valid Cases	662				

a 0 cells (0%) have expected count less than 5 The minimum expected count is 9 40

b Computed only for a 2x2 table

c 0 cells (0%) have expected count less than 5 The minimum expected count is 28 33

Table D9: Year 1 and 2 Comparison

	Year	N	Mean	Std. Deviation	Std. Error Mean
NBI Score	1	132	84.98	4.094	.356
	2	139	85.16	4.569	.388
NBII Score	1	131	81.37	4.196	.367
	2	139	81.23	3.699	.314
1st Year GPA Didactic	1	131	2.9302	.56317	.04920
	2	138	3.0208	.49105	.04180
1st Year GPA Lab Clinic	1	131	2.9749	.51596	.04508
	2	138	3.0065	.45859	.03904
2nd Year GPA Didactic	1	130	3.0545	.51672	.04532
	2	139	3.1047	.46103	.03910
2nd Year GPA Lab Clinic	1	130	3.0995	.44021	.03861
	2	139	3.0863	.39564	.03356
3rd Year GPA Didactic	1	129	3.0739	.48533	.04273
	2	139	3.0873	.43981	.03730
3rd Year GPA Lab Clinic	1	129	3.1361	.40448	.03561
	2	139	3.0777	.38933	.03302

Table D10: Year 1 and Year 2 T-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
	Equal variances	F	Sig	t	df	Sig (2-tailed)	Mean Difference	Std Error Difference	Lower	Upper
NBI Score	assumed	1 545	215	- 328	269	743	- 173	528	-1 213	866
	not assumed			- 329	268 110	742	- 173	526	-1 210	863
NBII Score	assumed	2 151	144	283	268	777	136	481	- 810	1 083
	not assumed			282	259 206	778	136	483	- 814	1 086
1st Year GPA Didactic	assumed	4 573	033	1 408	267	160	- 09057	06433	- 21723	03610
	not assumed			1 403	257 894	162	- 09057	06456	- 21771	03657
1st Ye GPA Lab Clinic	assumed	1 152	284	- 532	267	595	- 03164	05945	14869	08542
	not assumed			- 531	259 569	596	- 03164	05963	- 14906	08579
2nd Year GPA Didactic	assumed	2 980	085	- 843	267	400	- 05029	05963	- 16769	06712
	not assumed			- 840	258 598	402	- 05029	05986	- 16816	06758
2nd Year GPA Lab Clinic	assumed	1 290	257	259	267	796	01321	05097	- 08715	11357
	not assumed			258	259 232	796	01321	05115	- 08752	11394
3rd Year GPA Didactic	assumed	1 725	190	- 238	266	812	- 01346	05652	12474	09781
	not assumed			- 237	258 295	813	- 01346	05672	- 12516	09824
3rd Year GPA Lab Clinic	assumed	164	686	1 205	266	229	05843	04850	- 03706	15391
	not assumed			1 203	262 644	230	05843	04857	- 03720	15406

Table D11: Year 2 and 3 Comparison

	Year	N	Mean	Std Deviation	Std Error Mean
NBI Score	2	139	85 16	4 569	388
	3	140	85 51	4 042	342
NBII Score	2	139	81 23	3 699	314
	3	140	82 24	4 078	345
1st Year GPA Didactic	2	138	3 0208	49105	04180
	3	139	3 0688	53584	04545
1st Year GPA Lab Clinic	2	138	3 0065	45859	03904
	3	139	2 9231	50678	04298
2nd Year GPA Didactic	2	139	3 1047	46103	03910
	3	140	3 1135	46613	03940
2nd Year GPA Lab Clinic	2	139	3 0863	39564	03356
	3	140	3 0776	38990	03295
3rd Year GPA Didactic	2	139	3 0873	43981	03730
	3	140	3 0759	43863	03707
3rd Year GPA Lab Clinic	2	139	3 0777	38933	03302
	3	140	3 0925	37653	03182

Table D12: Year 2 and Year 3 T-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
	Equal varian-ces	F	Sig.	t	df	Sig. (2-tailed)	Mean Differ-ence	Std. Error Difference	Lower	Upper
NBI Score	assumed	1.507	.221	-.689	277	.491	-.356	.516	-1.373	.660
	not assumed			-.689	272.464	.491	-.356	.517	-1.373	.661
NBII Score	assumed	1.733	.189	2.172	277	.031	-1.013	.466	-1.931	-.095
	not assumed			-2.173	274.775	.031	-1.013	.466	-1.930	-.095
1st Year GPA Didactic	assumed	1.941	.165	-.778	275	.437	-.04805	.06177	-.16965	.07355
	not assumed			.778	273.258	.437	-.04805	.06175	-.16962	.07351
1st Ye GPA Lab Clinic	assumed	.763	.383	1.436	275	.152	.08343	.05809	-.03092	.19778
	not assumed			1.437	272.673	.152	.08343	.05807	-.03089	.19774
2nd Year GPA Didactic	assumed	.092	.762	-.158	277	.875	-.00875	.05551	-.11803	.10052
	not assumed			-.158	276.996	.875	-.00875	.05551	.11802	.10052
2nd Year GPA Lab Clinic	assumed	.165	.685	.185	277	.854	.00869	.04703	-.08389	.10127
	not assumed			.185	276.868	.854	.00869	.04703	-.08390	.10127
3rd Year GPA Didactic	assumed	.003	.953	.217	277	.828	.01141	.05259	-.09212	.11494
	not assumed			.217	276.973	.828	.01141	.05259	-.09212	.11494
3rd Year GPA Lab Clinic	assumed	.494	.483	-.323	277	.747	-.01480	.04586	-.10507	.07547
	not assumed			-.323	276.544	.747	-.01480	.04586	-.10508	.07548

Table D13: Year 3 and 4 Comparison

	Year	N	Mean	Std. Deviation	Std. Error Mean
NBI Score	3	140	85.51	4.042	.342
	4	138	85.75	4.656	.396
NBII Score	3	140	82.24	4.078	.345
	4	139	80.98	4.247	.360
1st Year GPA Didactic	3	139	3.0688	.53584	.04545
	4	139	3.1097	.56003	.04750
1st Year GPA Lab Clinic	3	139	2.9231	.50678	.04298
	4	139	2.8776	.47149	.03999
2nd Year GPA Didactic	3	140	3.1135	.46613	.03940
	4	140	3.0832	.50278	.04249
2nd Year GPA Lab Clinic	3	140	3.0776	.38990	.03295
	4	140	2.9566	.39367	.03327
3rd Year GPA Didactic	3	140	3.0759	.43863	.03707
	4	139	3.0559	.47920	.04065
3rd Year GPA Lab Clinic	3	140	3.0925	.37653	.03182
	4	139	3.0676	.36017	.03055

Table D14: Year 3 and Year 4 T-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
	Equal variances	F	Sig	t	df	Sig (2-tailed)	Mean Difference	Std Error Difference	Lower	Upper
NBI Score	assumed	3 344	069	- 444	276	657	- 232	523	-1 261	797
	not assumed			- 444	269 541	658	- 232	523	-1 262	798
NBII Score	assumed	325	569	2 537	277	012	1 264	498	283	2 246
	not assumed			2 536	276 371	012	1 264	499	283	2 246
1st Year GPA Didactic	assumed	369	544	- 622	276	535	- 04086	06574	- 17028	08856
	not assumed			- 622	275 463	535	- 04086	06574	- 17028	08856
1st Ye GPA Lab Clinic	assumed	1 082	299	774	276	439	04547	05871	- 07011	16105
	not assumed			774	274 574	439	04547	05871	- 07011	16105
2nd Year GPA Didactic	assumed	641	424	523	278	602	03029	05794	- 08378	14435
	not assumed			523	276 422	602	03029	05794	- 08378	14435
2nd Year GPA Lab Clinic	assumed	020	887	2 584	278	010	12100	04683	02882	21318
	not assumed			2 584	277 974	010	12100	04683	02882	21318
3rd Year GPA Didactic	assumed	752	387	364	277	716	02003	05499	- 08823	12829
	not assumed			364	274 501	716	02003	05501	- 08827	12833
3rd Year GPA Lab Clinic	assumed	006	938	564	277	573	02487	04412	- 06198	11173
	not assumed			564	276 617	573	02487	04411	- 06197	11171

Table D15: Year 4 and 5 Comparison

	Year	N	Mean	Std. Deviation	Std. Error Mean
NBI Score	4	138	85.75	4.656	.396
	5	139	85.08	5.210	.442
NBII Score	4	139	80.98	4.247	.360
	5	138	81.48	4.443	.378
1st Year GPA Didactic	4	139	3.1097	.56003	.04750
	5	138	3.0191	.56686	.04825
1st Year GPA Lab Clinic	4	139	2.8776	.47149	.03999
	5	138	2.8682	.45219	.03849
2nd Year GPA Didactic	4	140	3.0832	.50278	.04249
	5	138	3.1405	.46537	.03961
2nd Year GPA Lab Clinic	4	140	2.9566	.39367	.03327
	5	138	3.0259	.35384	.03012
3rd Year GPA Didactic	4	139	3.0559	.47920	.04065
	5	138	3.1128	.44712	.03806
3rd Year GPA Lab Clinic	4	139	3.0676	.36017	.03055
	5	138	3.0612	.32759	.02789

Table D16: Year 4 and Year 5 T-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
	Equal variances	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
NBI Score	assumed	2.791	.096	1.124	275	.262	.667	.594	-.502	1.836
	not assumed			1.124	272.015	.262	.667	.594	-.501	1.836
NBII Score	assumed	.041	.839	-.957	275	.339	-.500	.522	-1.528	.528
	not assumed			-.957	274.248	.339	-.500	.522	-1.528	.528
1st Year GPA Didactic	assumed	.187	.666	1.338	275	.182	.09058	.06771	-.04271	.22388
	not assumed			1.338	274.897	.182	.09058	.06771	-.04272	.22388
1st Ye GPA Lab Clinic	assumed	.003	.956	.170	275	.865	.00944	.05551	-.09985	.11873
	not assumed			.170	274.672	.865	.00944	.05551	-.09983	.11871
2nd Year GPA Didactic	assumed	.692	406	-.986	276	.325	-.05729	.05813	-.17172	.05714
	not assumed			-.986	274.917	.325	-.05729	.05809	-.17166	.05707
2nd Year GPA Lab Clinic	assumed	1.575	.211	1.541	276	.124	-.06923	.04491	-.15764	.01919
	not assumed			1.542	273.688	.124	-.06923	.04488	-.15758	.01913
3rd Year GPA Didactic	assumed	.320	.572	1.022	275	.308	-.05693	.05570	-.16658	.05272
	not assumed			1.022	273.948	.308	-.05693	.05568	-.16655	.05270
3rd Year GPA Lab Clinic	assumed	1.422	.234	.155	275	.877	.00639	.04138	-.07506	.08785
	not assumed			.155	272.919	.877	.00639	.04136	-.07504	.08783

Table D17: Year 5 and 6 Comparison

	Year	N	Mean	Std. Deviation	Std. Error Mean
NBI Score	5	139	85.08	5.210	.442
	6	138	82.22	4.660	.397
NBII Score	5	138	81.48	4.443	.378
	6	135	81.12	4.462	.384
1st Year GPA Didactic	5	138	3.0191	.56686	.04825
	6	138	3.1049	.56543	.04813
1st Year GPA Lab Clinic	5	138	2.8682	.45219	.03849
	6	138	2.9161	.49344	.04200
2nd Year GPA Didactic	5	138	3.1405	.46537	.03961
	6	136	3.2334	.45475	.03899
2nd Year GPA Lab Clinic	5	138	3.0259	.35384	.03012
	6	136	3.0856	.41296	.03541
3rd Year GPA Didactic	5	138	3.1128	.44712	.03806
	6	136	3.1883	.44275	.03797
3rd Year GPA Lab Clinic	5	138	3.0612	.32759	.02789
	6	136	3.0807	.40265	.03453

Table D18: Year 5 and Year 6 T-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
	Equal varian-ces	F	Sig.	t	df	Sig. (2-tailed)	Mean Differ-ence	Std. Error Difference	Lower	Upper
NBI Score	assumed	1.946	.164	4.817	275	.000	2.862	.594	1.692	4.031
	not assumed			4.819	272.065	.000	2.862	.594	1.693	4.031
NBII Score	assumed	.030	.864	.667	271	.505	.360	.539	-.701	1.421
	not assumed			.667	270.812	.505	.360	.539	-.701	1.421
1st Year GPA Didactic	assumed	.167	.683	1.258	274	.210	-.08572	.06816	-.21990	.04845
	not assumed			1.258	273.998	.210	-.08572	.06816	-.21990	.04845
1st Ye GPA Lab Clinic	assumed	.362	.548	-.841	274	.401	-.04790	.05697	-.16006	.06426
	not assumed			-.841	271.938	.401	-.04790	.05697	-.16006	.06427
2nd Year GPA Didactic	assumed	.178	.673	1.671	272	.096	-.09288	.05560	-.20233	.01658
	not assumed			1.671	271.981	.096	-.09288	.05559	-.20231	.01656
2nd Year GPA Lab Clinic	assumed	3.440	.065	1.286	272	.200	-.05972	.04644	-.15114	.03170
	not assumed			1.285	264.553	.200	-.05972	.04649	-.15125	.03182
3rd Year GPA Didactic	assumed	.097	.756	1.404	272	.161	-.07548	.05376	-.18133	.03036
	not assumed			1.404	271.994	.161	-.07548	.05376	-.18132	.03035
3rd Year GPA Lab Clinic	assumed	6.046	.015	-.440	272	.660	-.01950	.04432	-.10675	.06774
	not assumed			-.439	259.685	.661	-.01950	.04438	-.10690	.06789

Table D19: Year 1 and 6 Comparison

	Year	N	Mean	Std. Deviation	Std. Error Mean
NBI Score	1	132	84.98	4.094	.356
	6	138	82.22	4.660	.397
NBII Score	1	131	81.37	4.196	.367
	6	135	81.12	4.462	.384
1st Year GPA Didactic	1	131	2.9302	.56317	.04920
	6	138	3.1049	.56543	.04813
1st Year GPA Lab Clinic	1	131	2.9749	.51596	.04508
	6	138	2.9161	.49344	.04200
2nd Year GPA Didactic	1	130	3.0545	.51672	.04532
	6	136	3.2334	45475	.03899
2nd Year GPA Lab Clinic	1	130	3.0995	.44021	.03861
	6	136	3.0856	41296	.03541
3rd Year GPA Didactic	1	129	3.0739	.48533	.04273
	6	136	3.1883	44275	.03797
3rd Year GPA Lab Clinic	1	129	3.1361	.40448	.03561
	6	136	3.0807	.40265	.03453

Table D20: Year 1 and Year 6 T-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
	Equal varian-ces	F	Sig.	t	df	Sig. (2-tailed)	Mean Differ-ence	Std. Error Difference	Lower	Upper
NBI Score	assumed	4.871	.028	5.175	268	.000	2.767	.535	1.715	3.820
	not assumed			5.190	266.100	.000	2.767	.533	1.717	3.817
NBII Score	assumed	.119	.731	.466	264	.641	.248	.531	-.798	1.294
	not assumed			.467	263.740	.641	.248	.531	-.797	1.293
1st Year GPA Didactic	assumed	.022	.883	2.537	267	.012	-.17463	.06884	-.31016	.03909
	not assumed			2.537	266.380	.012	-.17463	.06883	-.31015	.03910
1st Ye GPA Lab Clinic	assumed	.484	.487	.955	267	.340	.05880	.06154	-.06238	.17997
	not assumed			.954	264.521	.341	.05880	.06162	-.06252	.18012
2nd Year GPA Didactic	assumed	3.526	.062	3.001	264	.003	-.17892	.05961	-.29630	-.06154
	not assumed			2.993	256.418	.003	-.17892	.05979	-.29666	.06119
2nd Year GPA Lab Clinic	assumed	.576	.448	.267	264	.790	.01395	.05231	-.08905	.11695
	not assumed			.266	260.900	.790	.01395	.05239	-.08921	.11711
3rd Year GPA Didactic	assumed	1.792	.182	2.007	263	.046	-.11443	.05702	-.22671	.00215
	not assumed			2.002	257.631	.046	-.11443	.05716	-.22699	.00187
3rd Year GPA Lab Clinic	assumed	.003	.955	1.117	263	.265	.05539	.04960	-.04227	.15304
	not assumed			1.117	262.130	.265	.05539	.04960	-.04228	.15306

Table D21: Year 2 and 5 Comparison

	Year	N	Mean	Std. Deviation	Std. Error Mean
NBI Score	2	139	85.16	4.569	.388
	5	139	85.08	5.210	.442
NBII Score	2	139	81.23	3.699	.314
	5	138	81.48	4.443	.378
1st Year GPA Didactic	2	138	3.0208	.49105	.04180
	5	138	3.0191	.56686	.04825
1st Year GPA Lab Clinic	2	138	3.0065	45859	.03904
	5	138	2.8682	45219	.03849
2nd Year GPA Didactic	2	139	3.1047	.46103	.03910
	5	138	3.1405	46537	.03961
2nd Year GPA Lab Clinic	2	139	3.0863	.39564	.03356
	5	138	3.0259	.35384	.03012
3rd Year GPA Didactic	2	139	3.0873	.43981	.03730
	5	138	3.1128	.44712	.03806
3rd Year GPA Lab Clinic	2	139	3.0777	.38933	.03302
	5	138	3.0612	.32759	.02789

Table D22: Year 2 and Year 5 T-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
	Equal variances	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
NBI Score	assumed	4.732	.030	.135	276	.893	.079	.588	-1.078	1.236
	not assumed			.135	271.370	.893	.079	.588	-1.078	1.236
NBII Score	assumed	3.977	.047	-.505	275	.614	-.248	.491	-1.215	.719
	not assumed			-.505	265.587	.614	-.248	.491	-1.216	.720
1st Year GPA Didactic	assumed	6.094	.014	.026	274	.979	.00167	.06384	.12402	.12735
	not assumed			.026	268.540	.979	.00167	.06384	-.12403	.12736
1st Ye GPA Lab Clinic	assumed	.094	.759	2.523	274	.012	.13833	.05482	.03040	.24626
	not assumed			2.523	273.946	.012	.13833	.05482	.03040	.24626
2nd Year GPA Didactic	assumed	.071	.791	-.642	275	.521	-.03576	.05566	-.14534	.07382
	not assumed			-.642	274.924	.521	-.03576	.05566	-.14534	.07382
2nd Year GPA Lab Clinic	assumed	2.398	.123	1.340	275	.181	.06046	.04511	-.02835	.14927
	not assumed			1.341	272.057	.181	.06046	.04509	-.02831	.14924
3rd Year GPA Didactic	assumed	.067	.795	-.478	275	.633	-.02549	.05329	-.13040	.07942
	not assumed			-.478	274.845	.633	-.02549	.05329	-.13040	.07943
3rd Year GPA Lab Clinic	assumed	3.912	.049	.381	275	.704	.01647	.04325	-.06868	.10161
	not assumed			.381	267.811	.704	.01647	.04322	-.06863	.10156