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Utilizing learning style preferences and quality function deployment for curriculum development

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UTILIZING LEARNING STYLE PREFERENCES AND QUALITY FUNCTION DEPLOYMENT FOR CURRICULUM DEVELOPMENT

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ABSTRACT

Workplace requirements continually evolve to keep pace with the developing global market. To meet ever increasing standards, educational institutions have been investigating methods to prepare students for their future employment. Course modifications should be carefully considered to meet the requirements of all stakeholders, including those of the students. The objective of this research was to provide students with an overall better learning experience that tailors the teaching methods to his/her individual learning preferences. To meet this objective, a comprehensive survey was provided to an undergraduate course in quality. The survey documented the student's individuality when learning and made note of his/her expectations from the class. Quality Function Deployment, an organized approach to take the voice of the customer into the design of products and services, was utilized to determine class modifications. The results indicated the implemented techniques and tools were beneficial to the students and helped his/her comprehension of the course material. The analysis also suggests that students experienced a change in motivation throughout the semester. This shows that in some aspects more investigation is required in order to identify causes for the motivational shifts.

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SECTION

1. INTRODUCTION

Workplace requirements continually evolve to keep pace with the developing global market. Therefore, there is a need to inspire motivation, self-directed learning, and critical thinking skills to prepare students to remain competitive when seeking future employment. The objective of this study is to provide students with an overall better learning experience that tailors the teaching methods to his/her individual learning preferences

Various techniques have been used to measure intelligence, motivation, and learning styles in an attempt to interpret human differences. Three different instruments were used in the present study to assess the goals and abilities of the students. The three surveys include: 1) Theory of Multiple Intelligence (MI), 2) Visual-Auditory-Kinesthetic (VAK) learning style survey, and 3) Motivated Strategies for Learning Questionnaire (MSLQ). An integrated survey which combined the benefits of these individual surveys was utilized to evaluate the student's learning preferences and expectations from the class. Questions were pulled from these three well known existing surveys because each survey template has had significant contributions within academia and were applicable to this study.

Data collected from the students regarding motivation and learning preferences is compared with the curriculum capabilities using an approach called Quality Function Deployment (QFD). QFD provides a structured approach to evaluating which course modifications will best meet the customer needs given the allotted timeline and budget.

Since a large range of educational tools are becoming available, the HOQ helps narrow down the options and focus on the tools that will have the largest impact on meeting customers' needs. The desired outcome was to provide students with an overall better learning experience while improving efficiency and decreasing resistance to change.

PAPER

I. A SYSTEMATIC REVIEW OF TECHNOLOGICAL ADVANCEMENTS TO ENHANCE LEARNING

Julie M. Ezzell and Dr. Elizabeth A. Cudney

Abstract

Assessing student learning styles and incorporating thought-provoking activities has been a focus of research for years. Virtual technology and social media are transforming traditional classrooms into training spaces that can be tailored for individual learning patterns and personalized for different skill levels. These technological tools are not only revolutionizing the conventional lecture-based classroom but also beginning to incorporate options such as flipped and blended classrooms. Students in these nontraditional settings are given additional hands-on experience that allows them to become immersed in a variety of subjects. Flipped classrooms in particular use class time effectively by challenging students to prepare prior to class. In return the allotted time provides a place for students to work through problems and encourage cooperative learning. Furthermore, social media is being used to increase subject interest and boost class attendance by improving instructor and student interactions. These techniques challenge students enough to maintain focus while remaining within their capabilities to preserve student curiosity. Learning enhancement using these new teaching styles was assessed through surveys provided at the beginning and end of each experiment. The studies sampled students from a variety of backgrounds and skill sets including military, medical, and college students. Alternative and cost effective approaches are

revolutionizing learning to help improve each student's motivation, concentration, and confidence.

Introduction

Advances in modern technology are providing new tools that enhance both the extensive value of interactive education and the focus on motivational factors. These innovations in teaching and technology will be used to raise student expectations and spark excitement for continual learning development. Social media and virtual technology are flipping the traditional lecture-style classroom to boost class attendance, heighten student curiosity, and improve peer interaction.

Traditional instruction methods have demonstrated consistent success. They have also provided a basis for incorporating progressive learning exercises. The National Academy of Engineering (NAE) has identified that the engineers of 2020 need to have strong analytical and problem solving skills while being readily adaptable to advancing technologies in a globally connected world [(1)]. A classroom syllabus typically contains conventional lectures and a group project. It may also contain a business example provided by a guest lecture or case study. These current teaching methods have displayed positive results, but barriers between academia and industry can be made seamless by incorporating both advances in technology and motivational techniques [(2)]. Students will find the transition to be more cohesive after they have completed a curriculum that facilitates superior student understanding.

Initial Assessment: Learning Styles and Motivation

Understanding individual student learning styles and establishing a baseline for the classroom has been proven to increase motivation and improve learning. Each individual's learning style is inimitable because it is a product of individual genetics and life experiences. Every person has the ability to learn, but his/her motivation to learn increases when his/her unique learning style is accommodated. As a result, learning styles have been an interest of study for years. Larkin and Budny [3] evaluated the stimuli that affect each person's ability to perceive, interact with, and respond to his/her learning/working environment. They found that a focus on either learning style or personality type tells students that they are not only cared about but also respected as individuals. Overall, when students feel valued, their sense of self-worth and ability increases dramatically. The awareness and acknowledgement of individual differences is critical to an effective teaching approach.

Student motivation is often overlooked when performance measures are studied. Academic performance can however be enhanced when the factors that influence a student's motivation are initially understood. Students are encouraged to take action when combinations of short-term and long-term goals are incorporated into the classroom. Kirn and Benson [4] addressed the different aspects of engineering student motivation by providing a Motivations and Attitudes in Engineering (MAE) test to Bioengineering (BIOE) and Mechanical Engineering (ME) students. The test assessed the student's perception of his/her present and future abilities to be successful. These students were also given an assessment pertaining to his/her problem solving self-

efficacy. The additional assessment evaluated how motivation related to problem solving skills (short-term tasks) is distinct from a student's goal of obtaining an engineering degree (long-term goals). Kirn and Benson [4] found that student perceptions of the present, future, major-related expectancies, and problem-solving self-efficacy are distinct pieces of student motivation. Students who had progressed further in completing their majors had higher expectancies than students who had progressed less, despite being in the same required courses. The research of Kirn and Benson [4] demonstrates how understanding the differences in student motivations across major and degree progression can help better direct instructional change. Even with similar entry requirements to universities, tailoring instructional improvements will motivate students in ways more beneficial for learning.

The type of motivation a student receives during his/her education will frame his/her academic engagement, performance, and satisfaction. Dillon and Stolk [5] used a cluster analysis to explore student motivation and examine group-based motivation profiles within academic settings. They applied a self-determination theory (SDT) model to gain insight into students' perceived motivations in a college course environment. They used their results to explore the correspondence between a person's intrinsic motivations and his/her environment. Dillon and Stolk [5] also investigated how interactions satisfy the basic needs of autonomy, competence, and relatedness in regards to influencing a person's observable characteristics. Data was gathered from engineering students enrolled in four different materials courses at three predominantly undergraduate institutions. Participants were surveyed at the beginning and end of their term to assess

how various motivations fluctuated throughout the semester. The study results concluded engineering students adopt a range of situational motivations that do not fall neatly into the conventional “intrinsic” or “extrinsic” categories. They found that a large percentage of students simultaneously adopted both external and internal drives to engage in course activities. Several students adopted relatively stable motivations within a single course while others responded drastically over time. Examining both when and how these shifts occur will provide information that instructors can use to revise course activities to maximize internalized motivators.

Collaborative learning offers many benefits to students who are working within groups. These benefits contribute to higher level thinking skills, increased social interaction skills, higher academic achievements, and increased class attendance. Unfortunately, an instructor will typically need to invent a large amount of time grouping students into heterogeneous groups that accommodate their learning strengths. Building on this information, Chang and Lee [6] studied computer-assisted tests for heterogeneous grouping to improve the efficiency of collaborative learning activities. During the study, students participated in a Team-Game Tournament where they transitioned through three phases. Students were divided into heterogeneous groups during the first phase. Learners were then regrouped during the second phase and participated in a tournament to win points. Students were then returned to their original groups for reflection. During the third and final phase Chang and Lee [6] were able to use the results gathered from this study to demonstrate that computer-assisted evaluation can be a valuable tool for

computer supported collaborative learning. The computer-assistance decreased group selection time and utilized classroom time more effectively.

Technology and Techniques that Support Student Motivation

The learning process involves relationships, classroom settings, teaching techniques, learning processes, and feedback. Utilizing a combination of teaching techniques and available technology allows instructors to adjust classroom variables until they are most effective for the audience. Various techniques (e.g., flipped classrooms and blended classrooms) repurpose class time to emphasize the value of education and encourage the development of community learners.

Techniques

Flipped classrooms use digital resources to change the customary way a student completes homework following a lecture-style class. Jiugen et al. [7] noted that the teaching structure of a traditional classroom involves teaching before training while flipped classrooms utilize learning before training. When students learn the concepts before class, teachers are able to interact and explain lessons to the students on a deeper level. As a result, teachers can provide a personalized learning approach that not only guides students through their studies, but also caters to their individual learning needs. Thus, this new teaching method may play a role in enhancing students' interests and improving teachers' effectiveness.

Flipped classrooms challenge students to shift from passive learners to interactive participants. Flipped classrooms educate students by studying the lecture at home and

participate in homework under a fixed schedule in school. Chen and Chen [8] addressed classroom shortcomings (such as a lack of student input, the exclusion of a ubiquitous learning platform, and an insufficient emphasis on learning objectives) by preparing weekly schedules and monitoring student progress. This new learning system provided the students with three hours of videos to be completed at home and three hours of classroom hands-on interactions. Chen and Chen [8] also distributed a questionnaire that consisted of 50 close-ended items and 4 open-ended questions to help gauge each student's perception of the new educational system. Overall, most students were satisfied with the results and felt they had benefitted from the flipped classroom. Chen and Chen [8] also found several forms of student engagements had improved, including class attendance, exposed content, and student interactions.

New technology and teaching methods utilize both visual and interactive methods to increase students' knowledge while enhancing the learning experience. Martin et al. [9] applied the benefits of blended learning to help students visualize a step-by-step process when analyzing circuits. During the study, students watched a pre-recorded lecture before each class was actually held. They then used the classroom time to better understand both the circuits and their components before completing the homework.

Current trends in teaching include the incorporation of a "learning-by-doing" approach, particularly with younger students. Introducing flipped classrooms becomes more difficult for students with two or more years of learning in a traditional classroom. These advanced students have adapted to the traditional style of learning and may resist a

different style of instruction. Amresh et al. [10] conducted a study with first and second year engineering students to demonstrate how flipped classrooms improve learning while also teaching the principles of programming. Amresh et al. [10] utilized three classroom sections. Two used the flipped model, and the third used traditional practices. Both a midterm and a final exam were administered to evaluate student learning. The assessment summary revealed that students participating in the flipped model had higher average scores. Amresh et al. [10] also administered a survey that captured an increase in students' self-efficacy from pre- ($\mu = 53.3$) to post-scores ($\mu = 71.8$). Thus, flipped classrooms show promise in improving learning. They can, however, be expected to overwhelm and intimidate during the adjustment process.

When introducing new teaching styles, it is imperative that students understand how changes in education will contribute to their long-term development. Changes are commonly met with resistance, but opposition can often be diffused if students have some say in the process. Creating an environment that is engaging and energizing will improve student's understanding of the material and retention rates after transitioning into the work force. Although flipped classrooms require an adjustment period, this learning approach allows instructors to prepare students for problems outside the textbook. Bishop and Verleger [11] addressed the concern that engineering graduates lack the ability to solve real-world problems. Students commonly work on a senior-level end of curriculum problem, but otherwise students are only well trained in solving textbook problems. Textbook problems can be limited, because equations or topics can be easily identified based on the chapter being studied. Flipped classrooms allow students to attend

a lecture and complete homework while outside the classroom. They can then participate in activities inside that classroom that will better prepare them for future employment.

Technology

In addition to integrated teaching techniques, such as flipped and blended classrooms, students also need exposure to technology. Technology breaks the mold and prepares students for the world they are about to inherit. Advances in technology, including social media, virtual technology, and phone applications, are used to put the latest information at the students' fingertips. These tools, give an educator the freedom to become a coach, motivator, and advisor.

Social Media in the Classroom

As the size of college classrooms continue to increase, professors are looking for ways to quickly and effectively evaluate a student's understanding of the material. For example, many have begun to use Twitter to ask short questions during lectures in an attempt to improve student engagement and interaction. An added benefit to using Twitter during the lecture, is this tactic prevents students from using smartphones for non-educational purposes. The smartphones instead provide the professors with immediate feedback of any possible learning gaps. Kim et al. [(12)] utilized Twitter in a college classroom to post questions at unexpected moments between lecture slides. These questions covered essential classroom material, and points were awarded to students on a first-come-first serve basis. This process encouraged students to focus on the lecture and, ultimately, improved student participation and understanding. Kim et al. [(12)] gave a total of 40 pop quizzes, each worth 80 points. The distribution of student scores was even, and most

students reported an increase in concentration. Three exam scores in 2012 were compared to scores recorded in 2011, and there was a significant increase in the statistical results. The Twitter-based smartphone response system is advantageous because almost all university students have smart phones. When utilized in the classroom Twitter has improved student understanding and concentration.

Unlike Twitter, Facebook has been avoided in the educational environment because it has been considered a platform for online social networking only. Faculty members were more likely to use customary professional communication options, such as e-mail, Blackboard, and Moodle. Even though students use Facebook primarily for social interaction, they are becoming more open to using Facebook in the classroom. Kio and Negreiros [13] found that research is abundant at the university level, but produced very little educational use. Therefore, Kio and Negreiros [13] focused their study on the high school level, ages 15 – 18, and utilized two schools in Macao. The teachers included in this study use Facebook to post information on lessons, homework, and class activities to stimulate student discussion. Throughout the study, teachers posted topics at least once each day for eight weeks. At the end of the eight weeks, students were surveyed about not only their experience in the classroom but also their interaction with the Facebook group. Kio and Negreiros [13] found that Facebook allowed teachers to plan, advocate, and lead constructive interaction within the group. Group members became closer and more collaborative with both each other and their teacher. This improved relationship helped advance each students learning experience and academic performance.

Leelathakul and Chaipah [14] examined the effects of Facebook activities on 98 students located in Nan province, Thailand in 2011. Facebook groups were used for class discussions between instructors and students in grades 10 and 11. Leelathakul and Chaipah [14] examined the relationship between Facebook activities and GPAs and found individual activity (frequencies of posts and comments) is not linearly correlated with students GPAs. Students who had actively participated in class-related activities, however, tended to have higher GPAs due to an increased confidence they had gained during peer-interactions. Thus, several positive trends were identified when Facebook was used as a supplementary tool in formal education.

These accessible communication options (e.g., Twitter, Facebook, Linked-In) could allow for positive interactions between students and teachers. Yadav and Srivastava [15] noted that some students were more comfortable asking honest questions from behind a screen. They also suggested that social media has helped increase the quality, success, and efficiency of education. This increase can be attributed to a student's ability to access learning tools outside the classroom. Yadav and Srivastava [15] reported that the average Facebook user is 40.5 years old, the average Twitter user is 37.3 years old, and the average LinkedIn user is 44.2 years old. Nevertheless, 52.33% of higher education is somehow influenced by professional social networking media in the form of blogs, wikis, and Slideshare. [15]

Online videos found on various websites including YouTube, are also being used as a platform for self-directed learning. These videos are being used to increase attention to,

motivation for, and curiosity in subjects the students are studying by providing an amusing way to learn. In one particular study, Chan et al. [16] analyzed the types of video content the students accessed on YouTube to the principles of animation. YouTube revealed an abundance of information on the subject, but narrowing the selection to the most beneficial results required a basic understanding of the principles of animation. The theories and concepts found during these searches were useful in lectures and demonstrations when students were guided by a knowledgeable instructor. Overall, Chan et al. [16] found that four classes of learning outcomes occurred when digital videos were used for educational purposes: seeing, engaging, doing, and saying. Social media is being highly utilized in the classroom to help students and teachers interact concurrently without incurring excess costs.

Social media provides places for group collaboration, personal inspiration, and peer review. Thus, students have become accustomed to social media in their personal lives. This media can however, be a useful learning tool in a profession setting if students are given the knowledge to adequately evaluate, synthesize, and share resources.

Using Smart Phone Apps

Mobile App Technology (MAT) is being used to re-design and re-blend the way formal education is offered to students today. With an overwhelming majority of students having access to cell phones, this technology is now accepted as a normal convenience. This valuable device offers significant potential to place thousands of educational tools at student's fingertips. Mobile apps have been designed to offer an extensive range of topics

(e.g., geography, astronomy, chemistry) to inspire students of all ages. Mobile technology can also be used to encourage a collaborative learning environment in both a formal and informal classroom. Khaddage et al. [17] argued that MAT is here to stay. Thus it should be considered a vital teaching and learning vehicle that can assist institutions in reaching their goals. This cost-effective approach would provide an easy user-interface (with minimal technical support) once installed on mobile devices. Students could then use the app to access information both inside and outside the classroom setting. This new form of informal learning is versatile and will be able to better prepare students for the job market. Even after graduation, mobile technology can be used as a reference tool or to continue education.

Before mobile devices became popular, personal digital assistants (PDAs) were used in nursing education as a compact personal tool (which carried multiple references) to use while logging clinical encounters. PDAs have been extensively studied and smart phones are a modern version of this effective teaching tool. Smart phones not only provide the same convenience but many additional features. Phillippi and Wyatt [18] state that 70% of medical students used either PDAs or PDA-like devices while learning. Since the use of PDAs have been consistently associated with high levels of student satisfaction, the use of smart phone applications is expected to have similar benefits and positive feedback. Over time, smart phones have begun to replace traditional PDAs because of their extensive functions. Building on this thought, Phillippi and Wyatt [18] noted that although cell phone functions are designed for leisure activities, they can be adapted to meet educational needs as well. Several apps now even allow students to look up patient

records, quickly calculate a patient's body mass index (BMI), search drug side effects, and more. An instructor can also provide students with videos that help him/her prepare before performing a procedure. During the procedure, the instructor can be summoned quickly if an observation is needed. By having all these tools at their finger-tips, students are prepared to accurately answer questions. The additional resources (e.g., texting, apps, and available web access) have helped build confidence and decrease beginner anxiety.

Without a doubt, e-Learning is becoming one of the most important applications used in the classroom today. Advances in wireless technology allow mobile learning to begin anywhere, any time, and in multiple forms. Mobile learning expands the scope of learning beyond the conventional classroom. Tan and Liu [19] discussed the use of a Mobile-Based Interactive Learning Environment (MOBILE) in elementary school classrooms in Taiwan. This technology allows students to download learning materials, reminds students of deadlines, stores learning records for teacher reference, and encourages the user to browse materials for diverse learning activities. Tan and Li [19] used a questionnaire to examine the effectiveness of the study, and they concluded that learning via MOBILE is better than traditional education. Results gathered from the questionnaire revealed that students like to use MOBILE to learn, and this technology increased the students' interest.

Technology Enhanced Motivation in a Real-World Application

In a world where everyone is trying to do more with less, the military is using a visionary concept to reduce instructor-led training and, instead, use a collaborative problem-solving exercise that blends institutional, operational, and self-development training into one.

This new style of instruction will provide educational experiences that are tailored to each individual's unique abilities, characteristics, and needs. Spain et al. [20] stated that each soldier, sailor, marine, and airman brings a unique set of characteristics and experiences to the classroom. They have different task proficiencies (both inside and outside their mission rolls), different operational leadership experiences, and different sustainment skills. Spain et al. [20] suggest that the "one size-fits-all" approach needs to be reevaluated and modified to incorporate adaptive training. Adaptive training will help effectively educate thousands of individuals at a high standard of performance while maintaining tight financial, resource, and time constraints.

The U.S. Army is comprised of individuals with diverse backgrounds and skill sets in both physical and mental aptitudes. According to Bink and Cage [21], however, information presented during Initial Military Training (IMT) is often presented by a single drill sergeant to large groups. The program is developed to assure the "average" individual can meet the given standard. Historically, matching effective training techniques to multiple soldiers with different military and education backgrounds was difficult. This study, however, conducted an initial assessment of each individual and provided supplemental training tools based on being either a low-performing or high-performing individual. After three weeks the soldiers were reevaluated and demonstrated how adapting training to individual soldiers could enhance training effectiveness.

Similar to military training, the education system at universities is commonly presented by a single instructor to a large group of students. Utilizing collaborative learning

teaching methods such as flipped and blended classrooms supports students as they achieve a higher level of thinking. Forming a team with fellow classmates and working on real-world problems aids one another to clarify ambiguity and build confidence. This exercise increases the student's awareness of the concepts and also refines social skills needed for working in future diverse groups. When compared to working alone, students are able to achieve more when aided by peers and teachers.

In contrast to conventional, lecture-based training, videogames are being designed to provide "adaptive training" that can be tailored to suit each individual trainee's skill level and progression. These video games are designed to provide an optimal level of difficulty, but remain within the given trainee's capability. This is done in an effort to foster a "manageable" challenge. Various researchers have suggested that performance improvement may be linked to the trainees' prior gaming experience and other individual personality differences. Bauer et al. [22] developed an initial questionnaire to assess each participant's openness to experience, conscientiousness, and neuroticism. After completing the questionnaire, participants engaged in six missions in a video game–based training task each lasting seven-minutes. Bauer et al. [22] concluded that individuals with higher characteristics of openness to experience and neuroticism performed better over the course of training. These results suggest that adaptive training can reach its greatest performance improvement when the trainee's personality is suited to the proper instruction presentation.

A number of researchers have indicated that PC-based games may provide an effective approach to education. Although, it is still undetermined which identifiable features of games encourage continual learning or motivation. Video games use a first-person perspective to allow players to feel immersed in the environment. This experience removes boundaries so the player can better experience what to expect in the real-life situations. Belanich et al. [23] suggest that players can use this perspective, to obtain a better understanding of the information because it is conveyed in three different ways: attempting the task (procedural), observing the game environment (episodic), or the player could be provided printed or spoken text (factual). The rationale behind training through games is that the act of playing a game will motivate the learner to continue playing. The training can be adjusted by controlling the amount of challenge, controlling the event outcome based on player's actions, encouraging the player's curiosity by allowing the player to uncover something new, and developing the fantasy that the players are engaging in a real activity. Belanich et al. [23] asked twenty-one participants to play a "basic training" military game, which included Army background information. The assessment suggests that PC-based training would be more effective for learning procedures than for learning facts. Belanich et al. [23] concluded that the training game should be both instructional and motivational to reach optimal effectiveness.

Virtual technology provides a low cost and generally effective option for delivering training, particularly in situations where consistent skill maintenance is required. Consequently, the use of virtual reality (VR) is increasingly being developed for the use of training. Stanney et al. [24] focused their study on a student's ability to transfer

information learned in a virtual environment to an equivalent real world task. A wide range of virtual systems are currently available, including systems that fully immerse to systems that are barely more than computer-based instruction. With so many VR learning options available, it is important to understand which optimal training strategy must be supported. The proper training experience is critical so the student can learn to effectively utilize the new skills in real life situations. Stanney et al. [24] conducted two studies to evaluate the efficiency of the training framework transfer to the student. The first study taught ship handling in a virtual environment. The second study involved the task of navigating a land-based route while flying a helicopter. The results of learning via VR were then compared to students who were taught in a classroom setting. Stanney et al. [24] concluded that a variety of training media would lead to a more robust knowledge transfer than would a single form of training. Stanney et al. [24] noted that VR systems must include sensory cues surrounding the actual task, similar to those found in real world operational settings, before their potential can be fully realized. This study provided system developers with the insight necessary to replicate sensory cues surrounding actual tasks within a virtual setting.

Outcomes and Benefits of New Approaches

Tsai et al. [25] noted that both learning and retention increased by as much as 100% when students were actively involved in a lecture, discussion, or self-study. The curriculum was enhanced when suitable technology was applied, hands-on approaches were incorporated, and clear personal feedback was provided. Tsai et al. [25] adapted a variety of pedagogical approaches including active learning, interactive learning with real-time responses, modeling activities, and group activities in the study. Students' learning

preferences were summarized after these activities were applied. Activities including active learning, e-learning, games, group activities, tutorials, videos, and pop quizzes were conducted in the class. Based on their experiment, it was concluded that tutorials (68%), videos (64%), and lectures (56%) were the most positive preferences. Online forums (36% not effective) and games (16% not effective) were the most negative. Furthermore, no students indicated the lectures were ineffective, and 96% of students requested more information on how the class concepts could be used in real-life applications. Overall, these results indicate that students do enjoy the interactive learning approach, but there should still be some individual time allotted for students to master basic techniques individually.

Group Collaboration

Group collaboration is valuable when aiming to achieve a common learning goal and is becoming more available with the use of virtual learning environments. Modern technology is bringing students together to collaborate across large distances. In addition, new technology and web-based education has changed old learning paradigms into a new opportunity to learn "anywhere and anytime". During their study Wan et al. [26] established a new student user profile. This profile included abilities, knowledge, and learning preferences. A recommendation process connected either people or organizations based on their personal preferences once the data had been entered into the system. Social science research has revealed that people build social relationships with each other, and these relationships may help them locate either information or services more effectively. Wan et al. [26] found that a collaborative group-learning environment in

which students could express their thoughts, voice their opinions, and share their experiences had a positive outcome.

Thus, incorporating teamwork and communication skills into the core curriculum of all engineering and technology programs is essential for success. McDonald [27] emphasizes that it is clearly important that faculty consider incorporating teamwork in their courses through assignments and laboratory experience. By sharing ideas with classmates, students develop a better understanding of the concepts being taught while keeping each other accountable. McDonald [27] also explained that, in cooperative learning, students work together to maximize both their own learning and group members learning.

Collaboration improves not only the student's knowledge and memory but also his/her confidence in both themselves and the class. A class of junior electronic students were divided into groups of two to four students. These students kept journals throughout the semester on their impression of group collaboration. At the end of the course, the students completed an evaluation that contained 21 short discussion questions. The results indicate the cooperative learning method was well received by the students. In particular, the students reported learning to discuss problems, share responsibility, and are more conscientious about completing tasks when they know other students are depending upon them. One student reported that "…At first I was quite scared to get up in front of a group of people, but towards the third week of class it really didn't bother me anymore." [27] This is a great example of how groups can empower the participants, and how groups are no longer restricted by location with the advances in technology.

There are many benefits associated with collaborative learning, but there are also times where great effort may be required to be successful. Difference in personalities is positive in a team dynamic because it will foster creativity while generating feasible solutions. Although, contrasts in opinion need to be addressed when a breakdown in communication begins to occur. Project preparation should include equipping students with best practices to help avoid a bad situation. Best practices should include establishing clear goals and outlining a team working agreement. All team members should have clear expectations of their contributions to the project before work begins. Throughout the process, building trust and maintaining open communication will assist the group in being effective.

Continual Learning through Self-Directed Learning

Self-directed learning is an important element in encouraging life-long education for students. This type of learning allows the teacher to be a guide in the learning process instead of an instructor. Because minimal work has been conducted on the effectiveness of self-directed learning, Harding et al. [28] designed an experiment for undergraduate engineering students to strengthen a student's self-directed learning readiness and motivation. Class time was largely devoted to team-based projects, and three surveys were given to measure student perceptions throughout the experiment. Harding et al. [28] suggested that students enrolled in the project-based learning course viewed their learning as driven by their own personal curiosity. Project-based learning appears to cause students to be more focused on learning as a means of furthering their personal growth instead of influencing grade-oriented motivations. New academic teaching

methods such as project-based learning are needed to influence and encourage life-long learning outcomes in engineering.

Self-directed learning allows learners to decide what to learn and to what depth they want to explore the subject at hand. It requires that students be allowed to outline, manage, and evaluate their own learning. This process helps students break out of the mold of using a syllabus and learn about topics they feel are of most importance. Building on this method, Vashe et al. [29] explained that self-directed learning readiness (SDLR) is defined as the degree to which the individual possesses the attitudes, abilities, and personality characteristics necessary for SDLR. Because SDLR is present in all individuals, Vashe et al. [29] conducted a study to explore changes in a students' readiness for self-directed learning as he/she experienced class curriculum. Changes in academic performance were monitored to determine whether the change is correlated with opportunities to participate in self-directed learning. A hybrid curriculum involving problem-based learning, SDL, practical lectures, and traditional lectures was provided throughout the study. An initial questionnaire was provided as a baseline, and following the experiment, there was a clear indication of a significant increase in SDLR among students using this hybrid curriculum. The results gathered also indicate that academic performance as the curriculum and SDL progressed.

Self-directed learning skills are needed for survival in college courses, and are also valuable in preparation for professional careers. Fellows et al. [30] based their study on a model to increase self-directed learning amongst freshman. The instruction was

organized in a manner that provides intellectual challenge that is appropriate and relevant to the student's life experiences in an effort to maintain their interest. Self-directed students will frequently branch out and work collaboratively with either other learners or other specialists. This collaboration helps encourage group relationships. The modules that Fellows et al. [30] described teach students the necessary skills of time management and study skills while those students are adjusting to a college environment. These skills will be put to use when students schedule their study time, and begin setting both short-term and long-term goals. These skills must provide students with a positive experience before they are accepted. A before and after assessment is also needed to monitor each modules effectiveness so that the teaching style can be adjusted to meet each student's needs. Study skills were found to be effective when used repeatedly throughout the semester. Overall, the modules had a positive impact and were gratifying to the students.

Resistance to Change and Risk of Failure

Change is inevitable in all organizations, including education systems. Even though it is exciting to implement new technology and techniques, modifications to the status quo can be met with resistance. Resistance often forms when the alteration is not perceived as necessary. These feelings can be initiated by either students experiencing the new style of learning or from faculty opposing changes to the curriculum. Students and faculty alike have become comfortable with how the standard lecture style teaching is carried out. For the benefits of new techniques to take root, the transition phase would require extra work from everyone involved. An extensive list of sources to resistance has been identified, in which most emphasize individual level explanations. These explanations include a professionals' denial to accept any information that is not desired, the tendency to

perpetuate old ideas and behaviors, the perceived cost of change, a reactive mind-set, feelings of resignation, and the belief that obstacles are inevitable. [31] Throughout the conversion process, individuals will embrace these changes on different levels. In general, people's motivations for a certain behavior can range from motivation (or unwillingness), to passive compliance, to active personal commitment.[31] Motivation is the driving force for change and can be cultivated. The stages of change have been the carefully examined through numerous influential studies such as Lewin's (1951) classic three-stage analysis of the change process. According to the theory, change unfolds through the sequence of unfreezing, changing, and refreezing behavior. This template has been used extensively for change at the organizational and individual level. [31] It is important to note that not all changes are equal, and they will not have the same impact. Despite the abundant options for revamping the education system, changes need to be kept simple and gradual. The business case for change needs to be related to issues that people care about to have adequate support from faculty and students. Feeling autonomy, that is having a sense of volition, choice, and willingness, makes it more likely for individuals to internalize the responsibility for the change process and to integrate new behaviors. [31] Initially understanding the most common reasons for resistance provides the opportunity to plan an initial strategy. The initial strategy can then be used to address these factors and make the process more seamless.

Even the best instructional programs result in limited gains if the teachers find them difficult to implement or antithetical to their established practices.[32] Teaching techniques should be evaluated on their probability of success and impact on students

before proceeding with implementation. Researchers and educators who advocate new programs must be aware of the ways in which programs change with each teacher as he or she works to construct a new practice. [32] Teachers generally rely strongly on their history and experience with success in education when selecting new approaches. Instructors need to take primary ownership of the curriculum modifications and be program advocates for students to be inspired. Even though new techniques may not be met with outright resistance, there is a risk that the new programs may not be carried to final implementation. A strategy is being developed to carefully select the correct tools to achieve optimal education improvements.

Conclusions and Future Work

Learning process improvements are continuously under development to increase motivation and encourage a passion for self-directed learning. The education process will never end, and preparing students for both the present and future is an unlimited opportunity. This review of best practices summarizes findings of recent research around the world, and will be utilized to improve courses across the Missouri University of Science and Technology campus.

The objective of future research is to apply the correct type and amount of modern technology to obtain the maximum learning experience for students. Most education systems are familiar with emerging teaching practices, but have not considered how to optimally apply all options. Future work includes a study addressing this issue. Within the study, an initial survey has been provided to students to analyze student personality traits and learning styles. The variety of educational approaches will then be dialed in to

reach the stakeholder requirements. Throughout the allotted time period, a tailored syllabus will allow students to experience different teaching techniques (e.g., flipped classroom, hands-on activities, and social media) to build on concepts explained in class. A final survey and assessment will evaluate student involvement, understanding, and material retention. This feedback will then be applied to future classes.

This detailed process will help mitigate the risk of losing valuable time on unproductive tasks. Instead of targeting the bulk of students, this new approach personally tailors the class to the university's customers: students and employers. An improved education system launches students into a successful future by promoting academic engagement, encouraging success, and improving the overall student learning satisfaction.

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II. ONE SIZE DOES NOT FIT ALL: UTILIZING QUALITY FUNCTION DEPLOYMENT FOR COURSE DEESIGN

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Abstract

Workplace requirements continually evolve to keep pace with the developing global market. To meet ever increasing standards, educational institutions have been investigating methods to prepare students for future employment. Course modifications should be carefully considered to meet the requirements of all stakeholders, including those of the students. The objective of this research was to provide students with an overall better learning experience that tailors the teaching methods to his/her individual learning preferences. A comprehensive survey was provided to an undergraduate class at Missouri University of Science and Technology. The survey documented the student's individuality when learning and made note of his/her expectations from the class. After documenting this information, Quality Function Deployment, an organized approach to take the voice of the customer into the design of products and services, was utilized to consider class modifications. The results indicated the implemented techniques and tools were beneficial to the students and helped his/her comprehension of the course material. The outcome provided students with an overall better learning experience while improving efficiency, and decreasing resistance to change.

Keywords: Quality Function Deployment, Learning Style, Motivation

1. INTRODUCTION

As technology persistently progresses, the workforce requires employees to continually develop his/her knowledge and improve their skills. “In a world where advanced knowledge is widespread and low-cost labor is readily available, the advantages of the United States in the marketplace and in science and technology have begun to erode. A comprehensive and coordinated federal effort is urgently needed to bolster competitiveness and pre-eminence of the United States in these areas.” (Lantz, 2009, p. 248) There is a need to inspire motivation, self-directed learning, and critical thinking skills within the classroom to prepare students to remain competitive in today’s global market.

Education institutions have been researching ways to meet this need and incorporate thought-provoking activities into the curriculum for years. Numerous alternatives, including virtual technology and social media, have been utilized to transform the traditional classroom. Curriculum alternatives that are being applied in various classroom settings were evaluated as potential options to incorporate into an undergraduate Engineering Management class on Quality at Missouri University of Science and Technology. The alternatives were judged on their ability to meet the student’s preferences: multiple intelligences, learning styles, and motivators. This study focused on implementing technology and teaching techniques that would inspire students to achieve high retention and engagement. The research objective was to better understand the student’s individuality when learning and processing information and to also make note of his/her expectations from the class. After documenting this

information, an organized approach called Quality Function Deployment (QFD) was utilized to consider class modifications. The desired outcome was to provide students with an overall better learning experience while improving efficiency and decreasing resistance to change.

Various techniques have been used to measure intelligence, motivation, and learning styles in an attempt to interpret human differences. Three different instruments were used in the present study to assess the goals and abilities of the students. The three surveys include: 1) Theory of Multiple Intelligence (MI), 2) Visual-Auditory-Kinesthetic (VAK) learning style survey, and 3) Motivated Strategies for Learning Questionnaire (MSLQ).

The theory of Multiple Intelligence (MI) was developed by a professor of neuroscience at Harvard in 1983 (Ostwald-Kowald, 2015). Psychologist, Howard Gardner, developed the MI theory and stated that humans have several different ways of processing information. "MI Theory is the fruit of cognitive science and reflects an effort to rethink the theory of measurable intelligence embodied in intelligence testing." (Silver et al., 2002, p. 22). Gardner's theory defines intelligence as the skills required for a person to gain new knowledge and solve problems beyond intelligent quotient (IQ). The intelligences that he determined are the following: visual – spatial (picture smart), logical – mathematical (logic smart), verbal – linguistic (word smart), auditory – musical (music smart), interpersonal (people smart), bodily – kinesthetic (body smart), naturalistic (nature smart), and intrapersonal (people smart) (Ostwald-Kowald, 2015).

The VAK learning style questionnaire is a straightforward model that evaluates student's learning preferences by asking how he/she would generally behave in different

real-life situations. VAK was developed by psychologists and teaching specialists such as Fernant, Keller, Orton, Gillinghamd, Stillman, and Montessori beginning in the 1920's (Chapman, 2015). VAK is similarly related to the MI concepts and helps illuminate Gardner's seven intelligences. The classic intelligence and learning style model, VAK, does not overlay Garner's model, but rather provides a different perspective for explaining a person's dominate thinking and learning preference. Typically, people have a predominant preferred style that he/she utilizes. In some cases, students favor a blend of two learning styles or even utilize a combination of three (Chapman, 2015).

The Motivated Strategies for Learning Questionnaire (MSLQ) is an instrument that is self-reported. Paul Pintrich and his associates were instrumental in its development at the University of Michigan. It was used to measure motivational factors in college students to assist in the selection of different learning strategies and their use in college courses (Pintrich et al., 1991). The MSLQ contains 81 questions and is divided into two main categories: motivation and learning strategies. The motivation category contains 31 questions and is divided into three sections. The sections evaluate a student's goals and value beliefs for a course, their beliefs about their own skills to succeed within a course, and also their anxiety with regard to tests in a course. The learning strategies category contains 31 questions in order to evaluate the students' meta-cognitive and cognitive strategies as well as 19 questions in order to evaluate the students' resource management.

It is not illogical that students are usually treated as the primary customers in higher education. However, some feel employers or industries in general are the customers, while students are the products of the education system (Hwarng and Tao,

2000). The question of who is the "customer" in higher education poses an interesting issue. Institutions and universities are not always in agreement on their specific definition of customer (Singh, 2008). Even though the student's preferences were focused on within this study, the learning content is based on multiple stakeholders. The department objectives were not changed, and the same end performance was required. For this study, the customer was assumed to be the student.

In an effort to improve the quality of education, a method called Quality Function Deployment (QFD) was utilized in this study for a course redesign. The voice of the customer is determined by using an integrated survey comprised of a combination of three well-known existing surveys. These surveys are specifically selected for their expertise in capturing student learning styles, learning preferences, and motivation. An analysis of existing teaching techniques and tools is evaluated to determine the best practices for course implementation. QFD provides a structured approach to evaluating which tools will best meet the customer needs given the allotted timeline and budget. To accomplish this goal, the standard QFD process has been expanded to seven steps to complete the initial research pilot.

The following section presents the research methodology for evaluating student learning styles were evaluated and how the subsequent curriculum alternatives were selected. Then the results of implementing the proposed methodology are presented. Finally, discussion and recommendations based on these results are provided in the conclusion.

2. LITERATURE REVIEW

2.1. ASSESSMENT OF TECHNOLOGY AND TECHNIQUES IN EDUCATION

Advances in modern technology aid in the development of new educational tools to enhance the extensive value of interactive education, and focus on motivational factors. This research focused on three teaching practices: 1) utilization of surveys to assess learning styles and perceived motivation, 2) implementation of technology and techniques to support student motivation, and 3) assessment of the outcomes and benefits of implemented approaches. The objective of the literature review was to evaluate current research studies related to available teaching practices and course improvement applications.

2.1.1. Assessing Learning Styles and Motivation. The utilization of surveys, interviews, and small group discussions provides a baseline for understanding individual student learning styles. Each student has the ability to learn, but his/her motivation to learn increases when his/her unique learning style is taken into consideration. Larkin and Budny (2005) found that a focus on either learning style or personality type tells the students that they are not only cared about but also respected as individuals. Taking a genuine interest in the students and investing time to make sure he/she is successful builds self-esteem and confidence inside and outside the classroom. Likewise, Dillon and Stolk (2012) surveyed students at the beginning and end of a class. They found that several students adopted relatively stable motivations within a single course while others responded drastically over time. Examining both when and how these shifts occur provides information that instructors can use to maximize internalized motivators when

revising course activities. Utilizing surveys at the beginning and end of each semester also provides insight into student's initial motivation and possible fluctuations throughout the semester.

Since Garner first published *Frames of Mind: The Theory of Multiple Intelligences* in 1983, educational institutions have been employing his theory in their classrooms (Campbell, 1997). The Theory of Multiple Intelligence has had a large and relatively positive reaction among educators. "No longer is the purpose of education simply to pick out those students who are intelligent, on one or another definition, and give them special access to higher education. Rather, the purpose of education now is to educate an entire population for we cannot afford to waste any minds" (Howard Gardner, 2007, p. 238). Garner's eight learning styles include: 1) Verbal – Linguistic (Word Smart) – people who possess this learning style have sensitivity to written and spoken language. He/she absorbs information by discussing ideas and reading materials; 2) Logical – Mathematical (Logic Smart) – those who exhibit this type of intelligence learn by classifying and categorizing. He/she also has the capacity to analyze problems logically, carry out mathematical operations, and investigate issues scientifically; 3) Visual – Spatial (Picture Smart) – these people learn by drawing or visualizing things; 4) Auditory – Musical (Music Smart) – musical intelligence encompasses skills in the performance, composition, and appreciation of musical patterns. He/she learn using rhythm or melody, especially by singing or listening to music; 5) Bodily – Kinesthetic (Body Smart) – body smart individuals learn best when using ones entire body or parts of the body. Kinesthetic learners work best standing up or moving around; 6) Interpersonal (People Smart) – those who possess interpersonal intelligence learn by relating to others

and have the capacity to understand the intentions, motivations, and desires of other people; 7) Intrapersonal (Self Smart) – Intrapersonal intelligent people have a high capacity to understand oneself. He/she learns best by working alone and setting individual goals; 8) Naturalistic (Nature Smart) – Naturalistics enjoy learning about living things and natural events. He/she may excel in the sciences and be very passionate about environmental issues (Ostwald-Kowald, 2015; Wares, 2011).

Linda Campbell (1997) discusses the applications of MI across a variety of curriculums, spanning from liberal arts to mathematics and science. MI can influence the design and implementation of a range of curriculums within elementary, high school, and even college education. Wares (2011) demonstrated how Gardner's Theory of Multiple Intelligences could be applied in mathematics classrooms. The study discusses the importance of teaching students in a broader manner to capitalize on the individual's strengths and balance their weaknesses in learning. Hoerr (1997) also discusses a decade's worth of experience in working with MI ideas at New City School in St. Louis, Missouri. Hoerr stated, "Though we always look for our students' strengths, valued the arts, and emphasized personal development; the multiple intelligences framework has focused our efforts and given us a common vision." (1997, p. 43) Hoerr (1997) elaborates that the biggest challenge is continually supporting the faculty. MI requires a large investment of time and energy, but there is a significant amount of power these concepts provide when designing curriculum.

A student's learning style describes how a student comprehends and processes information in a learning environment. The three learning styles assessed in the VAK Learning Style questionnaire are: 1) visual, 2) auditory, and 3) kinesthetic. A person with

a visual learning style will prefer to see and observe things such as diagrams, pictures, displays, handouts, diagrams, and films. They will typically be the ones that will begin work on a new task by first reading instructions or asking another person to work through the process with them. A person that has an auditory learning style will prefer to receive information by listening either to themselves or others. They will typically ask their colleagues to talk things over with them or ask to be told. A person that has a kinesthetic learning style will learn and retain information the best when there is a physical experience such as feeling, touching, doing, or holding. A kinesthetic learner will prefer a practical hands-on approach (Chapman, 2015).

The VAK Learning Style questionnaire assists educators by providing a simple assessment he/she can use to improve their class. Vaishnav (2013) utilized the VAK survey to determine the prevalent learning style amongst secondary school students. The results of the study found that kinesthetic learning was more common within this class of students than visual and auditory learning. Vaishnav (2013) also found a positive high correlation between kinesthetic learning and academic achievement of the students.

MSLQ is a well-established instrument and has been utilized to collect data for several diverse research purposes. This tool measures students' motivation orientations and his/her use of different learning strategies. In 2012, Robin Taylor performed a reliability study on the MSLQ to determine potential sources of measurement error within studies using these scales. According to Taylor, "Overall, results of reliability generalization studies for both the motivation and learning strategies sections of the MSLQ demonstrate that the MSLQ can be used across a variety of different samples with reasonable confidence for obtaining generally reliable scores." (2012, p. ii). McClendon

(1996) performed a study at The University of Akron in Northeastern Ohio to estimate the validity of the MSLQ within an open admissions university. These types of universities often need ways to help students succeed, and the MSLQ can be a valuable tool for guiding students in the lower percentiles.

2.1.2. Implementation of Technology and Techniques. Initial assessments help define the current student learning preferences and motivation. These assessments aid in prioritizing the student's needs and determining which tools would make the class more appealing to the customers. Applications involving virtual technology, social media, and flipped classrooms are examples of teaching techniques that are increasing student enthusiasm. In a study by Martin et al. (2011), students watched a pre-recorded lecture before each class period. The classroom time was then used to help the students develop a better understanding of the material before completing the homework. Similarly, Chen and Chen (2014) proposed a learning system that provided the students with three hours of videos to be completed at home, and three hours of classroom hands-on interactions. This approach allowed students to interact with the teacher and learn the material on a deeper level. It also challenged students to shift from being passive learners to actively participating during the class time.

In addition to flipped classrooms, social media is being used to maintain the attention of students during lectures. Kim et al. (2014) utilized Twitter in a college classroom to post questions at unexpected moments between lecture slides. These questions covered essential classroom material, and points were awarded to students on a first-come-first serve basis. This option challenged students to focus on the lecture, but also allowed the teacher to quickly evaluate the student's understanding of the material.

Moreover, social media has been utilized as a teaching aid outside of the classroom as well. Kio et al. (2013) studied classrooms where high school teachers used Facebook to post information on lessons, homework, and class activities to stimulate student discussion. Even though Facebook has commonly been used for social networking only, students are becoming more open to the opportunity of incorporating it into the classroom. Overall, social media options including Twitter, Facebook, or LinkedIn provide opportunities for positive group collaboration and learning.

The military is also using advances in teaching technology and techniques. Teaching methods are being piloted to reduce instructor-led training, and instead utilize collaborative problem-solving exercises. These exercises immerse the student in the environment they will be expected to perform within. Belanich et al. (2013) used video games to allow students to obtain a better understanding of the information being taught. The material is conveyed in three different ways: procedurally (attempting the task), episodically (observing the environment), or factually (where the player could receive printed or spoken text). Since the military is comprised of individuals with an array of backgrounds, new methods are assessing the student's skill level and adapting the curriculum to challenge him/her. Bink and Cage (2012) provided an initial skill assessment to individual soldiers. Supplemental training tools then were provided based on being either a low-performing or high-performing individual. Virtual technology provides a low cost yet effective option for delivering training.

2.1.3. Outcomes and Benefits. The class curriculum is enriched when suitable technology and teaching applications are incorporated to aid in the student's learning experience. Dillon and Stolk (2012) found that the type of motivation a student receives

during his/her education will frame his/her academic engagement, performance, and satisfaction. There are many benefits associated with an increase in motivation; including a desire for continual learning through self-directed learning. In a study by Harding et al. (2007), project–based education encourages students to study as a means of furthering his/her personal growth instead of influencing grade-oriented motivations. Self-directed learning and personal growth is an important piece of encouraging life-long development after leaving academia. "Current teaching methods have displayed positive results, but barriers between academia and industry can be made seamless by incorporating both advances in technology and motivational techniques." (Cudney et al., 2011, p.2). In short, improving motivation within the classroom improves academic performance, but also enhances the overall learning experience.

2.2. QUALITY FUNCTION DEPLOYMENT (QFD)

QFD has been selected for this application to help determine which emerging teaching practices would be most effective when incorporated into course curriculums. This method was intended to give product or service developers an orderly method for incorporating the Voice of the Customer into product design. Details and guidance of Modern QFD methods and tools can be found in ISO 16355. The classical QFD process may include using one or more matrices which are called quality tables (Ficalora, 2010). One such matrix is the House of Quality (HOQ).

The HOQ is very useful for organizing the collected data and facilitating the improvement process. The matrix diagrams show information about how well the employee expectations are being met. It can also show resources that exist to better meet those expectations (Chen and Susanto, 2015). Data collected from the students regarding

motivation and learning preferences is compared with the curriculum capabilities. Since a large range of educational tools are becoming available, the HOQ helps narrow down the options and focus on the tools that will have the largest impact on meeting customers' needs.

The Japanese demonstrated that this tool was effective in planning the quality related aspects of products, services, software, and processes. QFD combines the crucial characteristics and essential elements of the different phases in the lifecycle of a product (Singh, 2008). With its roots planted in industrial sectors, QFD has made its way into and found acceptance in education. These applications range from the redesign of departmental operations down to textbook selection.

Mazur (1996) used QFD to design a course curriculum and web-based learning for a course in Total Quality Management. Technical employer needs were used to prioritize the content of the course and student needs were used to design the websites for each lecture. Yearly reviews fine-tuned both sets of matrices as professional and student needs changed in priority. Competitive assessments were done against other college elective courses so that the enrollment increased from 12 to 130 students in the course of one year.

Chan (2010) used newly hired graduates to act as proxies between common job tasks for new employees in the Chinese textile industry. This focused the curri8culum design on job skills that would be needed during the first year of work after graduation. Liu et. al. (2012) utilized QFD in industrial design education to help align the competencies and abilities of graduates with the ever changing professional field requirements. This process allowed researchers to determine which competencies should

be cultivated. Proficiencies required in the field were identified and ranked by importance. Using these proficiencies, curriculum could be developed that would address the needs of the industry. Subjects and courses could then be recommended to prepare students for his/her career after graduation. Ultimately, QFD was utilized to help close the gap between industry and education.

Muda and Roji (2013) utilized QFD to determine what learning outcomes should have the highest priorities in the School of Mathematical Sciences. For the purposes of this study, the student was the customer and their needs were input into the HOQ as the customer needs. The HOQ was able to take the voice of the student and determine how effective the existing program was at preparing students for the working environment he/she would experience after graduation. The learning outcomes were first prioritized and the skills that were necessary and should be emphasized were determined. After seeing the results of this study, the curriculum could be modified to ensure that the skills required could be incorporated in the industrial training course.

Souhapensang and Seviset (2014) utilized QFD to design an educational program in industrial education, and evaluate the student's learning and satisfaction. The research found that students that participated in a program developed using QFD principles had higher achievement scores than students that participated in traditional classrooms. QFD has many proven benefits such as: 1) improving understanding of customer needs, 2) improving organization of developing projects, 3) decreasing design changes late in development, 4) reducing implementation problems, 5) carrying a high reputation for

quality, and 6) increasing business by improving customer satisfaction (Warwick Manufacturing Group, 2007). Therefore, it can be concluded that QFD produces positive result. This is the reason for selecting QFD to be utilized in this application.

3. METHODOLOGY

The main focus of QFD is on evaluation, timing, and resource commitment (Lockamy and Khurana, 1995; Chen, 2015). According to Ficalora and Zinkgraf, "All companies, be they public, private, or non-profit, must provide ever-increasing value to customers and markets they serve in order to have stability and growth." (2010, p. 32). The challenges companies experience are varied, but most businesses have to compete with others in regards to value creation and delivery. Rapid changes in today's market can compel companies to implement new technology, evolve business strategies, or modify organization structures to keep pace with changing business dynamics. Ficalora and Zinkgraf (2010) explain that QFD assists to lesson changes by utilizing the following four phases:

- Phase 1: Plan concepts, based on key customer needs and competitive alternatives,
- Phase 2: Design products or services,
- Phase 3: Make products, offer services, and
- Phase 4: Sell products or services.

The four phases of QFD for education are used to frame the outline of this study. The phases were expanded from 4 phases (beginning with Phase 1) to 7 phases (beginning with Phase 0). The approach was taken in an effort to make each phase more meaningful and manageable. The additional phases provided the case study participants with the opportunity to thoroughly visualize the project progression and anticipate challenges. The additional phases acted as guideposts to direct the study by outlining the distinct activities

that should be performed in sequence. This process structure proved to be efficient and aided in success. The proposed methodology follows this progression:

- Phase 0: Process outline phase.
- Phase 1: Product concept planning phase.
- Phase 2: Product specification phase.
- Phase 3: Parts development phase.
- Phase 4: Implementation phase.
- Phase 5: Acceptance testing phase.
- Phase 6: Recalibration phase.

Each phase is composed of sub-deliverables which can be viewed in Figure 1.

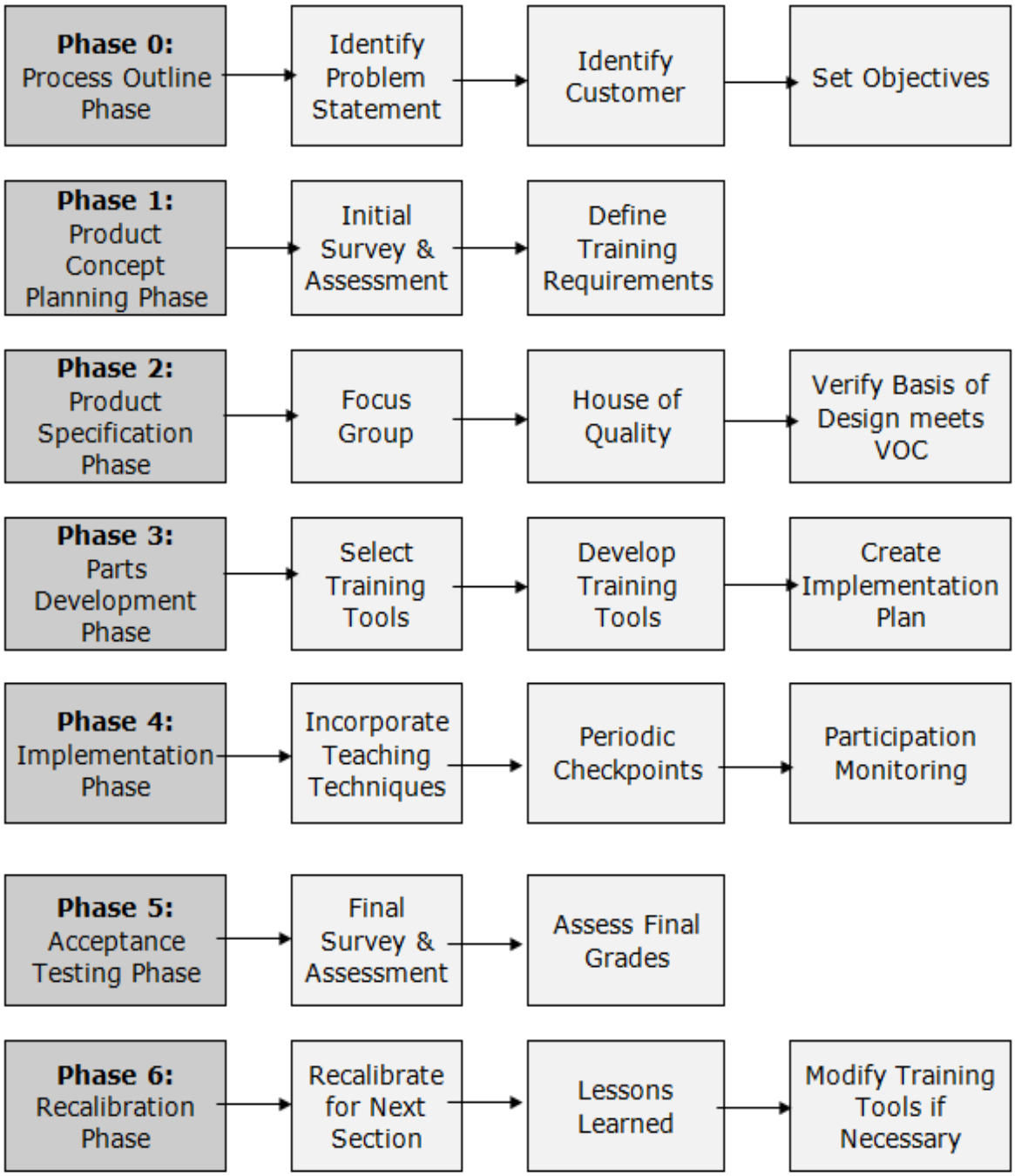

Figure 1. Course Redesign Phases

4. CASE STUDY

The proposed methodology was applied in an undergraduate course entitled, "Quality". The course is an undergraduate, core course in the Engineering Management Department. As a core course, the typical enrollment is approximately 45 students and consists of mainly juniors and seniors. The course is offered every spring and fall semester. This course was selected for course redesign due to its large class size and frequent offering.

4.1. PHASE 0: PROCESS OUTLINE

The initial phase, commonly referred to as Phase 0, is used to organize the resources required to meet the objectives. This step provided an opportunity to evaluate the current curriculum and establish a baseline. Ficalora (2010) advises that initial planning for a development project will be key to realizing success. Within this phase, the significant customers were identified, stakeholder alignment was achieved, and objectives were identified.

The content of the existing undergraduate course was evaluated to determine which intelligence and learning style was influenced by the current teaching methods. At the beginning of the study, the syllabus included traditional lectures, homework problems, tests, hands-on activities, a group project, a group report, a group presentation, and an extra credit option to make a video. Each method was paired with the learning style that would find it the most appealing. The results can be viewed in Table 1.

Table 1: Initial Class Assessment

Teaching Method	Learning Style
Traditional lectures	Auditory-Musical, Visual - Spatial, Verbal - Linguistic
Homework problems	Logical - Mathematical
Tests (interpret situation)	Real – world applications
Hands-on activities	Bodily – Kinesthetic, Logical – Mathematical
Group project	Verbal – Linguistic, Interpersonal
Group report	Verbal – Linguistic, Interpersonal
Group presentation	Verbal – Linguistic, Interpersonal
Videos	Bodily - Kinesthetic

4.2. PHASE 1: PRODUCT CONCEPT PLANNING

After initially planning the QFD progression, the subsequent step was to collect data to define the voice of the customer. A comprehensive survey was distributed at the beginning of a semester to collect data from the undergraduate students. The results were analyzed to learn the perceived intelligence, learning preferences, and motivation of each individual.

The survey, in its entirety, had five sections: 1) demographic questions, 2) self-evaluation and learning preferences questions, 3) Theory of Multiple Intelligence, 4) Visual Auditory Kinesthetic (VAK) learning style, and 5) Motivated Strategies for Learning Questionnaire (MSLQ). Questions were pulled from the Theory of Multiple Intelligence survey, VAK learning style survey, and MSLQ because each survey template has had significant contributions within academia and were applicable to this study. The

process flow the students encountered when taking the survey can be viewed in Figure 2. The survey begins with demographics questions and finishes with the MSLQ portion.

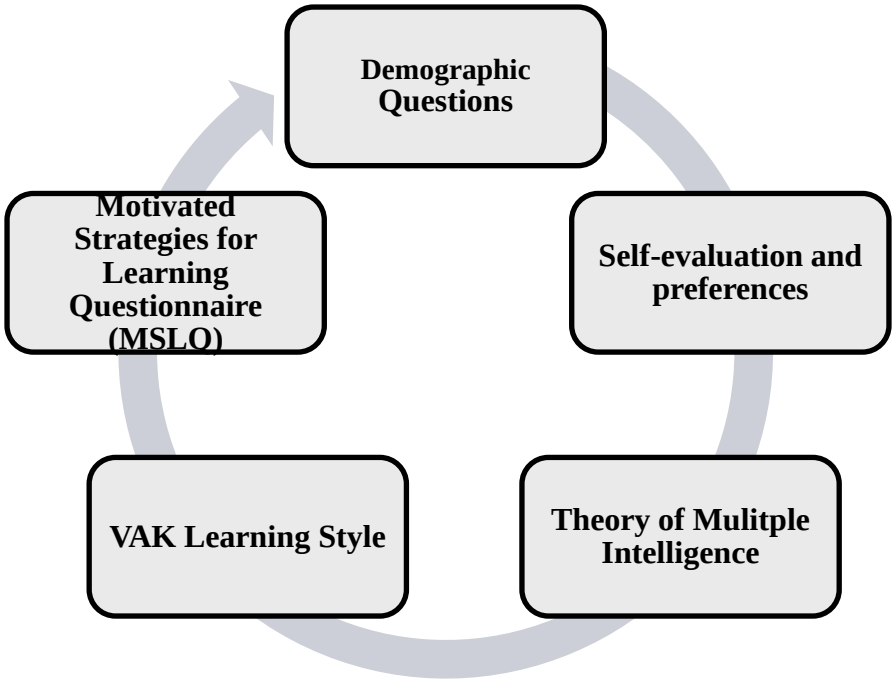

Figure 2. Survey Flow

The initial survey was based on a 5-point Likert scale. The rating consisted of the following categories: (5) strongly agree, (4) agree, (3) neutral, (2) disagree, and (1) strongly disagree. The data collected remained anonymous for the 52 students surveyed. This was done to help ensure that the students provided his/her candid feedback about their learning experience and style. The results obtained from this 63 question survey were used to form the House of Quality. Since a 5-point Likert scale uses ordinal scale values, there were converted later into ratio scale values using the Analytic Hierarchy Process (AHP) for the QFD matrices. Ratio scales are necessary because, unlike ordinal

scales, they support mathematical functions such as addition, subtraction, multiplication, and division (Saaty 1990).

4.2.1. Demographic Questions. The first set of questions within the survey contained demographic questions. Information collected was used in the data analysis to form cross tabulations across multiple demographics and class semesters. Table 2 provides information on major, work experience, class standing, and gender.

Table 2: Student Demographics for the Quality Course

Degree Major (first major)	**Percent Response**
Engineering Management	87.8%
Mechanical Engineering	4.9%
Civil Engineering	4.9%
Other	2.4%
Work Experience	**Percent Response**
One internship	20.6%
One co-op	11.8%
More than one internship	20.6%
More than one co-op	11.8%
0 – 1 year	32.4%
2 – 4 years	2.9%
Class Level	**Percent Response**

Table 2: Student Demographics for the Quality Course (continued)

Freshman	2.4%
Sophomore	0.0%
Junior	22.0%
Senior	75.6%
Graduate	0.0%
Gender	**Percent Response**
Male	92.7%
Female	7.3%

These demographic questions also inquired about the student's reason for taking the class. Students commonly have multiple motives for taking a class; therefore, he/she was allowed to select all the options that supported their decision. From the analysis shown in Table 3, 75.9% of the Quality class enrolled because this is a required course within his/her major curriculum. Although, students also agreed that the content would improve their career prospects (74.1%) and the content seemed interesting (48.1%). These results show that even though students are primarily taking the course to fulfill degree requirements, there are additional positive motivators for taking the class.

Table 3: Students' percentage responses for survey in Quality Course

Questions	Percent response (%)
REASON FOR TAKING CLASS	
Fulfills major/program requirement	75.9
Will improve career prospects	74.1
Content seems interesting	48.1
Material will be useful to me in other courses	38.9
Will help improve my academic skills	35.2
Fits into my schedule	25.9
Easy elective	1.9
Was recommended by a friend	1.9

4.2.2. Self-evaluation and Learning Preferences. The second portion of the survey inquired about student's preferred classroom activities. "A typical lean curriculum currently consists of some instructional lectures, a course project done at some company (if possible), one or two case studies and perhaps some manual simulations through seminars." (Cudney et al., 2011, p.2) The students were provided with four teaching methods and were asked to provide constructive feedback from his/her previous experiences. The four techniques each student ranked were hands-on exercises, traditional lectures, independent learning, and group activities. The results are shown in Table 4. These four options were selected because they could be found in traditional classes at Missouri University of Science and Technology. Therefore, the individuals were familiar with each practice and could identify which he/she found to be the most useful. The results indicated that this undergraduate class of primarily engineers preferred hands-on exercises (75.55% agreed). The students rated the opportunity to learn through group activities and traditional lectures similarly with scores of 57.77% and 55.55%, respectively. The question also revealed that the students ranked independent learning lowest of the four options. Only 42.23% agreed that independent learning was their preferred method for learning.

Table 4: Student Learning Preference

I prefer to learn using the following practices:	Percent					Standard Deviation	Variance
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**		
Hands-on Exercises	51.11	24.44	24.44	0.00	0.00	0.84	0.70
Traditional Lectures	11.11	44.44	35.56	8.89	0.00	0.81	0.66
Independent Learning	15.56	26.67	35.56	15.56	6.67	1.12	1.26
Group Activities	24.44	33.33	33.33	6.67	2.22	0.99	0.98

Figure 3 provides a visual display comparing the different learning practices from strongly agree to strongly disagree.

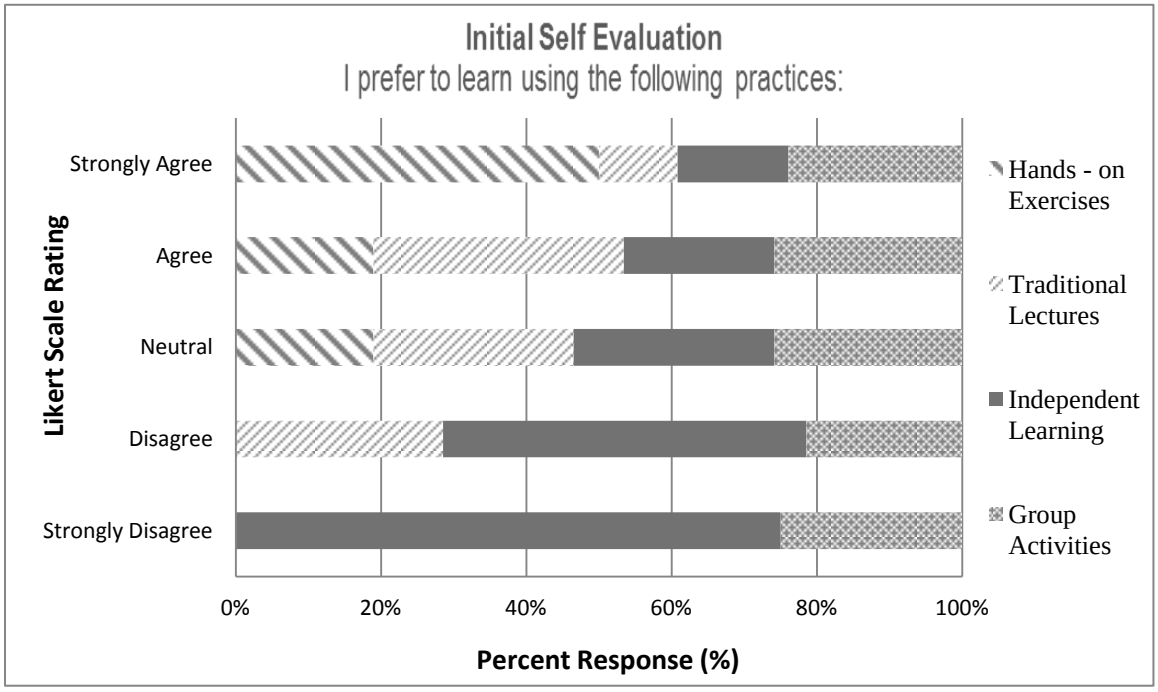

Figure 3. Initial Self Evaluation

The students were also asked six open ended questions to inquire about his/her self-perception. The six questions included: 1) What would make this class interesting? ; 2) What are your career goals? ; 3) What are your three biggest your strengths? ; 4) What are your three biggest weaknesses? ; and 5) What three things can be done to help you succeed? The three most frequent responses were recorded for each question and are provided in Table 5.

Table 5: Student response to open ended questions

	Student Response		
Question	Highest Response	Second Highest Response	Third Highest Response
What would make this class interesting? (Direct quotes from students)	Real - world scenarios and practical applications	Hands - on activities	Video examples
What are your career goals?	"To get a job that pays enough money for me to live a happy life."	"At this point, finding a full time job that I can see myself enjoying and doing as my career."	"I have had a few rough semesters and had to take some time off. So, realistically, (right now) my goal is to get my GPA up, graduate and get a job."
What are your three biggest strengths?	Work ethic, hard worker	Intelligent	Leadership
What are your three biggest weaknesses?	Perfectionist	Easily distracted, boredom	Procrastinator
What can be done to help your succeed?	Provide concepts that apply to career development (practical correlation between theoretical and actual processes by giving a number of examples)	Keep information interesting	Provide resources and opportunities to ask for clarification

4.2.3. Theory of Multiple Intelligence. The third portion of the survey investigated the combination of multiple intelligence. Ostwal-Kowald (2015) provided a learning style test that utilizes Gardner's Theory of Multiple Intelligences. The test identifies student's learning preferences. Determining, recognizing, and valuing the different combinations of these multiple intelligences is an important key to applying them effectively.

In order to understand the learning style of each student, the students were asked to rank how he/she affiliated with eight different statements. These statements were descriptions of each of the eight intelligences determined by Gardner. The students' responses indicated the highest learning preference for the class. The results can be viewed in Table 6.

Table 6: Multiple Intelligence Questions

		Percent				
Output	Questions	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Verbal - Linguistic (Word Smart)	I learn through reading, writing, listening, and speaking. I absorb information by engaging in reading materials and by discussing and debating ideas.	34.78	52.17	13.04	0.00	0.00
Logical - Mathematical (Logic Smart)	I learn by classifying, categorizing, and thinking abstractly about patterns, relationships, and numbers.	39.13	34.78	17.39	8.70	0.00
Visual - Spatial (Picture Smart)	I learn by drawing or visualizing things using the mind's eye. I learn the most from pictures, diagrams, and other visual aids.	43.48	30.43	26.09	0.00	0.00

Table 6: Multiple Intelligence Questions (continued)

Auditory - Musical (Music Smart)	I learn by using rhythm or melody, especially by singing or listening to music.	8.70	4.35	30.43	34.78	21.74
Bodily - Kinesthetic (Body Smart)	I learn through touch and movement. I am best at processing information by standing up and moving rather than sitting still.	4.35	13.04	39.13	39.13	4.35
Interpersonal (People Smart)	I learn through relating to others by sharing, comparing, and cooperating.	17.39	60.87	17.39	4.35	0.00
Intrapersonal (Self Smart)	I learn by working alone and setting individual goals. I consider myself independent and organized.	21.74	43.48	26.09	4.35	4.35
Naturalistic (Nature Smart)	I learn best by working with nature. I enjoy learning about living things and natural events.	17.39	13.04	47.83	21.74	0.00

From the data collected the top four preferred learning preferences in descending order are Verbal – Linguistic (86.95% of students agree), Interpersonal (78.26% of students agree), Visual – Spatial (73.91% of students agree), and Logical – Mathematical (73.91% of students agree), as shown in Table 6. On the contrary, Auditory – Musical (13.05% of students agree) was the least preferred method of learning. The high standard deviation in each of the data areas indicates the data is spread out over a wide range of values. It can be concluded that the students do not have one dominant method for learning new information, but the class makes use of multiple intelligence. The traditional course curriculum incorporated lectures, homework, tests, and a group project. By

incorporating additional emerging teaching practices that cover various learning styles, the audience can reach greater potential by utilizing multiple learning combinations.

4.2.4. VAK Learning Style. The fourth instrument utilized to assess the undergraduate students is the VAK Learning Style questionnaire. This portion of the survey consisted of 13 questions that evaluated student's learning preferences by asking how he/she would generally behave in different real-life situations. The responses for each question can be viewed in Table 7.

Table 7: Student response to VAK questionnaire

#	Question	Visual Learner Response	Visual Learner Percent Response	Auditory Learner Response	Auditory Learner Percent Response	Kinesthetic Learner Response	Kinesthetic Learner Percent Response	Standard Deviation	Variance
1	Operate new equipment	Read instructions	28.89%	Listen to explanation	24.44%	Try it on my own	46.67%	0.86	0.74
2	Travel directions	Look at a map	73.33%	Ask for spoken directions	15.56%	Follow your instinct, and possibly use a compass	11.11%	0.68	0.47
3	Cook a new dish	Follow a recipe	57.78%	Call a friend for explanation	4.44%	Follow your instinct, tasting as you cook	37.78%	0.97	0.94
4	Teach someone something	Write instructions	2.22%	Explain verbally	24.44%	Demonstrate and let them try it on their own	73.33%	0.51	0.26
5	You are most likely to say	Show me	48.89%	Tell me	13.33%	Let me try	37.78%	0.93	0.87
6	You are most likely to say	Watch how I do it	35.56%	Listen to me explain	37.78%	Try it on your own	26.67%	0.79	0.63
7	You are most likely to say	I see what you mean	53.33%	I hear what you are saying	11.11%	I know how you feel	35.56%	0.94	0.88
8	Faulty goods	Write a letter	2.22%	Call in your complaint	13.33%	Send or take it back to the store	84.44%	0.44	0.19
9	Leisure	Sight seeing	17.78%	Music and conversation	26.67%	Playing a sport or DIY	55.56%	0.78	0.6
10	You would prefer	Books	15.56%	Music	28.89%	Gadgets	55.56%	0.75	0.56
11	Shopping	Browse	68.89%	Discuss with clerk	4.44%	Try on options	26.67%	0.89	0.79
12	Selecting a vacation	Read a brochure	13.33%	Listen to recommendations	44.44%	Imagine the experience	42.22%	0.69	0.48
13	Buying a new car	Read the reviews	35.56%	Receive recommendations from friends	8.89%	Test-drive all options	55.56%	0.94	0.89

The results indicated that the largest percentage of students are visual and kinesthetic learners. Table 8 shows that 42.86% of students are visual learners, 42.86% are kinesthetic learners, and 14.29% are auditory learners.

Table 8: Individual Results

Learning Style	Percent of Students
Visual	42.86%
Kinesthetic	42.86%
Auditory	14.29%

4.2.5. Motivated Strategies for Learning Questionnaire (MSLQ). The Motivated Strategies for Learning Questionnaire (MSLQ) is an instrument that is self-reported. It is used in this application to measure the motivation factors of the undergraduate students. The MSLQ contains 81 questions and is divided into two main categories: motivation and learning strategies. The motivation category contains 31 questions and is divided into three sections. The sections evaluate a student's goals and value beliefs for a course, their beliefs about their own skills to succeed within a course, and also their anxiety with regard to tests in a course. The learning strategies category contains 31 questions in order to evaluate the students' meta-cognitive and cognitive strategies as well as 19 questions in order to evaluate the students' resource management. An outline of the MSLQ can be viewed below.

1. Motivation Scales
    a. Value Components
        i. Intrinsic Goal Orientation
        ii. Extrinsic Goal Orientation
        iii. Task Value
    b. Expectancy Components
        i. Control Beliefs
        ii. Self-Efficacy for learning and performance
    c. Affective Components
        i. Test Anxiety

2. Learning Strategy Scales
    a. Cognitive and Metacognitive Strategies
        i. Rehearsal
        ii. Elaboration
        iii. Organization
        iv. Critical Thinking
        v. Metacognitive Self-Regulation
    b. Resource Management Strategies
        i. Time and Study Environment
        ii. Effort Regulation
        iii. Peer Learning
        iv. Help Seeking

The different portions within the MSLQ can be used together or can be used individually. Overall, the instrument is designed to be segmental to meet the needs of the researcher or instructor. For this reason, only a portion of the MSLQ survey was utilized in this data collection.

For this research, 23 questions were selected from the original 81 question MSLQ based on their relevance to the research. This specific mixture of questions was selected to focus on the student's value components, expectancy components, cognitive and metacognitive strategies, and resource management. More specifically, ten sub-categories were evaluated, and the results can be viewed in Table 9. A description of each sub-category is provided next.

Intrinsic Goal Orientation: "Goal orientation refers to why a learner engages in an academic task. Learners with intrinsic goal orientations possess real interest in the learning process and aspire to increase their knowledge of the subject matter." (Taylor 2012, p.4)

Extrinsic Goal Orientation: “Extrinsic goal orientation describes learner’s interest in engaging in a task due to causes outside the individual, such as to demonstrate their ability, to outperform others, and/or to receive some external benefit such as getting good grades, recognition, or a reward.” (Taylor 2012, p. 4)

Task Value: “Task value refers to an individual’s appreciation for a task’s relevance. Task value relates to the degree of personal interest a learner has for a given task and includes beliefs about utility, relevance, and importance.” (Taylor 2012, p.5)

Self-efficacy: “In general, self-efficacy refers to a person’s judgments of their capabilities to perform an action successfully. Academic self-efficacy applies this general definition of efficacy to one’s internal belief for executing and succeeding in academic tasks at designated success levels.” (Taylor 2012, p.5)

Elaboration: “Elaboration is a learning strategy in which a learner paraphrases or summarizes learning material to help the individual understand the material. This strategy is intended to build internal connections between one’s prior knowledge and the new material. This strategy is considered a higher order learning skill because the strategy allows learners to store learned information into long-term memory.” (Taylor 2012, p.5)

Metacognitive Self - Regulation: “Metacognition refers to how one thinks about thinking; it encompasses methods of a learner’s awareness and knowledge of their cognitive processes.” (Taylor 2012, p.6)

Time and Study Environment: “Time and study management involves choosing environments that are conducive to learning (i.e., free from distractions) and effectively scheduling, planning, and managing one’s study time.” (Taylor 2012, p.6)

Effort Regulation: “Effort regulation enhances the ability of the learner to handle setbacks and failures within the learning process by correctly allocating resources and appropriate effort to increase more successful learning in the future.” (Taylor 2012, p.6)

Peer Learning: “Peer learning involves using peers (friends, classmates, etc.) to collaboratively understand course material or information to be taught.” (Taylor 2012, p.6)

Help Seeking: “Help seeking can be an adaptive learning strategy that allows a learner to optimize learning by seeking help from local resources such as instructors, peers, tutors, or even additional textbooks.” (Taylor 2012, p.7)

Instead of following the seven point Likert scale utilized in the original MSLQ study, the undergraduate Quality class students continued utilized the 5 point Likert scale to maintain consistency throughout the survey. The results for each question can be viewed in Table 9.

Table 9: MSLQ survey results

	Percentage responses				
Questions	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
INTRINSIC GOAL ORIENTATION					
In a class like this, I prefer course material that really challenges me so I can learn new things	7.32	39.02	43.90	7.32	2.44
In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.	24.39	60.98	14.63	0.00	0.00
The most satisfying thing for me in this course will be understanding the content as thoroughly as possible.	7.32	46.34	39.02	7.32	0.00

Table 9: MSLQ survey results (continued)

Questions	Percentage responses				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
When I have the opportunity, I choose course assignments I can learn from even if they don't guarantee a good grade.	7.32	34.15	41.46	14.63	2.44
EXTRINSIC GOAL ORIENTATION					
Getting a good grade in this class is the most satisfying thing for me right now.	19.51	46.34	14.63	19.51	0.00
The most important thing for me right now is improving my overall grade point average, so my main concern in this class is getting a good grade.	17.07	39.02	17.07	19.51	7.32
I want to do well in this class because it is important to show my ability to my family, friends, employer or others.	26.83	39.02	21.95	12.20	0.00
TASK VALUE					
I think the course material in this class is useful for me to learn.	46.34	53.66	0.00	0.00	0.00
I believe I will receive an excellent grade in this class.	24.39	65.85	9.76	0.00	0.00
I'm certain I can understand the most difficult material presented in the readings for this course.	29.27	48.78	19.51	2.44	0.00
I'm confident I can learn the basic concepts taught in this course.	70.73	29.27	0.00	0.00	0.00
I'm confident I can understand the most complex material presented by the instructor in this course.	24.39	63.41	12.20	0.00	0.00

Table 9: MSLQ survey results (continued)

Questions	Percentage responses				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
ELABORATION					
I try to relate ideas in this subject to those in other courses whenever possible.	26.83	56.10	17.07	0.00	0.00
METACOGNITIVE SELF-REGULATION					
When reading for a course, I make up questions to help focus my reading.	4.88	21.95	41.46	21.95	9.76
TIME AND STUDY ENVIRONMENT					
I attend class regularly.	53.66	39.02	7.32	0.00	0.00
EFFORT REGULATION					
When course work is difficult I give up or only study the easy parts (REVERSED).	2.44	4.88	7.32	65.85	19.51
Even when the course materials are dull and uninteresting, I manage to keep working until I finish.	21.05	68.42	10.53	0.00	0.00
When studying for this course, I often try to explain the material to a classmate or a friend.	14.63	43.90	31.71	9.76	0.00
I try to work with other students from this class to complete course assignments.	17.07	56.10	19.51	4.88	2.44
When studying, I often set aside time to discuss the course material with a group of students from the class.	7.32	21.95	43.90	21.95	4.88
HELP SEEKING					
Even if I have trouble learning the material for a class, I try to do the work on my own without help from anyone (REVERSED).	7.32	46.34	19.51	17.07	9.76

Table 9: MSLQ survey results (continued)

Questions	Percentage responses				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I ask the instructor to clarify concepts I don't understand well.	17.07	58.54	14.63	9.76	0.00
When I can't understand the material in a course, I ask another student in the class for help.	21.95	58.54	7.32	7.32	4.88

The final scores are constructed by taking the mean of all the questions within each sub-category. For instance, intrinsic goal orientation has four questions. The class score for intrinsic goal orientation would be calculated by summing the four items and taking the average. The question marked as "reversed" under "*Help Seeking*" is negatively worded and was inverted before calculating the final score. The averages can be found in Table 10.

Table 10: Averages for each category

Questions	Percent Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
INTRINSIC GOAL ORIENTATION	11.59	45.12	34.76	7.32	1.22
EXTRINSIC GOAL ORIENTATION	21.14	41.46	17.89	17.07	2.44
TASK VALUE	46.34	53.66	0.00	0.00	0.00
SELF-EFFICACY	37.20	51.83	10.37	0.61	0.00
ELABORATION	26.83	56.10	17.07	0.00	0.00

Table 10: Averages for each category (continued)

Questions	Percent Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
METACOGNITIVE SELF-REGULATION	4.88	21.95	41.46	21.95	9.76
TIME AND STUDY ENVIRONMENT	53.66	39.02	7.32	0.00	0.00
EFFORT REGULATION	11.75	36.65	8.92	32.93	9.76
PEER LEARNING	13.01	40.65	31.71	12.20	2.44
HELP SEEKING	16.26	44.72	13.82	21.14	4.07

The statics report the students have a very high task value (100%) and have devoted time and dedicated study environment (92.68% agree).

4.2.6. Summary of Survey Conclusions. The survey results indicated that the student's appreciated hands–on activities, group projects, and traditional lectures in previous classes. The open ended questions reiterated their interest by requesting hands – on projects and real-world scenarios that would tie the course material into his/her future career. The students also showed a great concern for improving their future career prospects and being marketable by improving their GPA. The individuals demonstrated strengths including intelligence and leadership skills, but activities were required to maintain their focus and inspire them to learn more about the topics being presented. The students also reported struggling with perfectionism. The MSLQ survey confirmed this observation by having low scores within the effort regulation (only 48.40% agreed that they could handle setback and failures).

The multiple intelligence survey concluded that verbal – linguistic, interpersonal, logical – mathematical, and visual – spatial learning methods should be considered while incorporating new activities into the curriculum. Likewise, the VAK survey questionnaire advised activities that tailored towards visual and kinesthetic learners. It is important to note, that incorporating specific activities that assist visual and kinesthetic learners decreased the percent of teaching methods and techniques that would cater to the auditory learner. The House of Quality helped rank these decisions to provide the optimal solution.

4.3. PHASE 2: PRODUCT SPECIFICATION PHASE

The House of Quality (HOQ), which is one of the tools within QFD, gives researchers a graphical display that is both clear and powerful because of its ability to condense a significant amount of information and show relationships between different elements (Hwarng and Teo, 2000). The sequence for constructing a HOQ began with constructing the list of customer needs and benefits from the initial survey given to the class.

Data collected from the learning style preference survey was utilized in order to determine the customer needs as well as their weight/importance. The emerging teaching tools identified in the literature review were evaluated as possibilities to be incorporated into the course.

After creating lists of the student's learning style, the university requirements, and optional teaching tools/techniques, a focus group was assembled to build the House of Quality. The focus group consisting of six students from different majors (including mechanical engineering, aerospace engineering, and engineering management) and

degree progression (freshman, sophomore, junior, and senior). The group was designed to be diverse to provide different perspectives when determining correlations and weighting. The outcome of this discussion can be found in Figure 4.

Strong Relationship	1
Moderate Relationship	0.112
Weak Relationship	0.059

Row #	Weight / Importance		Colum #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	26
			Teaching Methods and Educational Tools / Student Needs	Flipped Classroom	Synchronous Instruction	Asynchronous Instruction	Mobile App instead of textbook	Hands - on Examples	Discussion Board	Games/Competition	Social Media	Field Expert - Guest Speakers	Blended/Hybrid Delivery	Company Project	Networking Opportunities	Quality Certificates	Leadership Positions	Research Projects	Clickers	Quizlet	Ted-Ed Videos	Assignment Weighting System	Required Attendance	Case Studies	Group Project	Traditional Lectures	Global Projects	Video Solutions with step by step explanation	Scoop.IT	Tests/Exams
1	1.000	Learning Style	Verbal - Linguistic						1		1				0.112						0.112				1	1			0.059	
2	1.000		Interpersonal	1							0.1				0.059		0.112								1		1			
3	1.000		Logical - Mathematical					1		0.059										1										
4	1.000		Visual - Spatial																		1					0.112		1		
5	0.112		Intrapersonal	0.112	1	1							1					0.059		0.112	0.059								1	
6	0.112		Naturalistic																											
7	0.059		Bodily - Kinesthetic	0.112				1		1										1										
8	0.059		Auditory - Musical		0.112	0.112															1					1				
9	0.059	Motivaiton	Task value									0.112		0.112																
10	0.059		Time and study environment																1											
11	0.059		Self - efficacy																											θ
12	0.112		Elaboration									1		1										0.112			0.112		1	
13	0.112		Extrinsic goal orientation							1					0.112	1			0.059											
14	1.000		Help seeking	1			0.059		0.112						0.059													0.059		
15	1.000		Intrinsic goal orientation									1		1															1	
16	1.000		Peer learning	1					0.112	0.112	0.112		0.112		0.112								0.059		1		0.112			
17	1.000		Effort regulation																				0.059							0.112
18	0.112		Metacognitive self-regulation																											
19	1.000	Requests from open - ended quesitons	Improve career prospects									0.059		0.112	0.112	1	0.112							0.059			0.059			
20	0.112		Measure performance	0.112							1		0.112						1	0.112	0.059					0.059		0.112	0.059	
21	1.000		Increase motivation	1				1	0.112	0.112		0.112	1	0.112	0.112					1				1				1	0.112	
22	1.000		Provide real world examples					0.059			0.112	1		1	0.059			0.059								0.059	0.112		1	
23	0.112		Improve group (social) interaction	1					0.112	0.112	0.112		0.112		0.112								0.059		1		0.112			
24	0.112		Inspire continual learning				0.112					0.112						0.059											1	
25	1.000		Payback cost of education									0.059		0.112	0.112	1	0.112							0.059			0.059			
26	1.000		Increase confidence in graduating	0.112									0.112																	
27	1.000		Maintain focus during class time	1				1			1		1						1				0.059	1		0.059		0.112	0.059	
28	0.112		Improve grade point average	0.112				0.059	0.112	0.112	0.112		0.112						1	0.112	0.112		0.112					0.112	0.112	1
29	0.112		Provide congruency between classes											1				0.112						0.112			0.112		1	
30	0.112		Improve self-directed learning			1														1	1							0.112		
31	0.059		Provide leadership opportunities													0.112	1								0.059					
			Technical Requirement Importance	5.27	0.12	0.23	0.07	3.12	1.36	0.48	2.47	2.36	2.37	2.57	0.76	2.12	0.40	0.08	1.29	2.21	1.31	0.00	0.20	2.14	3.12	1.30	1.38	2.21	2.70	0.22
			Rank Order	1	24	21	26	2	14	19	6	8	7	5	18	12	20	25	17	9	15	27	23	11	3	16	13	9	4	22
			Difficulty (0 = Easy to Accomplish, 10 = Extremely Difficult)	9	9	9	9	3	3	6	3	6	9	9	6	9	6	9	3	1	6	3	3	6	3	1	9	6	3	1

Figure 4. House of Quality

4.4. PHASE 3: PARTS DEVELOPMENT (TOOL SELECTION)

Based on the results of the House of Quality, three tools were incorporated into the course syllabus. The tools implemented into the curriculum were TED-Ed lessons, Quizlet, and Scoop.it. These items were selected based on meeting the customers' needs as prioritized in the survey results. These tools also had lower difficulty levels for implementation and could be incorporated into the class curriculum in a succinct timeframe.

4.4.1. Tool Selected 1: TED - Ed Lessons. TED-Ed is an educational website where teachers can create or share educational lessons with students. This online website also encourages collaboration between educators to create customized lessons. Users can then distribute the lessons, publically or privately, and track the impact it has on the individual student.

This tool catered to the visual – spatial, auditory – musical, and interpersonal individuals. Figure 5 shows an example of a TED-Ed lesson provided in the undergraduate Quality class. Students were able to receive supplementary explanations and examples of the course material by initially viewing a video. Students could explore the subject further by answering questions within the "Think" section, explore additional resources within the "Dig Deeper" section, or converse with classmates within the "Discuss" section.

Figure 5. TED-Ed Lessons

4.4.2. Tool Selected 2: Quizlet. Quizlet is a website which provides learning tools for students. These learning tools include 1) flashcards - review the material by shuffling/randomizing, 2) learn mode - track correct/incorrect answers to focus study time on ones the student missed, 3) speller mode - challenge the student to type the auditory message they receive, 4) test mode - randomly generates tests based on the student's flashcard set, 5) scatter – student races against the clock by dragging and matching terms with correlating definition, 6) space race – the student types in the answer as the term/definition scrolls across the screen.

Quizlet is tailored for the logical – mathematical and bodily – kinesthetic learners. This tool helped the students master the course concepts and prepare for exams by playing games. Figure 6 shows an example of the "Scatter" game. The terms and

definitions have been randomly dispersed across the screen and the student has to classify the correct term and definition. The continual movement holds the attention of the kinesthetic learners and encourages him/her to continue participating.

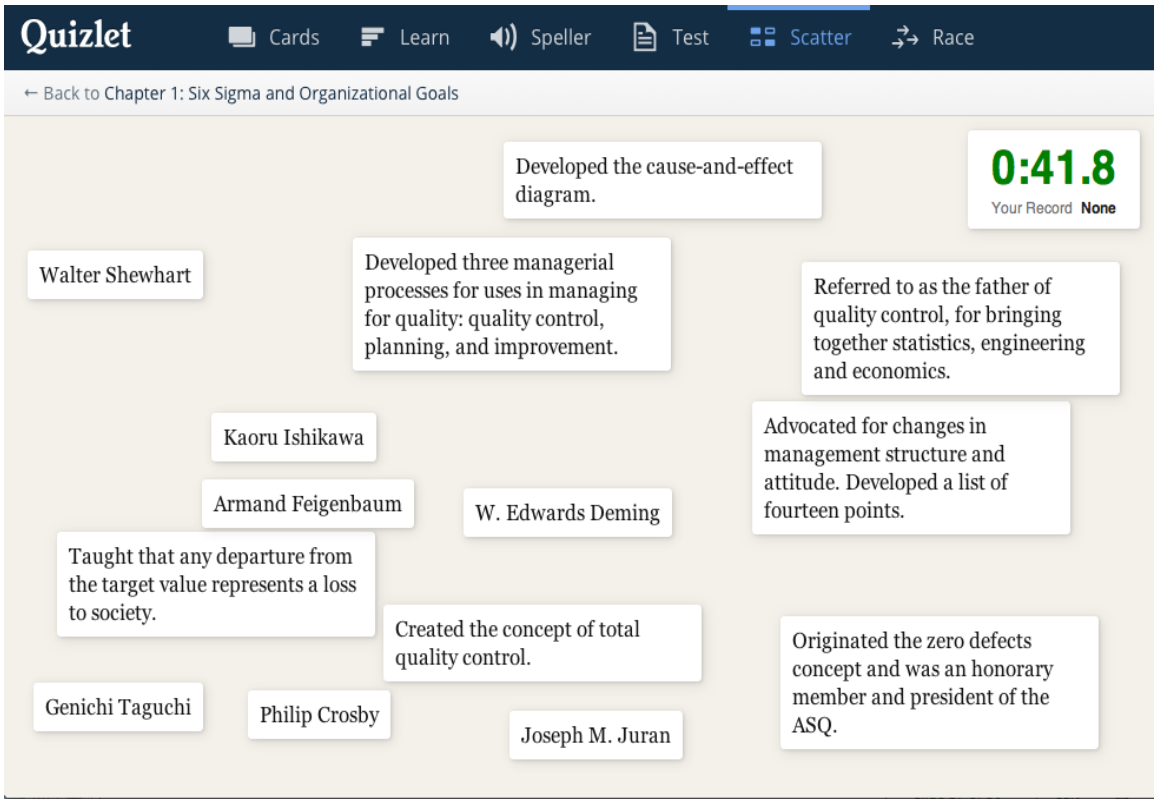

Figure 6. Quizlet

4.4.3. Tool Selected 3: Scoop.it. Scoop.it combines the benefits of a social networking sight with educational materials. This particular tool allows a student or teacher to create content-based on topics he/she selects, and then share thoughts on the content. Sharing thoughts and material allows individuals to connect based on similar interests. Scoop.it allows teachers to share real-world applications of the learning material and connect the students with subject matter resources.

Scoop.it provides students with the ability to relate the class material to real-world applications. These articles also offer students the opportunity to connect course principles to their future career interests. The intent was to make the information meaningful to the students and inspire continual self-directed learning on the topics. Figure 7 shows an example of the Scoop.it page used in the undergraduate Quality class.

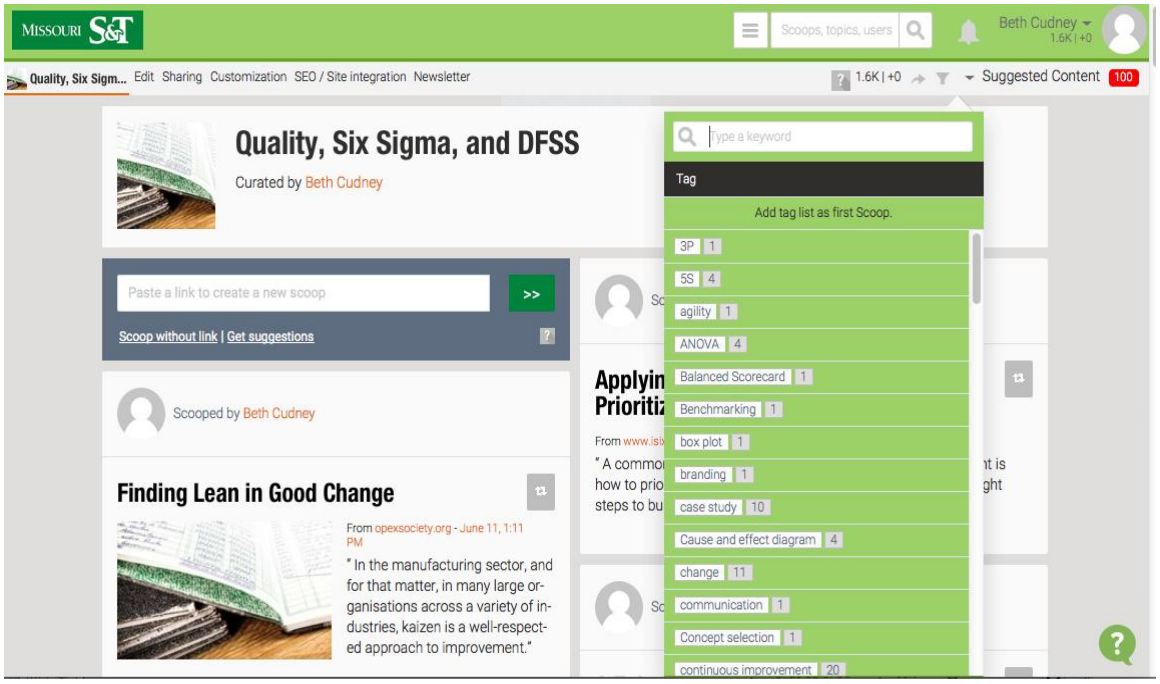

Figure 7. Scoop.it

The tools selected incorporated many of the customer requirements into the course. These three tools focused on the student's preferred methods for learning, and provided more opportunities for him/her to learn the material. Even though these tools highlighted the strengths of the visual and kinesthetic learner, they did not detract from the auditory learner. Instead, the tools provided additional group interaction through the discussion board, games, and test preparation guides.

4.5. PHASE 4: IMPLEMENTATION PHASE

After utilizing the House of Quality to select the learning instruments, preparation began to modify the tools to fit the class application. Within the case study, the use of the new tools was optional, but highly recommended. To motivate the students to try the tools, one to two test questions were taken from the TedEd lessons or Quizlet offered within the section. The class syllabus can be viewed in Figure 8.

EMgt 4710: Quality
Course Schedule
Spring 2015

Date	Topic	Reading	Scoop.It Topics*	Ted.Ed Videos	Homework/ Assignments Due
Jan. 20	Introduction - Course Overview, Grading, Semester Project			What is quality and continuous improvement?	
Jan. 22	Six Sigma and Organizational Goals	Ch. 1	Change, Continuous Improvement, Leadership, Quality Gurus	Introduction to Six Sigma	
Jan. 27	Lean Principles Design for Six Sigma	Ch. 2 and 3	DFSS, Flow, Lean, Kaizen, Pull, Supply Chain, Waste		HW#1
	DEFINE PHASE				
Jan. 29	Define – Process Management for Projects Define – Project Management Basics	Ch. 4 and 5	Project Management		HW#2
Feb. 3	Define –Management and Planning Tools Define –Business Results for Projects	Ch. 6 and 7	Benchmarking, Case study, Cost of Poor Quality, Customer	Is your process capable?	
Feb. 5	Define –Team Dynamics and Performance	Ch. 8	Culture, Teams		HW#3
Feb. 10	Define –Commonly Used Define Phase Tools	Ch. 9	Project Charter, FMEA	Will your process fail? Using FMEA	
Feb. 12	Define –Commonly Used Define Phase Tools Cont'd **ONE PAGE SEMESTER PROJECT PROPOSAL DUE**		Process Flow Diagram		HW#4 Project Proposal (Charter)

Figure 8. Class Syllabus

Periodic checkpoints were conducted throughout the semester to monitor the student's enthusiasm and utilization of the tools. These checkpoints included looking over the participation within each program and having informal conversations with the students.

The intentional checkpoints provided an opportunity for students to ask for clarification. In one instance, students asked for guidance on the topic of the group project. Even though the group project was not modified from the previous semester, the method for completing this case study allowed the students to feel comfortable asking for help within the class.

Table 11 displays the results of the student's views of provided TedEd and YouTube videos.

Table 11: Student Performance Quality Class Spring 2015

	Views	
Lesson/Video Titles	*TED-Ed Lessons*	YouTube Channel
Will Your Process Fail?	*56.0*	N/A
Is Your Process Capable?	9.0	14.0
Do You Measure Up?	16.0	21.0
How Do You Measure Up?	16.0	17.0
FMEA	30.0	76.0
What is Quality and Continuous Improvement?	45.0	58.0
Design for Experiments Example	N/A	13.0
Introduction to Six Sigma	N/A	59.0

4.6. PHASE 5: ACCEPTANCE TESTING PHASE

After the new learning tools were incorporated, a survey was provided to the students at the end of the semester. The purpose of the end of semester survey was to collect feedback from the students. The survey inquired about the students' use of the

tool, questioned if the tool was helpful in his/her studies, and asked if the students would recommend this tool for the next semester. The frequency student utilized Quizlet, Scoop.it, video solutions, and TED-Ed lessons can be viewed below in Table 12.

Table 12: Students' responses to survey

	Percent Response				
Did you utilize the tool?	**Often**	**Semi-frequently**	**Neutral**	**Rarely**	**Never**
Quizlet	11.36	34.09	9.09	25.00	20.45
Scoop.it	4.35	43.48	21.74	19.57	10.87
Video Solutions	18.60	51.16	9.30	11.63	9.30
TED-Ed Lessons	20.45	29.55	18.18	11.36	20.45

The survey results reported 45.45% of students utilized Quizlet, 47.83% utilized Scoop.it, 69.76% utilized the video solutions, and 50.0% utilized the TED-Ed lessons either often or semi-frequently. Figure 9 shows a bar chart with the frequency students utilized each tool.

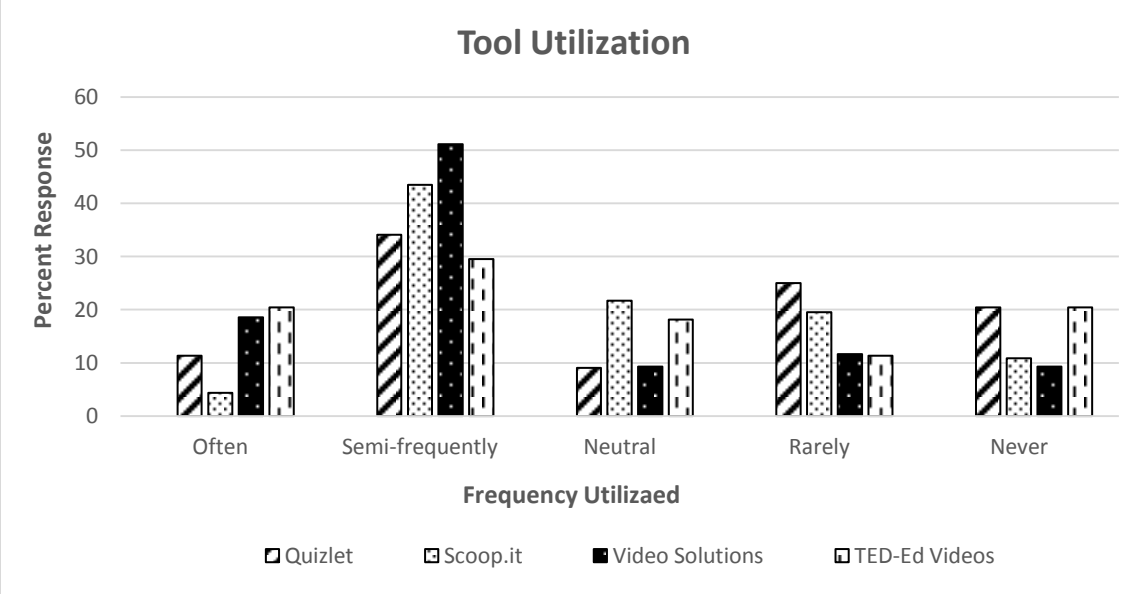

Figure 9. Utilization of Tools

The students also appraised the helpfulness of each tool and specified if he/she would recommend this tool for future classes. The results to both questions can be viewed in Table 13.

Table 13: Students' responses to survey

	Percent Responses						
Questions	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**Standard Deviation**	**Variance**
Quizlet							
The tool was helpful	15.91	40.91	25.00	0.00	0.00	1.65	2.71
I would recommend this tool for the next class	18.18	47.73	20.45	0.00	0.00	1.52	2.30
Scoop.it							
The tool was helpful	10.87	45.65	32.61	0.00	0.00	1.34	1.79
I would recommend this tool for the next class	15.22	43.48	28.26	0.00	2.17	1.42	2.02
Video Solutions							
The tool was helpful	23.91	50.00	17.39	2.17	0.00	1.45	2.10
I would recommend this tool for the next class	26.09	47.83	10.87	4.35	0.00	1.48	2.19
TED-Ed Lessons							
The tool was helpful	22.73	40.91	22.73	2.27	0.00	1.47	2.16
I would recommend this tool for the next class	31.82	25.00	25.00	4.55	2.27	1.59	2.53

From the results, students found the video solutions and TED-Ed lessons to be the most helpful tools with 73.91% and 63.64%, respectively, in agreement. The students also agreed that Quizlet and Scoop.it were helpful at 56.82% and 56.52% respectively. Furthermore, the students advocated using the tools in the next class with 73.92% in agreement for the video solutions, 65.91% in agreement for Quizlet, 58.70% in agreement for Scoop.it, and 56.82% in agreement for the TED-Ed lessons.

The final survey also inquired about the group project and gave students the opportunity to provide open feedback on his/her experience. Table 14 provides statistical results of the students' view of the group project. Overall, the students had a very positive experience, and offered suggestions for making enhancements for the next semester. One student commented: "I thought the project was beneficial to my learning but there was not very much structure in what was expected of us. I would consider maybe more structure in the group project so we fully understand what needs to be done." The periodic checkpoints and anonymous feedback provided through the survey permitted the opportunity to make even the existing course tools stronger.

Table 14: Group Project

	Percent Responses						
Questions	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**Standard Deviation**	**Variance**
I would recommend having a group project next semester	34.78	47.83	10.87	4.35	2.17	0.91	0.84
The group project helped clarify the course concepts	32.61	50.00	8.70	8.70	0.00	0.88	0.77
I struggled with the ambiguity of the course project	11.36	15.91	27.27	34.09	11.36	1.19	1.41

4.7. PHASE 6: RECALIBRATION PHASE

Feedback was gathered from the students about eight additional teaching tools and techniques. The eight tools included: 1) watching lectures outside of class to participate in more hands – on activities (i.e. flipped classroom), 2) providing additional video solutions, 3) arranging expert guest lectures, 4) making a certificate in six sigma available, 5) arranging global projects, 6) utilizing a mobile app instead of a textbook, 7) coordinating a company visit (site visit), and 8) using clickers during lecture. The questions and results can be viewed in Table 15. His/her opinion was used to assemble a schedule for incorporating more tools into future curriculum.

Table 15: Students' responses for survey in Quality course

	Percent Responses				
Questions	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
THE FOLLOWING TOOLS SHOULD BE IMPLEMENTED NEXT SEMESTER					
Watch lectures outside of class and use class time to participate in more hands-on activities	13.16	23.68	28.95	18.42	15.79
Additional video solutions	18.42	57.89	21.05	0.00	2.63
Expert guest lectures	26.32	36.84	31.58	2.63	2.63
Certificate in Six Sigma	57.89	31.58	7.89	2.63	0.00
Global projects	18.42	23.68	50.00	2.63	5.26
Mobile app instead of textbook	26.32	21.05	31.58	13.16	7.89
Company visit (site visit)	44.74	31.58	23.68	0.00	0.00
Clickers	10.53	13.16	36.84	15.79	23.68

The students indicated enthusiasm for making a certificate in six sigma available (89.47% agreed), coordinate a company/site visit (76.32% agreed), and providing additional video solutions (76.31% agreed). This feedback was taken into consideration and curriculum adjustments were implemented within the guidelines and standards set by University. These approval phases are still in progress.

5. CONCLUSION

Based on the final survey results, the quantity of Scoop.it and Quizlet utilized within the class curriculum will remain the same. Since the students had a positive response to the TED-Ed lessons, additional videos will be incorporated into the next class. Furthermore, alterations will be made to the group project outline to offer clarity. The students will be provided with a table to use as a checklist and guide when completing the project. The table will supply a list of all the quality topics taught in the class. The students will be prompted to justify if the quality tool should be used in his/her project, how he/she will use it, and what the data results tell him/her. This method acts as an outline to guide the student's thought process and progression through the project. Along the same lines, students showed enthusiasm for the opportunity to earn a certificate in Six Sigma. The prospect of incorporating a certification program into the curriculum is under investigation.

The quality of education was improved by using QFD to redesign the undergraduate course. The survey results suggest that introducing the new learning tools into the curriculum was beneficial to the students and there were no negative impacts observed on the student's education. Students felt the tools were relevant when learning the course concepts and would recommend using them in future classes.

The voice of the customer was clearly defined using the integrated survey comprised of Theory of Multiple Intelligence, VAK learning questionnaire, and MSLQ. The House of Quality translated the student's needs into development goals and technical capabilities. This method was a proactive approach to education development, and

maintained an intense customer focus. The curriculum and student's interest were enhanced when suitable technology was applied and clear personal feedback was permitted.

6. FUTURE RESEARCH

Future semesters will continue to participate in a beginning and end-of-semester survey to create a longitude trend that can be utilized in future studies. The current analysis was performed using anonymous surveys, but future studies could benefit from using analytics software. The software would correlate the student's grade with his/her learning preference and utilization of the tools.

In addition, the demographic background of the students surveyed within the case study is almost homogeneous. A majority of the students were seniors majoring in Engineering Management. Future studies could extend the survey into additional undergraduate and graduate classes. The learning styles and motivation factors may change between semesters and between degree programs.

The QFD analysis will be re-examined every 2 – 3 semesters to compare student learning preference trends with evolving teaching methods.

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III. EVALUATING THE IMPACT OF TEACHING METHODS ON COMPREHENSION AND KNOWLEDGE RETENTION

Julie M. Ezzell and Dr. Elizabeth A. Cudney

Abstract

Educational institutions are consistently looking for ways to prepare students for the competitive workforce. The challenge to do more with less is carried over from industry into the classroom. Various methods have been utilized to interpret human differences, such as learning preferences and motivation, to make the curriculum more valuable. The objective of this research was to determine the impact of new teaching methods on students' comprehension and knowledge retention within an undergraduate course at Missouri University of Science and Technology. New technology and techniques tailored to the student's individual learning preferences were introduced into the curriculum. The study surveyed students at the beginning and end of a semester to determine the impact on the student's experience. The survey assessed if implementing tools that catered to the student's specific learning preference would have an impact on his/her motivation. An analysis was performed using Chi-Square test to examine how the student's education experience improved through the application of the new curriculum tools. The results showed the tools had a positive impact on the student's learning experience. The analysis also suggests that students experienced a change in motivation throughout the semester. This shows that in some aspects more investigation is required in order to identify causes for the motivational shifts.

Keywords: Quality, Six Sigma, Engineering Education, Chi-Square Test, Student Motivation, Learner Preferences

1. INTRODUCTION

The bar of success continues to be raised for future engineers to keep pace with developing technology and the global market. As the demand placed on individuals to stay competitive intensifies, educational institutions are aggressively looking for ways to prepare students for their future careers. “The National Leadership Council for Liberal Education and America’s Promise supported by the Association of American Colleges and Universities issued a report that identifies four essential learning outcomes that graduates should possess: 1) a broad base of knowledge across multiple disciplines; 2) intellectual and practical skills such as teamwork and problem-solving; 3) a sense of personal and social responsibility, including ethical reasoning; and 4) experience applying what they learn to real-world problems.” (Furterer, 2007, p. 2). It is important for educators to consider ways to better prepare students for his/her future role, but also to motivate students to prepare themselves for the future transition. Current teaching methods have produced positive results, but the transition between academia and industry can be made seamless when motivational techniques and advances in technology are incorporated into the curriculum (Cudney et al., 2011). This study focuses on evaluating the motivation of an undergraduate Engineering Management class as they learn the principles of Quality and Six Sigma.

Quality management is a methodology that provides tools and techniques to maintain a desired level of excellence. Quality is determined by customer expectations and the goal is to achieve a defect free process (Ficalora and Cohen, 2009; Kanigolla et al., 2013). Similarly, Six Sigma is an improvement methodology focused on meeting customer requirements and stakeholder expectations by measuring and eliminating

defects (Siddh et al., 2014). Six Sigma uses a five–phase problem solving methodology for increasing productivity and customer satisfaction. These phases include define, measure, analyze, improve, and control (DMAIC). Six Sigma and Quality improvement were originally implemented in business sectors, but have been used in manufacturing environments with significant success (Chookittikul and Chookittikul, 2008; Lee and Haider, 2012). Teaching students the problem solving methodology, statistical tools, and quality tools offered within the quality and six sigma principles will help prepare graduating students for future employment. "Implementing quality principles and teaching students the principles of quality will lead to flexible learning that increases the effectiveness of undergraduate education and improves the student's future." (Kanigolla et al., 2013, p. 53).

The study was conducted within a course entitled, "Quality". The course is a core undergraduate course in the Engineering Management Department at Missouri University of Science and Technology. As a core course, the typical enrollment is approximately 45 students and consists of mainly junior and seniors. In this case study, 2.4% were freshmen, 22.0% were juniors, and 75.6% were seniors. The course is offered every spring and fall semester. The curriculum teaches students the basic tools and methodologies of quality engineering.

"Teaching Quality and Six Sigma in a classroom environment typically consists of lectures and the presentation of examples and case studies." (Kanigolla et al., 2013, p. 53). The course was enhanced to tailor to the student's learning preferences and increase motivation. The course was modified by adding educational tools including: 1) TED-Ed lessons, 2) Scoop.It, 3) Quizlet, and 4) video solutions. These additional tools enabled

students to gain practical knowledge in a manner that appealed to his/her learning preference. This technique also allowed the instructor to monitor the students' involvement while engaging the students in real-world applications.

Motivation is a significant factor within education because it encourages students to produce meaningful work and cultivate a desire for life-long learning. "Improving recruitment and retention of students into the engineering disciplines as well as enhancing their learning experience is a high priority amongst engineering educators." (Husman et al., 2010, p. 1). A students' mind-set towards engineering and motivation for learning influence the ways students approach education. Even though student motivation plays a large role in student success, there is no script for directly inspiring students. According to Husman et al., "Motivation, although clearly an important concept, has not established a set of theories, constructs, and measures within engineering education. Rather, the researcher or practitioner must find their own way through the psychological literature." (2010, p. 1). Several studies have been conducted to determine effective ways to increase motivation. Chickering and Zelda (1987) determined that frequent student–faculty contact in and out of class is the most important factor in student motivation and involvement. Larkin and Budny (2005) stated that a student's self–worth and abilities increase significantly when they feel valued as individuals.

Examining student behavior and observing when shifts in motivation occur provides information instructors can utilize when revising course activities. Dillon and Stolk (2012) stated that motivation has been used to provide insight into understanding people's actions since psychology shifted from a philosophical to an applied discipline in the mid 1800s. Within their study, Dillon and Stolk (2012) surveyed students at the

beginning and end of a class to observe changes in their motivation. From the results, it is possible to conclude that using surveys at the beginning and end of each semester provides insight into the student's initial motivation and possible fluctuations throughout the semester.

Building upon this research, a survey was employed in this study to measure the student's motivation at the beginning and upon completion of the course. Collecting feedback from the students provided the instructor with information that conveys the level of engagement and motivation the class was experiencing. The survey results were considered when evaluating enhancements to the course curriculum. In addition to the survey results, a comparative study was performed to analyze how motivated the students were at the beginning of the semester compared to the end of the semester.

The subsequent section presents the research methodology, the approach utilized for evaluating the surveys, and the computed results. Discussion and recommendations based on the results is provided within the conclusion.

2. METHODOLOGY

For this research, data was collected through a pre-semester survey and post-semester survey in the Quality class. The survey data was analyzed to determine the student's motivation orientations at the beginning of the semester compared to his/her perspective upon completion of the course. Students were provided with a variety of instructional tools to accommodate his/her individual learning preference and encourage motivation. The course syllabus included the following teaching methods: 1) traditional face–to–face lectures, 2) TED-Ed videos, 3) Quizlet, 4) Scoop.It, 5) group project, and 6) homework assignments. A description of each syllabus component is provided below.

- *Traditional Face-to–Face Lectures:* The course consists of weekly lectures that utilize PowerPoint presentations to teach the students the principles of Quality and Six Sigma in a traditional face–to–face setting. The lecture component occurs twice per week for 75 minutes.
- *TED–Ed videos:* TED-Ed is a website where educationalists can create and distribute lessons with students. The online website inspires collaboration between educators to develop customized lessons.
- *Quizlet:* Quizlet is a website that provides learning tools for students. These learning tools include 1) flashcards - review the material by shuffling/randomizing, 2) learn mode - track correct/incorrect answers to focus study time on ones the student missed, 3) speller mode - challenge the student to type the auditory message they receive, 4) test mode - randomly generates tests based on the student's flashcard set, 5) scatter – student races against the clock by

dragging and matching terms with correlating definition, 6) space race – the student types in the answer as the term/definition scrolls across the screen.

- *Scoop.It:* Scoop.It incorporated the benefits of a social networking sites and educational real-world applications. This tool allows students, teachers, and professionals to create and share thoughts on real-world applications.
- *Group Project:* The group project component consisted of students working in teams of three individuals to apply the course topics to a real-world, quality-based project. The students perform the define, measure, analyze, improve, and control (DMAIC) problem solving approach, provide process improvement suggestions, and control recommendations.
- *Homework Assignments:* The homework assignments provided logical and mathematical problems that would reinforce the material taught in the class. In addition, the homework assignments were selected to encourage students to gather information beyond what was taught in the class.

The pre-semester and post-semester surveys were framed by the Motivation Strategies for Learning Questionnaire (MSLQ). The survey is a self-reported instrument that Paul Pintrich and his associates were essential in developing at the University of Michigan (Pintrich et al., 1991). The original MSLQ contained 81 questions and was divided into two main categories: motivation and learning strategies. The different portions within the MSLQ can be used together or can be used individually. Overall, the instrument is designed to be segmental to meet the needs of the researcher or instructor. Only a portion of the original 81 question MSLQ survey was utilized based on their relevance to this research. A specific mixture of 28 questions was selected to focus on the

student's value components, expectancy components, cognitive and metacognitive strategies, and resource management.

The questions were categorized into eleven sub-categories, and the results can be viewed in Table 1. A description of each motivation and learning style sub-category is provided next.

- Intrinsic Goal Orientation: "Goal orientation refers to why a learner engages in an academic task. Learners with intrinsic goal orientations possess real interest in the learning process and aspire to increase their knowledge of the subject matter." (Taylor, 2012, p. 4)
- Extrinsic Goal Orientation: "Extrinsic goal orientation describes learner's interest in engaging in a task due to causes outside the individual, such as to demonstrate their ability, to outperform others, and/or to receive some external benefit such as getting good grades, recognition, or a reward." (Taylor, 2012, p. 4)
- Task Value: "Task value refers to an individual's appreciation for a task's relevance. Task value relates to the degree of personal interest a learner has for a given task and includes beliefs about utility, relevance, and importance." (Taylor, 2012, p. 5)
- Self-efficacy: "In general, self-efficacy refers to a person's judgments of their capabilities to perform an action successfully. Academic self-efficacy applies this general definition of efficacy to one's internal belief for executing and succeeding in academic tasks at designated success levels." (Taylor, 2012, p. 5)
- Elaboration: "Elaboration is a learning strategy in which a learner paraphrases or summarizes learning material to help the individual understand the material. This

strategy is intended to build internal connections between one's prior knowledge and the new material. This strategy is considered a higher order learning skill because the strategy allows learners to store learned information into long-term memory." (Taylor, 2012, p. 5)

- Metacognitive Self - Regulation: "Metacognition refers to how one thinks about thinking; it encompasses methods of a learner's awareness and knowledge of their cognitive processes." (Taylor, 2012, p. 6)
- Time and Study Environment: "Time and study management involves choosing environments that are conducive to learning (i.e., free from distractions) and effectively scheduling, planning, and managing one's study time." (Taylor, 2012, p. 6)
- Effort Regulation: "Effort regulation enhances the ability of the learner to handle setbacks and failures within the learning process by correctly allocating resources and appropriate effort to increase more successful learning in the future." (Taylor, 2012, p. 6)
- Peer Learning: "Peer learning involves using peers (friends, classmates, etc.) to collaboratively understand course material or information to be taught." (Taylor, 2012, p. 6)
- Help Seeking: "Help seeking can be an adaptive learning strategy that allows a learner to optimize learning by seeking help from local resources such as instructors, peers, tutors, or even additional textbooks." (Taylor, 2012, p. 7)

The questionnaire was based on the Likert scale rating and consisted of the categories: strongly agree (5), agree (4), neutral (3), disagree (2), and strongly disagree

(1). Instead of following the seven-point scale utilized in the original MSLQ study, the undergraduate Quality class utilized the five-point Likert scale to remain in concordance with learning preference questions contained within the same survey. The collected survey data contained anonymous responses from 41 students. The surveys were anonymous to ensure the students felt comfortable providing honest feedback. Respondents are less likely to embellish socially desirable behaviors and underreport socially undesirable ones when the possibility of embarrassment or negative repercussions is removed (Tourangeau and Yan, 2007).

The analysis is comprised of two sections. The first section discusses the percent response of each question to determine the students' motivation at the beginning and conclusion of each semester. By evaluating the number of responses for each question on the Likert scale, the analysis determined whether the students agreed or disagreed to that particular statement. The initial analysis considered agree as an aggregate of strongly agree and agree; and disagree as an aggregate of strongly disagree and disagree.

The second section analyzed the responses from the beginning and end–of–semester to observe patterns in which the students received motivation from the use of the implemented tools. Individual question comparisons identified the motivation classification the students experienced. To evaluate the responses, the Fishers Exact value (p) from the Chi-Square test of independence was employed. The Fisher's exact values are provided in Table 3.

Fisher's exact test is a statistical significant test which can be employed to deliver valid results even when sample sizes are small. The probability (p) value is generated between the range of 0.0 to 1.0. There is an indication of similarity between the response

patterns when the p value approaches 1.0. On the contrary, a lower p value (closer to 0) suggests that there is a difference in the student's motivation at the beginning of the semester when compared to the end of the semester. Fisher's Exact Test has not been used as frequently as other statistical calculations, because it involves factorials that are challenging to calculate using standard methods. However, the development of computer programs has provided a manageable way to complete these comparisons even with large sample sizes (Hackerott and Urquhart, 1990). The statistical analysis is utilized to recognize areas where the students' motivation changed throughout the semester.

3. RESULTS

The survey results were analyzed to determine the impact the education tools had on the student's motivation. The survey results in Table 1 include the percentage responses based on the Likert scale for the 41 students from the Quality course at the beginning of the semester. Similarly, Table 2 includes the percentage responses for the 38 students in the Quality course at the end of the semester. The numerical results and the Fisher's exact test values are tabulated and presented in Table 3.

3.1. FIRST PHASE

The survey contains eleven sections total. Within each of the sections are items/questions that investigate the student's view of themselves by asking similar questions more than once. The results were considered on an individual question basis and also by taking the mean of the questions within the sub-categories. For example, intrinsic goal orientation has four questions. The class score for intrinsic goal orientation would be determined by summing the four questions and calculating the average. Questions marked as "reversed" are negative worded statements, and were inverted before calculating the average.

Table 1: Beginning of Semester Survey Responses in Quality Course

	Percentage responses				
Questions	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
INTRINSIC GOAL ORIENTATION					
In a class like this, I prefer course material that really challenges me so I can learn new things	7.32	39.02	43.90	7.32	2.44
In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.	24.39	60.98	14.63	0.00	0.00
The most satisfying thing for me in this course will be understanding the content as thoroughly as possible.	7.32	46.34	39.02	7.32	0.00
When I have the opportunity, I choose course assignments I can learn from even if they don't guarantee a good grade.	7.32	34.15	41.46	14.63	2.44
EXTRINSIC GOAL ORIENTATION					
Getting a good grade in this class is the most satisfying thing for me right now.	19.51	46.34	14.63	19.51	0.00

Table 1: Beginning of Semester Survey Responses in Quality Course (Continued)

The most important thing for me right now is improving my overall grade point average, so my main concern in this class is getting a good grade.	17.07	39.02	17.07	19.51	7.32
I want to do well in this class because it is important to show my ability to my family, friends, employer or others.	26.83	39.02	21.95	12.20	0.00
TASK VALUE					
I think the course material in this class is useful for me to learn.	46.34	53.66	0.00	0.00	0.00
SELF-EFFICACY					
I'm certain I can understand the most difficult material presented in the readings for this course.	29.27	48.78	19.51	2.44	0.00
I'm confident I can learn the basic concepts taught in this course.	70.73	29.27	0.00	0.00	0.00
I'm confident I can understand the most complex material presented by the instructor in this course.	24.39	63.41	12.20	0.00	0.00

Table 1: Beginning of Semester Survey Responses in Quality Course (Continued)

ELABORATION					
I try to relate ideas in this subject to those in other courses whenever possible.	26.83	56.10	17.07	0.00	0.00
METACOGNITIVE SELF-REGULATION					
When reading for a course, I make up questions to help focus my reading.	4.88	21.95	41.46	21.95	9.76
TIME AND STUDY ENVIRONMENT					
I will attend class regularly even if attendance is not mandatory.	53.66	39.02	7.32	0.00	0.00
EFFORT REGULATION					
When course work is difficult I give up or only study the easy parts (REVERSED).	2.44	4.88	7.32	65.85	19.51
Even when the course materials are dull and uninteresting, I manage to keep working until I finish.	21.05	68.42	10.53	0.00	0.00
PEER LEARNING					
When studying for this course, I often try to explain the material to a classmate or a friend.	14.63	43.90	31.71	9.76	0.00

Table 1: Beginning of Semester Survey Responses in Quality Course (Continued)

I try to work with other students from this class to complete course assignments.	17.07	56.10	19.51	4.88	2.44
When studying, I often set aside time to discuss the course material with a group of students from the class.	7.32	21.95	43.90	21.95	4.88
HELP SEEKING					
Even if I have trouble learning the material for a class, I try to do the work on my own without help from anyone (REVERSED).	7.32	46.34	19.51	17.07	9.76
I ask the instructor to clarify concepts I don't understand well.	17.07	58.54	14.63	9.76	0.00
When I can't understand the material in a course, I ask another student in the class for help.	21.95	58.54	7.32	7.32	4.88
ADDITIONAL QUESTIONS					
I am confident in graduating.	75.61	21.95	0.00	2.44	0.00
I take responsibility for my own learning.	58.54	36.59	4.88	0.00	0.00

Table 1: Beginning of Semester Survey Responses in Quality Course (Continued)

I always go above the class requirements to makes sure I have a firm understanding of the class material.	9.76	43.90	34.15	12.20	0.00
I expect to be able to apply what I learn in this class to practical applications in my future employment.	48.78	43.90	7.32	0.00	0.00
I find using clickers/text message inputs useful in keeping my focus on the lecture during class.	4.88	24.39	39.02	24.39	7.32
I expect my knowledge and understanding to be checked regularly in this class.	12.20	58.54	21.95	7.32	0.00

The beginning of semester survey responses showed the students believed the course material would be useful for his/her education and development (100% agree). The students also indicated that they felt confident they could learn the basic concepts taught in the course (100% agree), and were even certain they could understand the most complex material presented by the instructor (87.8%). The student's responses indicated they were looking for material that aroused their curiosity, even if it was difficult to learn (85.37% agree). Even when the course materials seemed dull or uninteresting, the students believed they would manage to keep working until they finished the assignments (89.47% agree). At the beginning of the semester, a majority of the students were

confident in graduating (97.56% agree) and took responsibility for their own learning (92.68% agree). The students even claimed that they planned to attend class regularly even if attendance was not mandatory (92.68% agreed).

The survey results also identified areas where the students would encounter challenges. The student responses indicated that a slight majority (53.66%) of the individuals would go above the class requirements to make sure they had a firm understanding of the class material. The survey also indicated that 53.69% agreed that understanding the course content as thoroughly as possible would be the most satisfying thing for them.

When evaluating each motivation and learning strategy sub-category as a whole, the initial survey indicated 100.00% of the students showed an appreciation for the course's task value and relevance. The students also choose environments that are conducive to learning with a 92.68% score within the time and study environment category. Furthermore, the students positively evaluated their own capabilities with 89.02% evaluation within the category of self – efficacy. A slight majority of the class (62.60%) agreed that they had an interest in engaging in the course material due to causes outside of themselves (extrinsic goal orientation).

The pre-semester survey also reported that students selected reduced scores within effort regulation (48.40% agreed), peer learning (53.66% agree) and intrinsic goal orientation (56.71% agree). These statistics state that only a minority of the students are able to handle setback and failures during the learning process. Although, a slight majority of the students involve peers to collaboratively understand course material and possess a real interest in increasing their knowledge on the subject matter.

Table 2: End of Semester Survey Responses in Quality Course

	Percentage responses				
Questions	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
INTRINSIC GOAL ORIENTATION					
I believe the class material really challenged me and taught me new things.	13.16	55.26	21.05	2.63	7.89
This class provided material that provoked my curiosity to investigate topics beyond the course requirements.	13.16	52.63	31.58	2.63	0.00
The most satisfying thing for me in this course was trying to understand the content as thoroughly as possible.	7.89	44.74	39.47	7.89	0.00
When I had the opportunity in this class, I chose course assignments that I could learn from even if they didn't guarantee a good grade.	5.26	42.11	39.47	10.53	2.63
EXTRINSIC GOAL ORIENTATION					
Getting a good grade in this class will be the most satisfying thing for me right now.	18.42	34.21	23.68	13.16	10.53

Table 2: End of Semester Survey Responses in Quality Course (Continued)

The most important thing for me right now is improving my overall grade point average. Therefore my main concern is getting a good grade in this class.	15.79	15.79	44.74	13.16	10.53
Doing well in this class is important to me because it will show accomplishment to my family, friends, employer, or others.	10.53	63.16	13.16	10.53	2.63
TASK VALUE					
I think the course material in this class is useful for me to learn.	23.68	63.16	10.53	2.63	0.00
SELF-EFFICACY					
I'm certain I understood the most difficult material presented in this course.	7.89	63.16	18.42	10.53	0.00
I'm confident I mastered the basic concepts taught in this course.	21.05	63.16	15.79	0.00	0.00
I'm certain I understood the most difficult material presented in this course.	7.89	63.16	18.42	10.53	0.00
ELABORATION					
I tried to relate ideas in this subject to those in other courses whenever possible.	18.42	55.26	18.42	5.26	2.63

Table 2: End of Semester Survey Responses in Quality Course (Continued)

METACOGNITIVE SELF-REGULATION					
When reading for a course, I make up questions to help focus my reading.	2.63	34.21	28.95	26.32	7.89
TIME AND STUDY ENVIRONMENT					
I attend class regularly.	52.63	36.84	7.89	2.63	0.00
EFFORT REGULATION					
When the course work became difficult, I either gave up or only studied the easy parts.	0.00	10.53	23.68	52.63	13.16
Even when the course materials were dull and uninteresting, I managed to keep working until I finished them.	21.05	68.42	10.53	0.00	0.00
PEER LEARNING					
When studying for this course, I often tried to explain the material to a classmate or friend.	2.63	47.37	15.79	26.32	7.89
I worked with other students from this class to complete the course assignments.	10.53	52.63	26.32	7.89	2.63
When studying for this course, I often set aside time to discuss course material with a group of students from the class.	2.63	31.58	34.21	26.32	5.26

Table 2: End of Semester Survey Responses in Quality Course (Continued)

HELP SEEKING					
Even if I have trouble learning the material in this class, I try to do the work on my own without help from anyone (REVERSED).	13.16	60.53	21.05	2.63	2.63
I felt comfortable asking the instructor to clarify concepts I didn't understand well.	26.32	50.00	23.68	0.00	0.00
When I couldn't understand the material in this course, I would ask another student in the class for help.	15.79	50.00	21.05	10.53	2.63
ADDITIONAL QUESTIONS					
I am confident in graduating.	60.53	26.32	10.53	0.00	2.63
I take responsibility for my own learning.	42.11	44.74	10.53	0.00	2.63
I always went above the class requirements to make sure I had a firm understanding of the class material.	18.42	23.68	42.11	13.16	2.63
I expect to be able to apply what I learn in this class to practical applications in my future employment.	31.58	47.37	13.16	5.26	2.63

Table 2: End of Semester Survey Responses in Quality Course (Continued)

Clickers should be implemented next semester.	23.68	15.79	36.84	13.16	10.53
My knowledge and understanding was checked on a regular basis to maintain my focus.	23.68	63.16	10.53	2.63	0.00

The end of semester survey indicated the students felt confident they mastered the basic concepts taught in the course (84.21% agreed), took responsibility for their own learning throughout the semester (86.85% agreed), and kept working even when they felt the material was uninteresting (89.47%). Upon completion of the semester, 73.69% of the students felt doing well in the class was important to be able to show their accomplishment to their family, friends, employer or others. A majority of the class was comprised of seniors, and 86.85% felt confident that they would graduate.

At the end of the semester, 31.58% of the students agreed that the most important thing for them was to improve their overall grade point average. When given the opportunity, 47.37% of the students chose course assignment that he/she could learn from even if it did not guarantee a good grade. Furthermore, when the students were asked about their preference for working with fellow students, 50.00% agreed that they tried to explain the material to a classmate or friend, and 34.21% often set aside time to discuss course material with a group of students from the class.

The survey offered upon completion of the course indicates the students continued to place high importance on time and study environment (89.47% agreed), task value (86.84% agreed), and self–efficacy (75.44%). There was also an increase in the

percent of students (89.47% agreed) that felt comfortable seeking help from fellow students or the instructor.

3.2. SECOND PHASE

Within the second phase a comparison of the survey responses between the beginning and end of semester was performed to determine if students sustained the same level of motivation. Fisher's exact test was utilized to compare the beginning survey question with its corresponding end of survey question. The p-vales for the Fisher's exact test were calculated and are shown within the last column in Table 3.

Table 3: Survey Responses in Quality Course with Fisher's Exact Test Value

	Questions	Survey Response					Fisher's exact p-value
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	
Survey		**5**	**4**	**3**	**2**	**1**	
Beginning Survey	In a class like this, I prefer course material that really challenges me so I can learn new things.	3	16	18	3	1	0.20
End Survey	I believe the class material really challenged me and taught me new things.	5	21	8	1	3	

Table 3: Survey Responses in Quality Course with Fisher's Exact Test Value (continued)

Beginning Survey	In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.	10	25	6	0	0	0.13
End Survey	This class provided material that provoked my curiosity to investigate topics beyond the course requirements.	5	20	12	1	0	
Beginning Survey	The most satisfying thing for me in this course will be understanding the content as thoroughly as possible.	3	19	16	3	0	1.00
End Survey	The most satisfying thing for me in this course was trying to understand the content as thoroughly as possible.	3	17	15	3	0	
Beginning Survey	When I have the opportunity, I choose course assignments I can learn from even if they don't guarantee a good grade.	3	14	17	6	1	0.95
End Survey	When I had the opportunity in this class, I chose course assignments that I could learn from even if they didn't guarantee a good grade.	2	16	15	4	1	
Beginning Survey	Getting a good grade in this class is the most satisfying thing for me right now.	8	19	6	8	0	0.27
End Survey	Getting a good grade in this class will be the most satisfying thing for me right now.	7	13	9	5	4	
Beginning Survey	The most important thing for me right now is improving my overall grade point average, so my main concern in this class is getting a good grade.	7	16	7	8	3	0.05
End Survey	The most important thing for me right now is improving my overall grade point average. Therefore my main concern is getting a grade in this class.	6	6	17	5	4	

Table 3: Survey Responses in Quality Course with Fisher's Exact Test Value (continued)

Beginning Survey	I want to do well in this class because it is important to show my ability to my family, friends, employer or others.	11	16	9	5	0	0.19
End Survey	Doing well in this class is important to me because it will show accomplishment to my family, friends, employer, or others.	4	24	5	4	1	
Beginning Survey	I think the course material in this class is useful for me to learn.	19	22	0	0	0	0.04
End Survey	I think the course material in this class was useful for me to learn.	9	24	4	1	0	
Beginning Survey	I'm certain I can understand the most difficult material presented in the readings for this course.	12	20	8	1	0	0.06
End Survey	I'm certain I understood the most difficult material presented in the reading for this course.	3	24	7	4	0	
Beginning Survey	I'm confident I can learn the basic concepts taught in this course.	29	12	0	0	0	0.00
End Survey	I'm confident I mastered the basic concepts taught in this course.	8	24	6	0	0	
Beginning Survey	I'm confident I can understand the most complex material presented by the instructor in this course.	10	26	5	0	0	0.05
End Survey	I'm confident I understood the most complex material presented by the instructor in this course.	3	24	7	4	0	
Beginning Survey	I try to relate ideas in this subject to those in other courses whenever possible.	11	23	7	0	0	0.57
End Survey	I tried to relate ideas in this subject to those in other courses whenever possible.	7	21	7	2	1	
Beginning Survey	When reading for a course, I make up questions to help focus my reading.	2	9	17	9	4	0.74
End Survey	When reading for this course, I made up questions to help focus my reading.	1	13	11	10	3	

Table 3: Survey Responses in Quality Course with Fisher's Exact Test Value (continued)

Beginning Survey	I will attend this class regularly even if attendance is not mandatory.	22	16	3	0	0	0.99
End Survey	I attended class regularly.	20	14	3	1	0	
Beginning Survey	When course work is difficult I give up or only study the easy parts (REVERSED).	1	2	3	27	8	0.28
End Survey	When the course work became difficult, I either gave up or only studied the easy parts. (REVERSED)	0	4	9	20	5	
Beginning Survey	Even when the course materials are dull and uninteresting, I manage to keep working until I finish.	8	26	4	0	0	1.00
End Survey	Even when the course materials were dull and uninteresting, I managed to keep working until I finished them.	8	26	4	0	0	
Beginning Survey	When studying for this course, I often try to explain the material to a classmate or a friend.	6	18	13	4	0	0.02
End Survey	When studying for this course, I often tried to explain the material to a classmate or friend.	1	18	6	10	3	
Beginning Survey	I try to work with other students from this class to complete course assignments.	7	23	8	2	1	0.85
End Survey	I worked with other students from this class to complete the course assignments.	4	20	10	3	1	
Beginning Survey	When studying, I often set aside time to discuss the course material with a group of students from the class.	3	9	18	9	2	0.77
End Survey	When studying for this course, I often set aside time to discuss course material with a group of students from the class.	1	12	13	10	2	

Table 3: Survey Responses in Quality Course with Fisher's Exact Test Value (continued)

Beginning Survey	Even if I have trouble learning the material for a class, I try to do the work on my own without help from anyone (REVERSED).	3	19	8	7	4	0.18
End Survey	Even if I had trouble learning the material in this class, I tried to do the work on my own without help from anyone. (REVERSED)	5	23	8	1	1	
Beginning Survey	I ask the instructor to clarify concepts I don't understand well.	7	24	6	4	0	0.19
End Survey	I felt comfortable asking the instructor to clarify concepts I didn't understand well.	10	19	9	0	0	
Beginning Survey	When I can't understand the material in a course, I ask another student in the class for help.	9	24	3	3	2	0.57
End Survey	When I couldn't understand the material in this course, I would ask another student in the class for help.	6	19	8	4	1	
Beginning Survey	I am confident in graduating.	31	9	0	1	0	0.18
End Survey	I am confident in graduating.	23	10	4	0	1	
Beginning Survey	I take responsibility for my own learning.	24	15	2	0	0	0.54
End Survey	I take responsibility for my own learning.	16	17	4	0	1	
Beginning Survey	I always go above the class requirements to makes sure I have a firm understanding of the class material.	4	18	14	5	0	0.45
End Survey	I always went above the class requirements to make sure I had a firm understanding of the class material.	7	9	16	5	1	

Table 3: Survey Responses in Quality Course with Fisher's Exact Test Value (continued)

Beginning Survey	I expect to be able to apply what I learn in this class to practical applications in my future employment.	20	18	3	0	0	0.38
End Survey	I expect to be able to apply what I learn in this class to practical applications in my future employment.	12	18	5	2	1	
Beginning Survey	I find using clickers/text message inputs useful in keeping my focus on the lecture during class.	2	10	16	10	3	0.16
End Survey	Clickers should be implemented next semester.	9	6	14	5	4	
Beginning Survey	I expect my knowledge and understanding to be checked regularly in this class.	5	24	9	3	0	0.52
End Survey	My knowledge and understanding was checked on a regular basis to maintain my focus.	1	22	12	2	1	

The results were initially compared to understand the student's interest and excitement for increasing their knowledge on the subject matter at the beginning of the semester compared to the end of the semester. The data indicates there was no similarity between the initial and final survey for students desiring course material that challenged them to learn new things (p-value 0.20). The results also indicate the students had a decrease in desire for course material that aroused their curiosity when it was difficult to learn (p-value 0.13). However, students had a similar response pattern when asked if understanding the content as thoroughly as possible would be the most satisfying thing for them (p-value 1.00). The students also responded in a similar manner when asked if given the opportunity, he/she would choose course assignments that they could learn from even if it did not guarantee a good grade (p-value 0.95).

The student's self-efficacy was also compared at the beginning of the semester with the end of the semester. The student's internal beliefs for executing and succeeding in the academic tasks changed from the start to the end of the semester. The students felt less confident that they understood the most difficult material presented in the course (p-value 0.06). The results also indicate there were no similarities between the student's initial confidence in mastering the basic course concepts when compared to the end of the semester (p-value 0.00). Furthermore, the student were less certain they mastered the most difficult material presented in the course and the responses showed no similarities with a p-value of 0.05.

Finally, the students were surveyed on their ability to handle setback and failures throughout the semester by utilizing resources to increase their success. The results indicated there was a decrease in effort students gave when studying difficult material. There was no similarity between the initial survey and the final survey when the students were asked if they gave up or only studied easy parts when the course work became difficult (p-value 0.28). However, there was a strong comparison between the surveys when students were asked if they continued to keep working on the course materials even when they became dull or uninteresting.

4. CONCLUSIONS

Overall, the students displayed a continuous desire to learn the course material, and believed the material was beneficial for their development. The survey results imply that introducing the new educational tools into the Quality course was helpful to the students, and there were no negative impacts observed on the student's education. Even though the new tools catered to the student's individual learning preferences, the tools did not necessarily inspire an increase in motivation.

As the semester progressed, there was a decrease in the percent of students eager to go above and beyond the course requirements to make sure they had a firm understanding of the material. There was also a percent drop in the number of students that felt achieving a good grade or improving their grade point average was critical. On the contrary, there was an increase in the number of students that wanted to do well in the class to show their ability to family, friends, employers, or others. A majority of the class was entering into their final semester, and there was an increase in the percent of student that felt confident in graduating. The analytics clearly suggests the students experienced a change in motivation throughout the semester. This shows that in some aspects more investigation is required in order to identify causes for the motivational shifts.

5. RECOMMENDATIONS

From the results, it is unclear if the implementation of the new teaching tools in the Quality course helped increase the student's motivation throughout the semester. Since a large percentage of the students are in their senior year, it would be beneficial to incorporate topics that would relate the subject matter to their future employment or specific area of interest. Incorporating the student's individual interest would help them feel actively involved in the curriculum development process.

There is a need to inspire more self–direct learning that will compel students to research beyond the course content. The students would benefit from material that is more challenging and holds their attention until the end of the semester. Incorporating more hands-on activities, Scoop.It articles, or a certificate in Six Sigma would increase the student's active participation in the course.

6. FUTURE RESEARCH

Further research would benefit from incorporating questions into the survey that identify specific causes for the change in the student's motivation. Since a majority of the class was seniors, it would be beneficial to include questions to determine the number of semesters each individual has remaining until graduation. It would also be valuable to know if the students have an available employment opportunity. In addition, it would be advantageous to have more than two surveys offer throughout the semester. Multiple surveys would identify the timeframe when changes in motivation begin to occur.

The current analysis was performed using anonymous survey. Future studies could gain from utilizing analytics software to correlate the student's motivation throughout the semester with his/her grade. In addition, the survey could be extended into additional undergraduate and graduate classes. Student motivation may change between subject areas and semesters.

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SECTION

2. CONCLUSION

The quality of education was improved by using QFD to redesign the undergraduate course. The survey results suggest that introducing the new learning tools into the curriculum was beneficial to the students and there were no negative impacts observed on the student's education. Students felt the tools were relevant when learning the course concepts and would recommend using them in future classes.

The voice of the customer was clearly defined using the integrated survey comprised of Theory of Multiple Intelligence, VAK learning questionnaire, and MSLQ. The House of Quality translated the student's needs into development goals and technical capabilities. This method was a proactive approach to education development, and maintained an intense customer focus. The curriculum and student's interest were enhanced when suitable technology was applied and clear personal feedback was permitted.

Overall, the students displayed a continuous desire to learn the course material, and believed the material was beneficial for their development. Even though the new tools catered to the student's individual learning preferences, the tools did not necessarily inspire an increase in motivation. The analytics clearly suggests the students experienced a change in motivation throughout the semester. This shows that in some aspects more investigation is required in order to identify causes for the motivational shifts.

VITA

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