DEFINING AND DETERMINING THE IMPACT OF A FRESHMAN ENGINEERING STUDENT'S APPROACH TO LEARNING (SURFACE VERSUS DEEP)

A Dissertation

by

DEBRA ANNE FOWLER

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2003

Major Subject: Interdisciplinary Engineering

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Approved as to style and content by:

Karan Watson (Chair of Committee)	Jeffrey Froyd (Member)
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ABSTRACT

Defining and Determining the Impact of a Freshman Engineering Student's Approach to Learning (Surface versus Deep). (August 2003)

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Chair of Advisory Committee: Dr. Karan Watson

When an engineering student attends four or five years of college to become a professional engineer one makes the assumption that they approach this learning process in such a way to gain the most knowledge possible. The purpose of this study is to measure the learning approach (deep versus surface) of first-year engineering students, test the impact of two interventions (journaling and learning strategy awareness) on increasing the deep approach to learning, and determine the relationship of the approach to learning on retention within an engineering program.

The study was conducted using a quantitative self-reporting instrument to measure surface and deep learning at the beginning and end of the first and second semesters of the freshman year in an engineering program. Retention was measured as the continuous enrollment of a student in the second semester of the first-year engineering program.

Results indicate that the first-year engineering students have a slightly higher level of the deep approach to learning than a surface approach to learning when they begin college. However, the results also indicate that the deep approach to learning decreased during the first semester and during the second semester of their freshman year. A student's approach to learning can be impacted by their prior knowledge, the teaching context, the institutional context or the motivation of the student. Results surrounding the learning strategies intervention also indicate that the first-year engineering students do not possess the strong learning strategies that are anticipated from students accepted into an engineering program with stringent application requirements. Finally, results indicate that a deep approach to learning appears to have a positive relationship and a surface approach to learning appears to have a negative relationship to retention in an engineering program.

This study illustrates that incorporating learning theory and the use of current learning strategy measurements contributes to the understanding of a freshman engineering student's approach to learning. The understanding of the engineering student's approach to learning benefits faculty in establishing curriculum and pedagogical design. The benefit to the student is in understanding more about themselves as a learner.

ACKNOWLEDGMENTS

A journey begins and ends with the contribution of many individuals. First, my loving family who trusted in me to pick up everything and move on a leap of faith that it would lead to a better place in life; Timothy, Jonathan and Louis thank you for that faith and continued support through the years of coursework and the compiling of this final document. Thanks for understanding when time was limited and especially for listening to all of the new and wonderful ways that you just had to try because it could enhance your learning.

To my parents, Orville and Helen Graslie, the years and years of support that you have given me are forever cherished. It is from you that I gained the strong desire to learn. May that desire never end and may I contain that special ability to grow it in others. I would like to thank my sisters and brother who have also followed me and cheered me on in times of frustration. I always knew that I could count on you.

I would like to thank my committee members who gave me much valued time, feedback, and support throughout the entire process. My chair, Dr. Karan Watson, it was truly through your desire to improve engineering education that created this opportunity. It would not have been possible without your support in so many ways. Dr. Jeff Froyd, your understanding of the learning process and the drive to enhance the process, helped to structure this project. Dr. Richard Cummins, your patience and gentle guidance continued to move me in the direction of my goal. Dr. Charles Glover, your eye for detail and dedication to engineering will always be remembered as contributing to a better research product.

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CHAPTER I

INTRODUCTION

Basis for Study

Individuals attend post-secondary education to develop an expertise and become a professional in a designated discipline. In this case the discipline is engineering. Many colleges and universities exist to teach and grow these individuals into professional engineers. A national accreditation program assists in setting standards for universities so the quality of engineering graduates remains current and consistent with stakeholder expectations. The Accreditation Board for Engineering and Technology (ABET) defines specific criteria that university programs must demonstrate to become accredited in teaching engineering and technology. These criteria are established through a great deal of interaction with the stakeholders of the college of engineering (industry members, academicians and researchers, etc.) [2]. The most current criteria are defined for the 2003-2004 accreditation cycle [1]. Criterion 3 requires the demonstration of specific learning outcomes by seniors graduating from a university. Criterion 3 also requires that the university demonstrate the process for the assessment of those outcomes. The detailed learning outcomes state that engineering programs must illustrate their engineering graduates demonstrate the following: (a) an ability to apply knowledge of mathematics, science, and engineering, (b) an ability to design and conduct experiments, as well as to analyze and interpret data, (c) an ability to design a system, component, or process to meet desired needs, (d) an ability to function on multi-disciplinary teams,

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This dissertation follows the style and format of the *Journal of Engineering Education*.

(e) an ability to identify, formulate, and solve engineering problems, (f) an understanding of professional and ethical responsibility, (g) an ability to communicate effectively, (h) the broad education necessary to understand the impact of engineering solutions in a global and societal context, (i) a recognition of the need for, and an ability to engage in life-long learning, (j) a knowledge of contemporary issues, and (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. A key word in Criterion 3 is “learning”. The “learning” outcomes define the success of an engineering program in graduating well prepared engineers. In order to optimize the learning outcomes for students graduating in engineering one must truly understand the learning process. Once the learning process is understood, it can be analyzed and optimized through many different approaches based on learning theory research.

Texas A&M University introduced learning communities into the first-year and sophomore curricula in an effort to fulfill some of the learning outcome requirements by ABET [18]. The learning community design was developed with a focus on learning theory while incorporating some key aspects of the change process. The main components of the learning communities are 1) clustering of students in common courses (math, engineering, science); 2) teaming; 3) active/cooperative learning; 4) industry involvement in the classroom; 5) technology-enhanced classrooms; 6) undergraduate peer teachers; 7) curriculum integration; 8) faculty team teaching; and 9) assessment and evaluation. These components are recognized as key areas of teaching and learning, but when analyzing the learning process one can determine that all of these activities surrounding learning communities are focused on the environmental/external aspect of learning. Learning theory does indicate that the external factors must be considered when optimizing the learning process, [10, 29]; however, one must also consider the internal process of the student/learner. Such internal processes may include personal learning strategies, creativity, approach to learning, critical thinking and motivation toward learning. The current enhancements to engineering education at Texas A&M University, although contributing to the external component of the learning system, are lacking in the specific internal focus of the learner.

Problem

The US Department of Education's National Assessment of Educational Progress (NAEP) tests the performance of school children in mathematics, science, reading and writing every four years [16]. The results of the assessments are published by the Department of Education in *The Nation's Report Card.* The following is a quote regarding the NAEP results:

> The NAEP results show that most students have command of lower-level, rote skills, such as computation in math, recalling facts in science, decoding words in reading, and spelling, grammar, and punctuation in writing. Most students can remember facts, solve routine textbook problems, and apply formulas. Many fewer students can use what knowledge they have to solve more complex problems—problems that might take several steps and have no obvious, immediate answer. Many if not most students have difficulty using what they know to interpret an experiment, comprehend a text, or persuade an audience. They can't rise above the rote, factual level to think critically or creatively. They can't apply what they know flexibly and spontaneously to solve ill-structured, ambiguous problems that require interpretation [16, p. 5].

Bruer [16] also goes on to say that if students are to have higher-order reasoning and learning skills that one must change teaching methods and the current approach to education.

Much anecdotal information from employers indicates that job applicants are lacking communication, problem-solving, reasoning and innovation skills that are required in the workplace. This is being confirmed by engineering alumni surveys that are being conducted to meet some of the current ABET criteria [41]. Employers are also indicating that they want individuals that know how to learn [16].

Anecdotal information from the faculty at Texas A&M University indicate that students entering into current engineering programs lack the ability to solve multiple-step problems and do not contain the higher-order thinking skills necessary to dig into and solve engineering problems. The students do not contain the questioning attitude that often accompanies a desire to truly understand the meaning behind many concepts. The faculty sees the lack of higher-order thinking not only at the freshman engineering level, but proceeding on through to the junior and senior engineering levels [26]. Is all of this anecdotal and preliminary research information indicating that an opportunity exists to change some current teaching methods and the focus of the learner?

It would be of value to know how engineering students approach learning in the first-year engineering curricula. Information is lacking in answering this question and hence limits the efforts to improve teaching and learning as it relates to a student's approach to learning in a freshman engineering program.

Significance of the Study

The results of this study can impact how assessment of specific criteria for accreditation for the college of engineering is addressed in the learning outcomes, but even further than that, the results can impact course curriculum, individual course content and course delivery in the engineering classroom. If the approach to learning for entering Texas A&M freshman engineering students can be determined, then it can perhaps be generalized that a similar approach is being taken by a student with the same attributes in an engineering college at another university. The same may be true of the determination of learning strategies especially at other universities in Texas since the majority of the enrollment at the state universities is from within the state. The results may also broaden the perspective for engineering faculty to see the need for understanding a student's approach to learning and building learning strategy awareness and reflection into the classroom. Implementing some of these actions focused on the internal aspect of the learner and supported by learning theory will ultimately increase the learning performance of a university's graduating engineers.

Definitions

Learning strategies are the thoughts, behaviors or actions a learner engages in during learning that is intended to influence the acquisition, storage in memory, integration, or availability for future use of new knowledge and skills [60]. Learning strategies are directly related to how one processes information and especially as it relates to how that information can be recalled and utilized in the processing of new information.

Deep approach to learning is the desire of the learner to attach personal meaning to what is being learned. The learner will seek additional resources, discuss and reflect on the material without being asked to do so. The learner often draws on previous experience during the new learning process and thus makes a connection between the new and old information. The deep learner often asks questions about the new information that they are learning [10, 13].

Surface approach to learning is the desire to meet the requirements of the task with as little time and effort as possible. The learner is focused on the assignment or details of the assessment and not the true meaning of what is being learned. Rote learning without understanding is common in surface learning [10, 13]. Surface learning often leads to the storage of a great deal of information in memory that is not well connected.

Achieving approach to learning is the desire to reach top performance and receive the high grade. The learner is more focused on the grade than the learning outcome. The learner may actually utilize both surface and deep learning approaches, but it will be very much determined by the course objectives and requirements [10, 13].

Research Questions

Addressing the issues of lack of higher-order thinking skills and lack of data available regarding freshman engineering students' approach to learning, requires several questions to be answered. According to Biggs' 3P model of teaching and learning [13], it is important to look internally at the student and understand what type of learning approach the student brings with them to the university from the primary and secondary educational experience as well as their external environment. The approach to learning impacts how information is taken in and processed by the individual, which ultimately impacts the final outcome of the learning. Therefore, the first question investigated:

1) What is the approach to learning (surface versus deep) for a student entering the freshman engineering program at Texas A&M University?

Students acquire learning strategies to access and assist them during their learning process [39]. Again, much of this is an internal learning process occurring within the mind of the student. Research has demonstrated that one way to influence the way in which students process new information and acquire new skills is to instruct them in the use of learning strategies [59]. Students are often not aware of the processes involved in their personal learning strategies and faculty currently do not measure the student's learning strategies to have an awareness of how they might help the students to improve upon their learning strategies. Hence the second and third questions of this study:

2) What strengths and weaknesses in learning strategies do entering freshman engineering students at Texas A&M University possess (bring with them)?

3) Does making the incoming engineering students aware of their strengths and weaknesses in learning strategies impact their approach to learning (surface versus deep)?

Reflection is a technique that is recognized as a tool to increase the level of thinking [25] and is also recognized as one of the highest cognitive activities leading to a deeper approach to learning [10]. Journaling is a process that is built on the use of reflection and studies indicate that it allows the students to apply meaning to their learning as well as link previous knowledge to new material that is learned [34, 50, 53]. The fourth question investigates whether journaling on a course's text can lead to deeper learning for the freshman engineering students:

4) What is the impact of reflective journal writing regarding class reading assignments on the freshman engineering student's approach to learning?

The current freshman engineering curriculum at Texas A&M University was designed to include recent pedagogical changes such as active and collaborative learning, teaming, and curriculum integration to enhance the learning process and based on current learning theory [18]. Many of these pedagogical techniques are designed to improve the overall learning process and the ability for a student to succeed once they begin their career, but the current pedagogy fails to focus on the individual and the specific impact these techniques have on the student's approach to learning. The fifth question addresses the deep or surface approach to learning based on the current pedagogy:

5a) Do current curriculum and pedagogy for the freshman engineering students promote deeper learning at the end of the first semester of the freshman year?

5b) At the end of the second semester of the freshman year?

Finally, persistence in engineering programs is a significant issue, because nationally the percentage of engineering graduates is slightly over 50% of those who enter engineering at the freshman level [6]. The ability to increase the retention percentage has a significant potential impact, and it would be valuable to determine if the approach to learning is linked to retention. Many studies exist regarding the retention of material using the deep or surface approach to learning, but there does not appear to be studies on school retention as it relates to deep or surface learning. The sixth and final question addresses the issue of retention in an engineering program in relation to the surface or deep approach to learning:

6) What is the impact of a freshman engineering students' approach to learning on retention from first to second semester of the freshman year?

CHAPTER II

REVIEW OF THE LITERATURE

The review of the literature begins with two major learning theory models that encompass the overall picture of the learner. The models are reviewed according to the following outline:

Biggs [10, 13]

- 3P Model (Presage, Process, and Product)
- Approaches to Learning
    - Surface, Deep and Achieving
- Levels of Cognitive Activity

Hartman and Sternberg [28, 29]

- BACEIS Model (Behavior, Affect, Cognition, Environment, and Interacting Systems)
- Internal and External
    - Cognitive and Affective
    - Academic and Nonacademic

The models are followed by a review of cognitive learning strategies including, how the learner processes information, and the use of rehearsal, elaboration and organizational learning strategies in the storage of information. The review of the literature concludes with an interpretation of current research and how the research conducted in the described study may contribute to this field.

Learning Theory

3P Model

How students learn was the topic of research studies around the globe from Sweden to Great Britain to Hong Kong to the United States in the last half of the twentieth century and into the beginning of the twenty-first century [10, 15, 16, 23, 29, 35, 36, 37, 38, 42, 44, 46, 54, 54, 59] It was Marton and Saljo [37, 38], in Sweden that completed some of the initial studies to understand the qualitative differences in the learning outcomes among university students. They found that the qualitative differences were linked to the differences in the processes that were utilized to reach the learning outcomes. They first wanted to determine a better way of describing what it is that students learn (content based) instead of how much (correct number of answers) they learn [37]. The processes utilized by the university students to understand the new content were defined as either a surface-level or a deep-level of processing. The processing definitions (surface-level and deep-level) were really determined by the different student conceptions of the content. During surface-level processing the student is focused on the learning of the text itself and often uses a rote-learning strategy (memorization). During deep-level processing the student is more focused on the significance of the learned material and in comprehending what the author is trying to say. Next Marton and Saljo [38] were trying to determine if external processes imposed on the students could impact the students' utilized learning approach. In other words, were the teaching practices impacting the learner's approach to learning i.e. deep-level versus surface-level? Their results indicated that students adopt a learning approach that is determined by what is expected of them from their instructor or specific course requirements. So if a deep level of learning is a desired goal for the students in a course, then assessment techniques and learning objectives must be adopted that require the use of such skills.

Biggs [10] continued Marton and Saljo's [37, 38] research with studies in Australia, Canada and Hong Kong by bringing together several developments in educational psychological research namely:

1) The need to study in educational context and not solely in the laboratory [7, 52],

2) Learning should be from the perspective of the learner and not that of the teacher or academic researcher, specifically as it relates to how the learner uses the knowledge to interpret reality [36], and

3) Several key developments in cognitive psychology including:

a) The content of learning comes from within through personal motivation and prior knowledge and experience [21, 45],

b) Learners are aware of cognitive processes and can control them (metacognition) [24] and

c) Learning is knowledge specific and varies in content and procedure from task to task [4].

Biggs [10, 13] compiled the above information with Dunkin and Biddle's [22] original teaching model and formed the 3P model of teaching and learning. The 3Ps of the model include the *presage*-before the teaching takes place, the *process*-during the teaching, and the *product*-the outcome of the teaching. See Figure 1 for a representation of the model. The 3P model is described as a systems model because each of the components has the potential to act upon the other as indicated by the reverse arrows in the diagram.

The *presage* level is the first level of the 3P model and contains attributes that the student brings with them such as prior knowledge, abilities and motivation as well as preconceived ideas that they have about learning and how they plan to approach it. The *presage* level also contains the teaching context such as the current curriculum, method of instruction, classroom and institutional climate and assessment and evaluation techniques [10].

The *process* level is the second level of the 3P model and includes the learning activities that actually occur such as the completion of specific tasks both inside and outside of the classroom. The process level also includes the approach that the student takes towards the learning process and the completion of these tasks. It is here that the student determines the learning strategies that will be used in approaching the task. The approach to learning that a student takes is directly related to the learning outcomes and, as mentioned earlier, can actually be adjusted based on perceived expectations of the course assessments. In other words, if a student looks over the course objectives and sees that multiple choice exams are described and homework is based on problems straight out of the text, he or she will begin to plan the strategy that it will take to meet those specific objectives. Often multiple-choice exams are used when a large amount of detail is expected to be remembered and the student will focus on the details instead of the

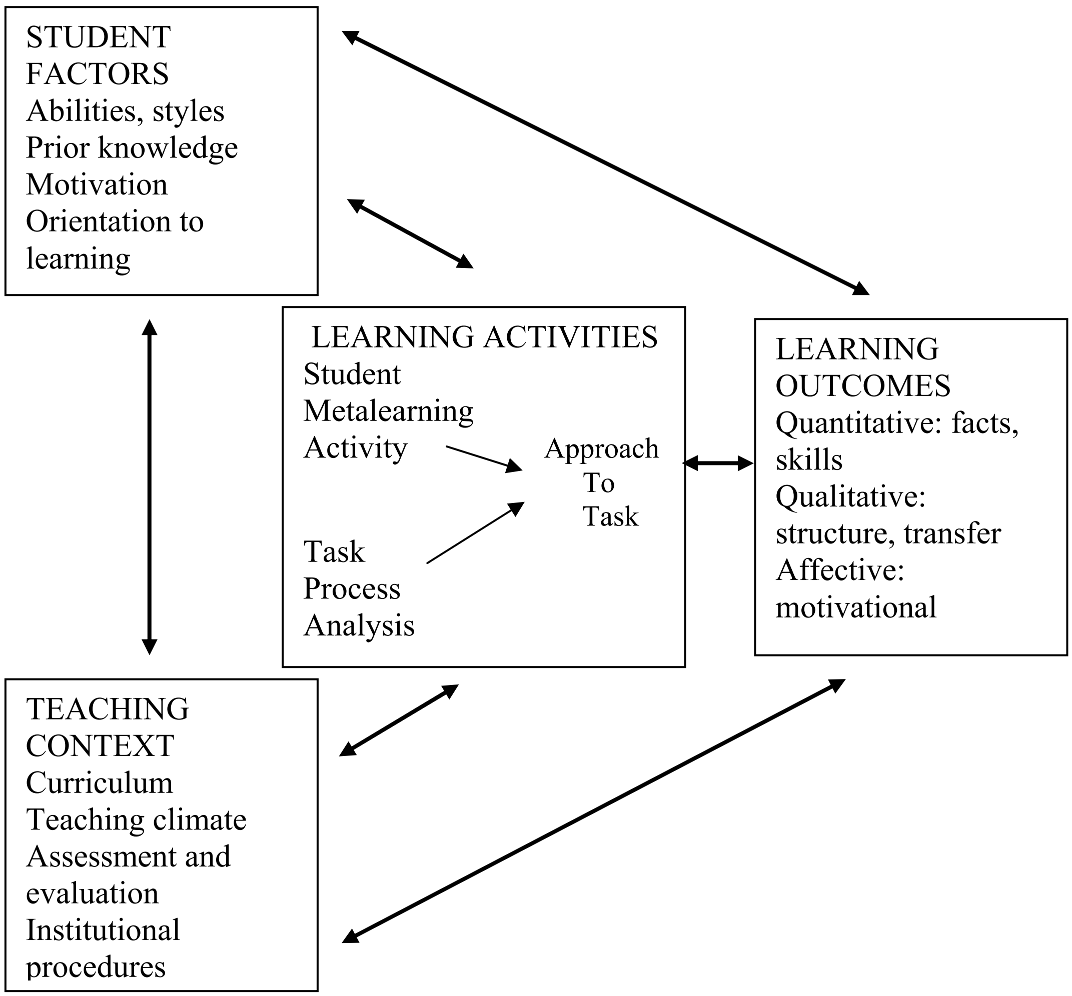

Figure 1. 3P model of teaching and learning [10, 13].

main concept. These strategies will lead to not spending the amount of time and effort that it takes to get to the deeper level of thinking.

Biggs [10] also expands on Marton and Saljo's [37, 38] deep-level and surface-level definitions regarding learning by looking at the student's motives and strategies that are utilized during the learning process to accomplish a result. He terms this as their "approach" to learning. Biggs further breaks the approach to learning into three categories: surface, deep, and achieving. Discussion in further detail assists in the understanding of the impact of these learning approaches on learning outcomes. The three approaches are described as follows:

1) The surface approach is seen as external to the task. In other words the student is working to quickly meet the requirements (homework assignments or exam questions) with as little time and effort as possible and is not really focusing on what they are trying to learn. The student will often complete only what is absolutely necessary to accomplish the required tasks for the course. Rote learning without real understanding is common with surface learning. Surface learning can result from course requirements and learning objectives that are highly focused on detail and not on a complete understanding of the basic concepts [10].

2) The deep approach is intrinsic in nature and sees the student as truly engaged in the meaningfulness of the task. The student wants to understand in more detail why the result is what it is. The deep approach is recognized as requiring a prior knowledge base because the student often makes connections to previous experiences. The student applying this approach also seeks additional resources until they feel comfortable with their full understanding of the task and its result [10].

3) The achieving approach is the focus on recognition for high performance. The student is more focused on enhancing their ego and self esteem through competition. In this approach the student is more interested in the grade than the learning outcome. The

student schedules study time around the specific syllabus requirements [10]. The student will study the syllabus at the beginning of the semester and based on the objectives and outcomes of the class, they plan schedules, create partnerships and very specifically layout what they believe it will take to reach top performance. They are likely to include both of the other surface and deep approaches at some point in the process. These three basic approaches are outlined in Table 1.

	MOTIVE	STRATEGY
SURFACE	Extrinsic: meet requirements with minimum work	Focus on selected details and reproduce accurately
DEEP	Intrinsic: satisfy curiosity about topic	Maximize understanding: read widely, discuss, reflect
ACHIEVING	Achievement: compete for highest grades	Optimize organization of time and effort

Table 1. Three approaches to learning [10].

The learning outcomes encompassed in the third level of the 3P model, the *product* level, vary greatly based on the learning approach (surface, deep, achieving) utilized [11]. The learning outcomes that result from a surface approach may consist of a broad range of information, but often there is a lack of understanding of how the information is interrelated. The deep approach is considered a high quality approach and because of the students' understanding of the information's interconnectedness, the information can be more easily recalled to augment further learning in the future. The achieving approach is typically associated with high grades and the desire for competition [10]. Specific learning outcomes in the *product* level might include concept designs, lists of facts/details, affective information such as feelings of efficacy and rationalizations of what contributed to the success/failure and the grade assigned.

Ideally, an instructor would like to maximize the deep approach to learning to get the student to a more complete understanding of the topic and to a level of knowledge where they can draw on this information in the future. Understanding the student's approach to learning can be utilized as a quality tool at all three levels and can assist in determining what changes or interventions need to be implemented. For example, if a student is assessed and determined to be utilizing surface learning at the expense of deep learning, one can first look at the prior knowledge of the student and determine if the prior knowledge is adequate for the student to complete the assessment with the level of understanding that is expected. If the level of prior knowledge is not adequate, course materials can be redirected or specific content can be reviewed to strengthen the knowledge base. Additionally, one can look at the other aspect of the presage level, the types of teaching techniques and the learning objectives, to determine if these are actually contributing to the surface approach. Questions that one could ask: Is there too great of a focus on the details and not enough focus on putting things in context? Are the course objectives and assessments leading to memorization and not conceptual thinking? Are the exams more focused on time limitation than true learning? If the approach has been determined by the outcome results to be a surface approach, then one needs to understand the details of why this approach is being taken and take a deeper look at the process level. What specific learning strategies is the student using and is the student using limited learning strategies because that is all that exists in their repertoire? Finally, if a student is assessed through an exam and is asked to utilize a concept that requires a deep approach to learning, but utilizes a surface approach and totally misses the point, this is a good indication that a disconnect has occurred and the presage or process level should be examined [10].

Biggs [13] lists cognitive activities at varying levels and illustrates how they contribute to a surface or deep learning approach as outlined in Figure 2. He also illustrates how teaching can work to support or eliminate the cognitive activities that ultimately support the different approaches to learning. The instructor can impact the cognitive activities by varying course requirements, learning objectives and everyday class activities.

One of the highest levels of cognitive activity is to reflect, which leads to a deeper understanding of the material. Reflecting is recognized as enhancing learning content through the interconnection of sequences of ideas and the questioning those ideas, while taking into consideration previous learning and knowledge [30]. The use of reflective writing creates a process during which thoughts and ideas are captured and expounded upon on paper, which encourages further reflection to occur.

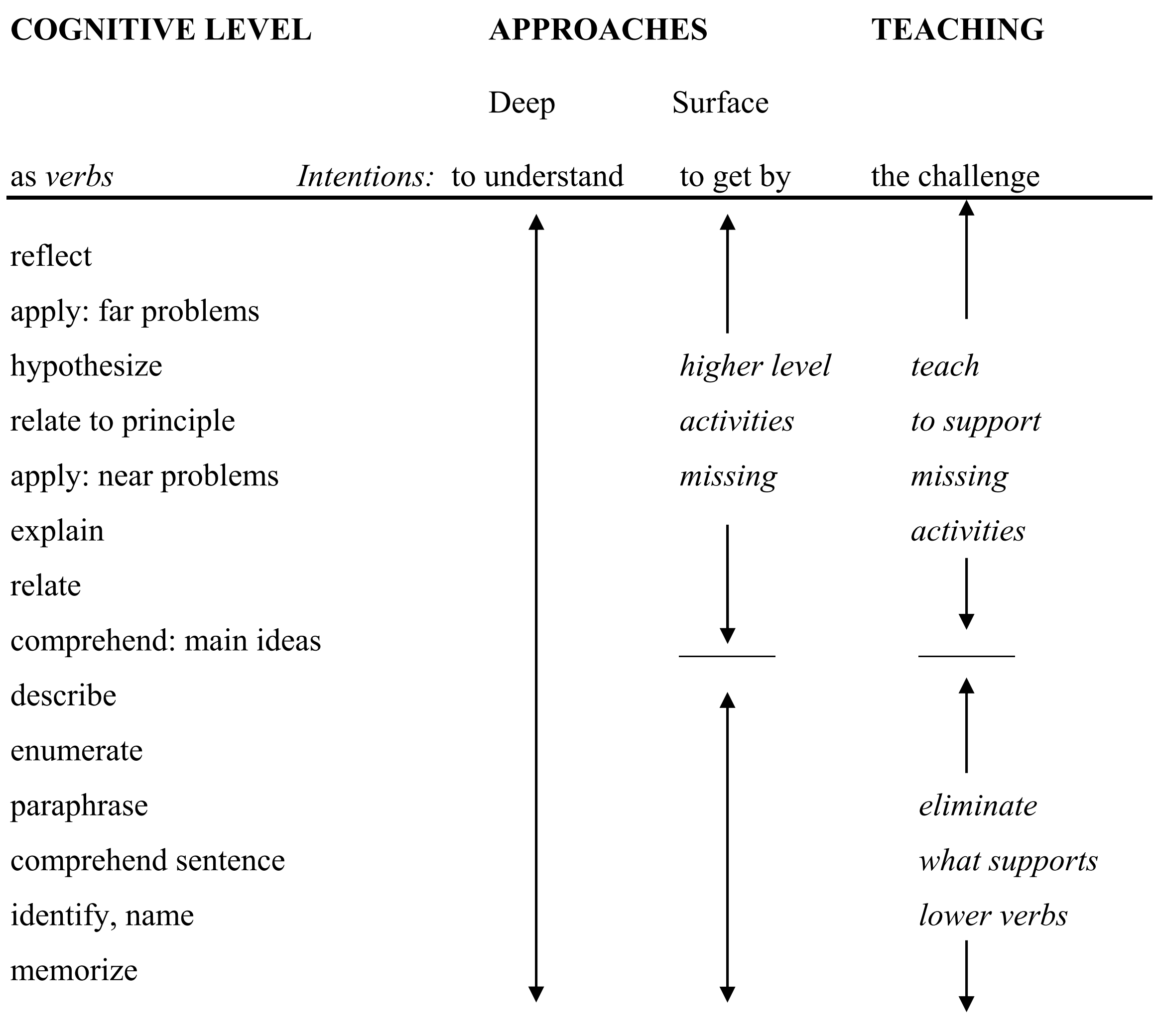

Figure 2. The cognitive level of learning activities leading to approaches to learning [13].

BACEIS Model

As Biggs [10, 13] assembled the systems model of teaching and learning containing the presage, process and product levels, Hartman and Sternberg [29] were in the United States working on the BACEIS model for improving thinking. The BACEIS model also includes both external and internal factors of the learner, which have an impact on the learner's academic performance. The internal factors are cognition and affect. The external factors are the academic and nonacademic environments. The BACEIS acronym stands for the following: Behavior, Affect, Cognition, Environment, and Interacting Systems. This model has more detail than the 3P model, but follows similar concepts and is represented in Figure 3. Hartman and Sternberg [29] comment that "The goal of our model is to help students become effective thinkers and self-directed learners" (p.416).

The BACEIS model is considered to be a constant state of interaction with the internal affective and cognitive systems that are active through self-regulation [29]. The internal affective system consists of motivation, affective self-regulation and attitudes. Affective self-regulation occurs through the interactions of values, expectations, beliefs about self-worth, self-efficacy, and emotions from prior experiences. The cognitive system is made up of cognition and metacognition with cognition further broken down into three applications: critical thinking, creativity and learning strategies. Cognition contains the ability to acquire and process information.

Metacognition regulates the cognition system through two major categories, executive management and strategic knowledge. Executive management includes planning, monitoring and evaluating/revising. Planning includes the recall of prior knowledge, goal setting and allocation of time and resources. Monitoring is a constant checking/questioning on the status of the knowledge and skills utilized such as: is all prior knowledge available, is the new knowledge linked appropriately, is the process leading to the goal, etc? Evaluating/revising examines at the results of the process as well as results on previous processes and determines the need for revision. The revision is considered and implemented in future actions. The second aspect of metacognition, strategic knowledge, includes declarative, procedural and conditional (contextual) information about the skills being utilized. Declarative knowledge determines what skills need to be utilized, procedural knowledge tells how to implement these specific skills and conditional knowledge tells when and why to use these specific skills [49, 60]. Hartman and Sternberg [29] take the position that this strategic knowledge is necessary for the students to process information intelligently.

The external component of the BACIES model consists of 1) teacher characteristics, content, instructional techniques and class atmosphere in the academic environment and 2) family history, cultural background and socioeconomic status in the nonacademic environment. All of these subsystems interact and behavioral consequents result, which impact intellectual performance. Hartman & Sternberg [29] propose that each of the subsystems is continually evolving and are only loosely connected. The model allows for intervention at several different sites and because of the constant interaction between components, these interventions have the potential of impacting the overall structure (i.e. improve thinking) [29]. The model is illustrated in Figure 3.

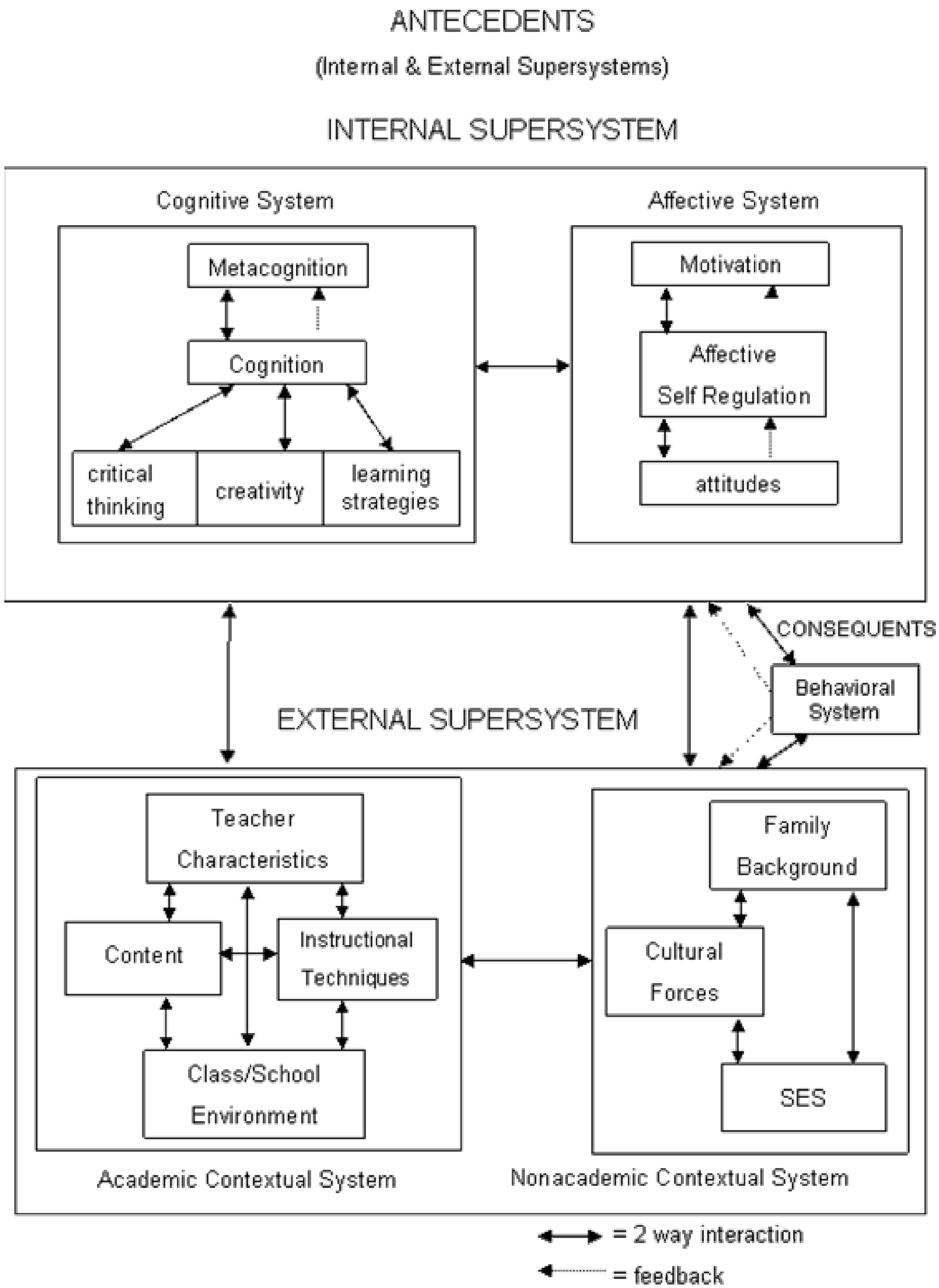

Figure 3. BACIES model components. [29].

Hartman and Sternberg [29] also maintain that the comprehensive approach will allow students to develop a more differentiated, refined, elaborated and interrelated structure of knowledge, skills and attitudes across contexts. In other words they would have the capability of utilizing these skills in many different situations or environments. The differentiation occurs because of the consideration of the different external environments (academic and nonacademic) as well as the interchange of internal environments (cognitive and affective) and their impact on the thinking and learning process. The students will be more refined because they are utilizing the subsystems (metacognition and cognition) to build upon existing knowledge, skills and attitudes. Elaboration will occur as they take information and expand it to create new meanings of knowledge and skills. The interrelatedness occurs because the skills and attitudes are developed in combination with each other, within subject, across subjects and connected to typical real-life experiences [29].

Each model described by Biggs and Hartman and Sternberg [10, 29] has sections that function independently and then ultimately interact for the final outcome of the learning process (academic or intellectual performance). The next step of this literature review is to look at one of the independent components of the research model in further detail to help understand the impact of cognitive processes and learning strategies on the learner.

Cognitive Learning Strategies

Cognitive psychology seeks to understand the thoughts and mental processes utilized to influence other thoughts and behaviors [63]. In other words cognitive psychologists seek to determine what goes on in the mind as we process information and how is it used to impact behavior, in this case, learning. Cognitive psychology also says that the learner is actively involved in determining what information he or she receives from instruction. The learner has control over what information is taken in for processing. Therefore, it is first helpful to understand how this information is taken in and processed and then recalled for later use.

How the Mind Processes Information

Many cognitive scientists use the computer to help them understand how the mind processes information based on the similarities of information processing by a computer and the mind. Bruer [16] describes the mind as a cognitive architecture. This cognitive architecture consists of a sensory system, working memory (sometimes referred to as short-term memory), and long-term memory. The sensory system first takes in the information from the outside world through the senses and moves it into the working memory. The mind then makes a decision in working memory whether to examine or evaluate it, and if the information is relevant, to store in long-term memory. The learner is said to have to pay attention to the information in order for it to remain in the working memory and selective attention can determine what information reaches working memory [39]. Furthermore, the working memory has limitations regarding the amount of information that it can hold. This information can be in groups of information called chunks, but the limit of the working memory is recognized as seven plus or minus two chunks of information at a time [42, 66]. So the working memory takes in these chunks of information and very quickly has to decide which pieces of the information will be passed into long-term memory. Here rehearsal learning strategies (linking or repetition) influence how much information is retained in the working memory plus how much is ultimately moved into long-term memory [39]. Examples of these rehearsal strategies could include linking simple ideas presented in the classroom or memorization of information in a textbook.

How the information is then organized in the long-term memory, so it can easily be retrieved for use at a later time, is also of relevance. The information is stored in long-term memory in what cognitive psychologists call associative structures [16]. The associative structures are then linked in networks of related information. This requires that the new information be linked to prior information that has already been stored in these networks. The more prior information that one has organized and stored on a subject in long-term memory, the easier it is for the new information to be linked and moved quickly from the working memory. Here organizational and elaboration learning strategies impact how the information is stored. A very large amount of information stored in long-term memory regarding one subject or topic may indicate that individual has a domain or subject-specific knowledge base [16].

Bruer [16] adds that long-term memory is stored in two ways: 1) declarative memory: events, specific facts and word meanings and 2) nondeclarative memory: procedures (often unconscious). The associative structures in declarative memory are called schemas. These schemas are built on specific events and facts, but then as new events and facts enter long-term memory they are integrated into the initial schemas which impact how the new events and facts enter long-term memory. Basically, the associative structures actually impact what the individual notices, how they interpret it, and how it is remembered. This indicates that prior knowledge affects our interpretation of new experiences and therefore impacts the way we learn [16].

Mayer [39] describes the process of moving information from short-term memory to long-term memory as encoding. He indicates that the learning strategies that are chosen have an impact on how the information is stored. Such learning strategies may impact any of the following: the time it takes the information to be stored, the integration of how it is stored with existing information, and whether or not the information is integrated at all. For example, when new chemical compounds are introduced they may be stored just as presented or they may be stored in the chemical reaction that is most common for their use. The integration of how information is stored will impact the retrieval process when the information is recalled. The long-term memory must be organized such that the information can easily be pulled into working memory for further learning [39].

For the information to be processed in working memory at an efficient rate processes must be in place to control the flow of information. These processes are referred to as executive processes and include setting priorities, choosing strategies, monitoring the effectiveness of the strategies, changing the strategies if necessary and finally evaluating the overall outcome [63]. Recall in the BACEIS theory that these activities are referred to as planning, monitoring and evaluating and occur during metacognition [29]. Planning, monitoring and evaluating are also referred to as activities that regulate cognition [49]. The BACEIS theory also indicates that declarative (the what), procedural (the how), and conditional (the when and why) are strategic knowledge subcategories within metacognition, which helps to determine which skills and learning strategies to use and when to use them. This strategic knowledge helps to move information in and out of long-term memory and allows individuals to function within their environment [63]. Hence, information processing or how information is received and ultimately stored in memory is very key to the learning process [16, 39, 63].

Learning Strategies

Learning strategies often utilized by students range from the following categories: rehearsal, elaboration and organizational strategies [62]. These strategies are further broken down by basic learning tasks: knowledge acquisition and comprehension; and complex learning tasks: application, analysis and synthesis. Each of the learning strategy categories are discussed in more detail as they relate to the basic or complex learning tasks.

Rehearsal strategies for basic learning tasks include repetition of information to increase awareness and storage in memory and are common for small pieces of information that one desires to move from working memory to long-term memory, such as a definition of a simple scientific term. Rehearsal strategies for complex information include selection of important information to increase familiarity, understanding and again store in memory. An example includes tasks such as highlighting main ideas in a textbook or taking notes during class. Both of which are more complex learning tasks because they require not only the intake of information, but first deciding which parts of the information are important [60].

Elaboration strategies help students tie new information to things that they already know. Adding information to what they already know builds meaning into the material and helps to store the information in memory. It also helps the students to store information in a usable form. Elaboration strategies used for basic tasks may consist of building lists of conceptually related items or linking items through meaningful relationships. For example, relating a scientific concept to an everyday experience would be a source of basic elaboration. More complex elaboration includes paraphrasing or summarizing (in the learner's own words) the course material, teaching the material to someone else, or using it to solve a problem. This strategy requires some type of active interaction with the material, which allows a deeper understanding of the material and stores it in memory with other related information [60].

Organizational strategies create a framework of new information or a combination of new information with prior information. These strategies are really an extension of elaboration strategies, but are recognized as a category unto themselves [60]. Organizational strategies assemble information in frameworks such that it makes information easier to manage and remember. This assembling or clustering of information also helps the working memory become capable of storing more information since it has the seven plus or minus two chunks of information limitation. The organizational strategies for basic tasks include such things as classifying information into categories like animal, plant, liquid, gas, etc.; or clustering artists during the Renaissance into countries where they lived. More complex organizational strategies include the assembling of information to help build capacity in working memory while at the same time working to establish meaning with the new information [60]. Again this is an active process and may include specific tasks such as creating a flowchart to understand a procedure (time order), developing a concept map to understand interrelationships (compare and contrast) or developing a fishbone diagram to look at cause and effect relationships [57].

Cognitive learning strategies can help determine if a student reaches his/her learning goal, but first the student must be aware of whom he/she is as a learner (distinct qualities), specific characteristics about the task that he/she is to perform, and the fact that different learning strategies exist [60, 63]. When the student understands his/her strengths and weaknesses as a learner and understands the detailed requirements of the task, the two interact with his/her knowledge about what learning strategies are available and he/she makes a decision regarding how to proceed with the task. This illustrates that learning is related to the executive processes in basic information processing that were discussed earlier. Declarative knowledge includes the knowledge about self as a learner and the influences that may impact the learner’s performance. Procedural knowledge is the knowledge about how to do things and typically includes heuristics and personal strategies that the learner has in their repertoire. Conditional knowledge is the ability to know when and why to apply the declarative or procedural knowledge. The situation is critical to choosing the right learning strategy based on the constraints of the individual and the specific task requirements [63]. It is the continual planning, monitoring and evaluating that allow the learner to stop and redirect to another strategy if they see it not contributing to their goal.

Interpretation of Current Research

Current learning theory takes on two perspectives: 1) the overall process which includes the learner (prior knowledge and during the learning process), motivation, the teaching and institutional context and the nonacademic environment, and 2) the more narrow approach which focuses only on the learner and more from an internal processing perspective. Some of the researchers such as Biggs, Hartman and Sternberg [10, 29] have taken the holistic picture of the teaching and learning process based on the fact that all aspects impact the learner. It is from this perspective that changes have been incorporated in the classroom such as active collaborative learning, integrated curriculum and problem-based learning. Additionally, efforts have been made outside the classroom such as building cultural awareness and offering assistance to enhance integration of diverse students. While the holistic approach appears to provide a reasonable big picture view, it does limit the possibilities of research on the entire model due to the many variables that are impacting the whole learning process. Consequently, only specific components of the overall learning process, such as the cognitive aspect, are the focus of many current research studies.

Several models have been formulated surrounding the cognitive theory of learning. Some of the first models were focused on the in-take and storage of information. The learner-centered model has been around since the mid-1980s and was the beginning of the concentrated focus on the learner. The expectation was that the learner must be responsible for his or her own learning process [56]. Researchers who use this model focus specifically on the cognitive component of the learner and rely on metacognition. Included in the metacognitive area of research is self-regulation. There are many aspects of this component that offer the opportunity for research. Areas include activities that enhance the use of metacognitive techniques such as learning strategies, reflection, modeling and other activities related to planning, monitoring and evaluating. Furthermore, building an awareness of the learning process with the learner is an area of research in and of itself.

Research utilizing metacognitive techniques is focused in subject specific areas such as math, science, reading and writing. Some similar studies exist in engineering such as the use of reflection through journal writing, but because engineering greatly emphasizes problem-solving and higher level thinking it would be beneficial to see additional studies focused specifically in engineering. The same is true for the deep versus surface thinking. Studies exist that illustrate the overall impact of deep and surface learning, but there could be more studies relating to engineering subject or domain specific areas. Research does exist indicating that both general learning strategies and domain specific learning strategies are necessary in the learning process [16, 42].

The research in this dissertation expands the data on deep and surface learning from Great Britain, Australia and Hong Kong to the United States. It also establishes a database specifically focused on first-year engineering students. The research expands the results of deep and surface learning to look not only at the impact on the learning process, but also the impact on retention in engineering. This study also builds upon some current research in first-year engineering students regarding reflection by looking at the link between adding this higher level cognitive activity and deep and surface learning. The portion of this research regarding the Learning and Study Strategies Inventory (LASSI) again elaborates on some of the research that is currently available by focusing specifically on first-year engineering students. The LASSI has been used extensively with at-risk students, but the opportunity exists to examine the impact with university students that are considered academically advantaged at the outset, such as the engineering students.

CHAPTER III

RESEARCH METHOD

Participants

Previous studies indicate that there is a concern about the skill level of incoming freshman especially as it relates to reasoning, problem-solving and some of the deeper levels of thinking [16]. The freshman or entry level engineering students were selected to substantiate these concerns, as well as the fact that this is the level where changes can have the largest impact, because they are implemented early in the college career. The study was conducted with freshman engineering students enrolled in their first *Foundations in Engineering* courses (ENGR111 and ENGR112) at Texas A&M University. (The study was approved by Texas A&M's Institutional Review Board.) The courses are based on engineering fundamentals and are designed to give a general overview of the engineering profession.

It is beneficial to understand the details of the freshman engineering courses in order to provide a context for this study. The freshman students in this sample were calculus-ready which means that they had taken enough mathematics in high school or junior college to be ready for the first calculus course as opposed to pre-calculus. Six classes of the first semester freshman engineering class (ENGR111) were selected to allow for three classes with interventions and three classes as a control. Three classes of the second semester freshman engineering class (ENGR112) were selected with no intervention. Each class contained approximately 90 students, so the maximum possible sample was about 540 freshman students for the first semester and 270 for the second semester. The number varied based on the number present in class on the day of the assessments and the delivery method of the assessment. The classes were selected to be as similar as possible and therefore honors sections were not included. Freshman engineering students also have the opportunity to participate in “cohort” classes, which means that the same students will enroll in the same sections of two or more courses (i.e. freshman engineering, physics, and calculus). Cohorting enhances the potential for getting acquainted with other students early in the freshman year and encourages study groups. The classes selected for this study were all cohort classes.

The selection process for the professors asked to teach each class varies according to the engineering department that supplies their services; however, all class materials (i.e. presentation slides, project materials, etc.) are standard and their use is required by all instructors. The classes administrate two common exams as well as a common final. The study was conducted in six ENGR 111 classes at the beginning of the fall semester 2002 and four ENGR111 classes at the end of the fall semester 2002 in the following groups:

1. Contrast group – No intervention (three classes)
2. Learning strategy assessment only
3. Reflective journaling only
4. Learning strategy assessment and reflective journaling

The study was also conducted on three Engineering 112 classes in the spring semester of 2003. The spring semester classes had no intervention performed.

Procedure

The freshman engineering students in all six ENGR111 classes were asked to complete an online pre-assessment to determine their approach to learning at the beginning of the semester. The pre-assessment captures the learning approach they bring with them from previous experience and education. Four of the ENGR111 classes were also asked to complete the online post-assessment to determine the approach to learning at the end of the semester. Three of the ENGR111 classes were requested to fill out the post-assessment via an email request while all other pre- and post-assessments were conducted during the class period. The post-assessment measures the student's approach to learning following the first semester and following the second semester of freshman engineering courses.

The freshman engineering students in ENGR112 during the spring semester 2003 were asked to complete the online pre-assessment to determine approach to learning the first week of the semester and the online post-assessment to determine the approach to learning the last week of the semester.

Instruments available to assess a student's approach to learning include self-reporting questionnaires such as the Approaches to Study Inventory (ASI) [23], the revised ASI or the Approaches and Study Skills Inventory for Students (ASSIST) [40], the original Study Process Questionnaire (SPQ) [11], and the Revised Study Process Questionnaire (R-SPQ-2F) [14]. The R-SPQ was selected based on its recent validity and confirmatory factor analysis as well as the fact it is a short simple questionnaire that the students can fill out during class time.

The Revised SPQ instrument is the result of reducing the original Study Process Questionnaire (SPQ) from the three-factor (deep, surface and achieving) design to a two factor (deep and surface) design. This redesign was based on the request by teachers for a simple tool to evaluate their students learning approaches and a desire to update the tool with reference to current curricula, methods of delivery and assessment, and heterogeneity of the student population. The deep and surface strategies describe the student's approach to the task itself, while the achieving strategy focuses more on the student's organization and time management skills. The desire in this study was to focus on the deep and surface approach and hence the use of the revised questionnaire. A copy of the R-SPQ-2F is listed in Appendix A.

Some of the revisions of the SPQ to the R-SPQ-2F were based on re-wording to update terminology to reflect the many changes in higher education since the SPQ was developed in the early 1970's. The questionnaire was also revised to reflect insights (producing clearer descriptions) that were gained from some intensive studies of Asian students [31]. In addition changes were made to reflect the better understanding of extrinsic motivation which had contributed to the original surface motive scale [33]. Next, the number of items on the SPQ was reduced by using two statistical tests. The first was the Reliability procedure of SPSS [43] which produced statistics following a test of reliability of items specified as forming a hypothesized scale. The procedure produces a Cronbach alpha coefficient for the scale and also indicates the alpha for the scale if an item were deleted. The second statistical program was the EQS program [5], which was used in the confirmatory analysis mode. Parameters were assessed by using the multivariate Lagrange Multiplier (LM) and Wald Tests accomplished in EQS [14]. The LM tests provide information to identify parameters which when added to the hypothesized model result in a significant drop in the model chi squared value. The Wald tests assist in assessing the statistical significance of the parameter estimates. Therefore, the LM tests tell when to add new items and the Wald tests tell when to delete items (based on theoretical reasoning). There was broad concurrence between the quite different approaches [14]. The reduction resulted in two deep and surface factors with 10 items each. The final questionnaire had two main scales, Deep Approach (DA) and Surface Approach (SA) with four subscales, Deep Motive (DM), Deep Strategy (DS), Surface Motive (SM) and Surface Strategy (SS).

The R-SPQ-2F was tested with 495 undergraduate students from various disciplines across each year of study at the University of Hong Kong. Dimensionalities of the four components (deep motive, deep strategy, surface motive and surface strategy) were examined by confirmatory analysis to check whether the items contributed to the intended component. Good fits of the single factor models for the four subscales to the observed data were supported and it was concluded that the items were unidimensional for each of the subscales. Once homogeneity is established, Cronbach alpha can be used to determine subscale reliability [14]. The reliabilities for the two main measures, deep approach (DA) and surface approach (SA), resulted in Cronbach alpha values of 0.73 for DA and 0.64 for SA. These values are considered acceptable for testing reliability of scales in a short assessment such as the R-SPQ-2F. Typically, the closer the number is to 1, the better. Additional testing was conducting on hypothesized models illustrating additional aspects of the questionnaire [14]. The SPQ and R-SPQ-2F instruments were previously utilized in Australia, Hong Kong and Great Britain [14, 32].

The retention was measured by looking at the freshman engineering student enrollment in the selected ENGR111 classes at the beginning of fall semester 2002 and the continued freshman engineering enrollment of these same students in ENGR112 at the beginning of the spring semester 2003. The retention was then examined based on the student’s approach to learning, utilizing the pre/post revised SPQ data.

Intervention 1

The first intervention was the Learning and Study Strategies Inventory (LASSI) second edition [65] assessment and was offered to two classes (Groups 2 and 4). The contrast group received no intervention throughout the semester. The LASSI was chosen as the instrument to increase both awareness of learning strategies for the students and to give them an indication of the level of their personal learning strategies. The LASSI 80-item assessment is world renown for addressing the skill, will and self-regulation components utilized in strategic learning. This particular tool is designed to measure at the post-secondary education level. "The focus is on both covert and overt thoughts, behaviors, attitudes, motivations and beliefs that relate to successful learning in post-secondary educational and training settings and that can be altered through education interventions." [64, p. 2] The norming sample for the second edition LASSI included students from three universities, five community colleges, three state colleges and one technical institute. Demographics for this same sample varied in grade point average, ethnicity, gender and age. Specific details of each demographic area can be obtained from the LASSI's User's Manual, second edition developed by Weinstein and Palmer in 2002.

The LASSI incorporates the learning strategy intervention and was available to the students until October 1, 2002. The ten scales within the LASSI include: anxiety, attitude, concentration, information processing, motivation, selecting main ideas, self testing, study aids, test strategies and time management. The scores range from 0 to 100. The scores on the individual LASSI scales determine the requirements necessary for each student on the learning strategy modules should they decide they would like to work toward extra credit. A score of 75 or less on one of these individual LASSI scales requires completion of the self-paced module designed to enhance the skills associated with that particular study scale. The students that complete the required modules can earn extra credit (see the details in Appendix B). The students were encouraged to use the help session time to work on the modules when other homework is complete. The status of each student was monitored through an administrative program, which automatically updates each time the student works on or completes a module.

The impact of making the engineering students aware of their current learning strategies by taking the learning strategy assessment was measured analyzing the pre/post results of the revised SPQ.

Intervention 2

The final intervention was the task of reflection and was accomplished through the use of reflective journal writing on the weekly reading assignments. Reflective journal writing was selected as a tool to enhance deeper thinking based on Biggs [10] research that indicates refection is one of the highest cognitive strategies as well as the fact that it is referenced in metacognition research as a monitoring and evaluating process utilized during the learning process. This intervention was required of two classes (Groups 3 and 4). The specific requirements can be obtained in Appendix C. The impact of completing the journal writing on the weekly reading assignments was analyzed through the pre/post revised SPQ of those students who chose to participate in the journaling.

Contrast Group

During the fall semester 2002 the contrast group was the group that received no type of intervention ENGR111 (Group 1). The students in this class were asked to complete the pre/post assessment of the revised SPQ to determine the approach to learning with no intervention. During the spring semester of 2003 all three classes had no type of intervention ENGR112 (Group 5). The students in these classes were asked to complete the revised SPQ to determine the approach to learning during the second semester of the freshman program with no intervention.

Group	Intervention 1	Intervention 2
1 – ENGR111	None	None
2 – ENGR111	LASSI	None
3 – ENGR111	None	Journaling
4 – ENGR111	LASSI	Journaling
5 – ENGR112	None	None

Table 2. Interventions by research group.

The raw data for each group is located in Appendix E.

CHAPTER IV

STATISTICAL ANALYSIS

The first question of this study was addressed statistically by looking at the basic descriptive data analysis such as mean, standard deviation and frequency data including the histogram. The question establishes a baseline for the entering freshman engineering students approach to learning. The results are indicated in Table 3, below and figures containing the histograms are available on page 51.

Approach to Learning Fall 2002	**Mean**	**Standard Deviation**	**N**
Pre-Deep	30.91	5.60	161
Pre-Surface	26.17	6.55	161

Table 3. Descriptive statistics of pre/post approach to learning.

The second research question is addressed statistically by looking at the results of the intervention instrument, the LASSI. The LASSI results were analyzed to determine the mean percentile rank for each of the LASSI scales. The results are indicated in Table 4.

LASSI SCALE	ENGR111 (Mean)	Standard Deviation	N
Skill Component			
Information Processing	61.02	23.75	88
Test Strategies	65.24	21.57	88
Selecting Main Ideas	56.08	24.08	88
Will Component			
Anxiety	61.26	24.89	88
Attitude	42.98	27.22	88
Motivation	63.58	25.55	88
Self-regulation Component			
Concentration	61.48	25.58	88
Self-testing	53.26	30.57	88
Study Aids	60.52	29.16	88
Time Management	55.80	28.68	88

Table 4. Calculated mean percentile ranks of the LASSI scale results.

The skill component scores for the freshman engineering students completing the LASSI range from 56.08 to 65.24. The scores for the will component range from 42.98 to 63.58. Here the anxiety score is reverse scored, in that the lower the score the more the student may be directed away from academic tasks. The scores for the self-regulation component range from 53.26 to 61.48. The range in all three components is below the recommended percentile for a strategic learner [65]. The score below the 50^{th} percentile indicates a need to improve skills to avoid serious problems succeeding in college according to the LASSI developers. The recommendation of the developers of the LASSI is that if the scores are from the 50^{th} - 75^{th} percentile then the student should consider improving those strategies for those scales. None of the LASSI scale mean percentile scores in this study are above the 75th percentile. According to the LASSI developers if you score above the 75th percentile you probably do not have to give a high priority to improving your strategies in those areas although reviewing techniques in those areas is projected to positively impact strategic study skills [64].

The third, fourth and fifth questions are all addressed statistically by looking at the deep and surface approach to learning scores from the R-SPQ-2F assessment. This statistical analysis is based on a sample population where there is one set of individuals with two observations on each individual (pre and post R-SPQ-2F scores). Based on these criteria and the desire to compare means (μ_1 and μ_2) the data is best analyzed by a paired analysis. The assumption is that there are *n* selected pairs (X_1, Y_1), (X_2, Y_2),...,(X_n, Y_n), with $E(X_i) = \mu_1$ and $E(Y_i) = \mu_2$. Let $D_1 = X_1 - Y_1$, $D_2 = X_2 - Y_2$, …, $X_n - Y_n$, so the D*i*'s are the differences within pairs (pre and post). The differences between pairs are assumed normally distributed [19]. A paired-samples *t* test was conducted to test for significance as to whether there was a difference in freshman engineering students' approach to learning at the beginning of the first semester and at the end of the first semester of the freshman engineering curriculum as well as at the beginning and at the end of the second semester of the freshman engineering curriculum. The null hypothesis is $H_0: \mu_D = 0$. The test statistic is $t = \frac{\bar{d} - 0}{s_D / \sqrt{n}}$. The paired t test was conducted for the fall semester class with no intervention, the LASSI invention, the journaling intervention, all student observations in fall semester 2002 and the spring semester 2003 classes with no intervention. The results are listed in Table 4.

The results indicated that the mean surface approach to learning at the beginning of the fall semester 2002 [pre] (M = 26.17, SD = 6.55) was not significantly different from the surface approach to learning at the end of the fall semester 2002 [post] (M = 25.95, SD = 5.87), $t(160) = 0.418$, $p < .67$ when all students in the study were considered (both with and without an intervention). The 95% confidence interval for the mean difference between the surface approach to learning pre/post ratings was -.83 to 1.28.

	Deep (Mean) Pre	Post	Significance *(p)*	Surface (Mean) Pre	Post	Significance *(p)*	N
Fall 2002							
No Intervention	30.36	25.55	.01	26.80	26.66	**N/A	126
LASSI	34.00	37.45	*N/A	21.00	20.45	*N/A	11
Journaling	32.64	29.00	.05	24.64	23.68	**N/A	28
All students	30.91	26.70	.01	26.17	25.95	**N/A	161
Spring 2003							
No Intervention	28.09	26.62	.01	25.88	28.26	.01	185

Table 5. Summary table of statistics for pre and post surface and deep approach to learning.

*Sample too small to determine significance.
**Level of significance not below .05.

The results also indicated that the mean deep approach to learning at the beginning of the fall semester 2002 [pre] (*M* = 30.91, *SD* = 5.60) was significantly different from the deep approach to learning at the end of the fall semester 2002 [post] (*M* = 26.70, *SD* = 6.66), *t*(160) = 8.04, *p* <.01 again for all students in the study. The 95% confidence interval for the mean difference between the deep approach to learning pre/post ratings was 3.18 to 5.25.

A commonly accepted value for a moderate sample size is 30 pairs of scores [27]. The students completing both the LASSI assessment and the pre/post R-SPQ assessment in the two intervention classes was 11. The statistical significance was calculated using the paired *t* test. The statistical significance and the descriptive analysis are as follows: pre-surface approach (*M* = 21.00, *SD* = 4.29), post-surface approach (*M* = 20.45, *SD* = 5.47), t (11) = .104, *p* < .919 and pre-deep approach (*M* = 34.00, *SD* = 5.81), post-deep approach (*M* = 37.45, *SD* = 5.63), *t*(11) = -.752, *p* < .472. The number of students completing the journaling and the pre/post R-SPQ was 28, and although not the recommended sample size of 30, the statistics were calculated using the paired *t* test. The results indicated that the surface approach to learning at the beginning of the fall semester 2002 [pre] (*M* = 24.64, *SD* = 4.96) was not statistically significant from the surface approach to learning at the end of the fall semester 2002 following the journaling intervention [post] (*M* = 23.68, *SD* = 4.97), *t*(27) = .879, *p* < .38. The deep approach at the beginning of the fall semester 2002 [pre] (M = 32.64, SD = 5.93) was statistically significant at the .05 significance level from the deep approach to learning at the end of the fall semester 2002 following the journaling intervention [post] (M = 29.00, SD = 7.15), $t(27) = 2.23$, $p < .034$.

The results for the R-SPQ-2F for the second semester (spring 2003) indicate a statistically significant difference in both the surface and deep approaches to learning. The surface approach to learning at the beginning of the spring semester 2003 [pre] (M = 25.88, SD = 5.926) was statistically significant from the surface approach to learning at the end of the spring semester 2003 [post] (M = 28.26, SD = 6.397), $t(184) = -5.735$, $p < .01$. The same was true for the deep approach to learning. The deep approach to learning at the beginning of the spring semester 2003 [pre] (M = 28.09, SD = 6.071) was statistically significant from the deep approach to learning at the end of the spring semester 2003 [post] (M = 26.62, SD = 6.623), $t(184) = 3.935$, $p < .01$.

The sixth research question is addressed statistically by looking at the pre and post R-SPQ-2F scores and the students enrolled in the second semester of freshman engineering (ENGR112) in the spring semester 2003.The statistical analysis for retention was conducted using a logistic regression. Logistic regression was used based on the presence of a dichotomous dependent variable where there were only two possible outcomes, 1) the students progressed into the second semester of the engineering program (ENGR112) or the students did not progress to the second semester of the engineering program (0 meaning not retained and 1 meaning retained). In logistic regression the probability of an event occurring (student being retained) can be directly estimated [55]. For one predictor (X), the probability of an event can be written as Prob(event) = $1 \big/ 1 + e^{-(B_1 + B_2 X)}$ where B_0 and B_1 are estimated regression coefficients and *e* is the base of the natural logarithms. For several predictors ($X_1,\ldots X_p$), the probability of an event can be written as Prob(event) = $1/(1+e^{-Z})$ where Z is the linear combination $Z = B_0 + B_1X_1 + B_2X_2 + \ldots + B_pX_p$. The probability of the event not occurring is Prob (no event) = 1 – Prob (event).The two important things to remember about logistic regression are 1) the relationship between the independent variables and the dependent variable is nonlinear, 2) the regression coefficients are estimated using maximum likelihood [3, 55]. The independent variables were the deep and surface learning measures at the beginning (pre) and end (post) of the spring semester 2003 using the R-SPQ-2F instrument. The logistic regression creates a model with the Y component equal to the logarithm of the odds of success, referred to as the logit. It is typical to interpret the data through odds ratios, which are calculated by taking the antilog of the logit coefficient. Once the odds ratio is calculated it is easy to calculate the projected percent of the odds if the independent variable is increased by one. The logistic regression analysis was performed using the Statistical Package for Social Sciences (SPSS). See Table 6 for the summary of logistic regression statistics.

Independent Variable	Odds Ratio	Percent change retention/ unit change approach	Significance *(p)*
Deep Pre	**1.025**	**2.5**	**0.444**
Deep Post	**1.050**	**5.0**	**0.065**
Surface Pre	**0.973**	**-2.7**	**0.320**
Surface Post	**0.967**	**-3.3**	**0.248**

Table 6. Logistic regression statistics regarding retention.

It appears that none of the data are significant at the $p < .05$ level; however the deep approach to learning post component is significant at the $p < .1$ level. This says that for every point of increase on the deep post assessment there is a 5% increase in the odds of that individual being retained. One can observe from Table 6 that the odds of being retained increase as the points on the post R-SPQ-2F deep component increase. One could also note that the percent change in retention goes the opposite (is negative) if the surface approach increases.

Figure 4 is a graphical representation of the odds of being retained (0 not retained and 1 being retained) based on the post-score of the deep approach to learning. An increase in the odds of being retained as the deep approach to learning score increases can be noted on the plot.

The null hypothesis for the retention portion of the study is that there is no difference in retention based on a change in the deep or surface approach to learning. The null hypothesis is tested using the likelihood ratio chi-square statistic, also referred to as LR chi-square or L^2 [3, 19].

LR chi-square = -2(Log likelihood at iteration of 0 – Log likelihood at final iteration)

If LR is statistically significant ($p < .05$), then we reject the null hypothesis and conclude that information about the X variables allows us to make better predictions of $P(Y=1)$ than we would be able to make without the X variables. In this case $p > .05$, so the null hypothesis is accepted.

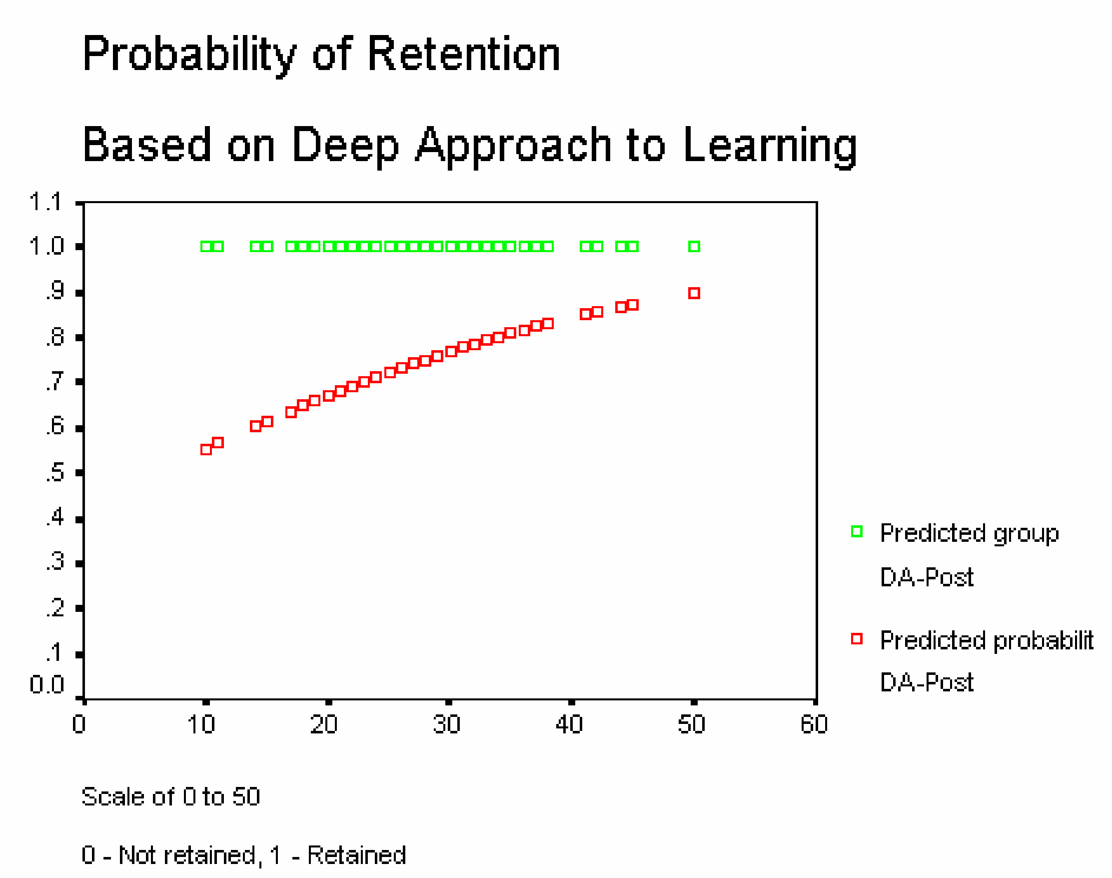

Figure 4. *Odds ratio versus the post deep approach to learning.*

CHAPTER V

DISCUSSION/RESULTS

Looking specifically at the first question that was posed in this study:

1. What is the common approach to learning (surface versus deep) for a student entering the freshman engineering program at Texas A&M University?

The entering freshman in this study have surface approach to learning scores ranging from 19.62 to 32.72 (M = 26.17) and deep approach to learning scores ranging from 25.31 to 36.51 (M = 30.91). These are on a scale of 0 to 50. The surface approach to learning scores are very close to the midpoint on the scale and the deep approach to learning scores only slightly higher. In general, with these students having been accepted into the engineering program with very stringent requirements, one might have anticipated that the deep approach to learning scores would have been higher than the average of 30.91 and the surface approach to learning scores would have been below the midpoint of 25.00. See Figures 5 and 6 for histograms of the data. Both sets of data appear to fit a normal distribution (note the curve overlaid on the data). The surface approach to learning scores has a broader spread in distribution of the data. This may be an indication of the broad spectrum of expectations that the students are seeing in the secondary curriculum before coming to the university. The surface approach scores (M = 26.17) are slightly lower than the deep approach scores (M = 30.91) with the comparison of means conducted using a paired *t* test, resulting in significance at the $p < .01$ significance level. National or international norms do not exist for these measures.

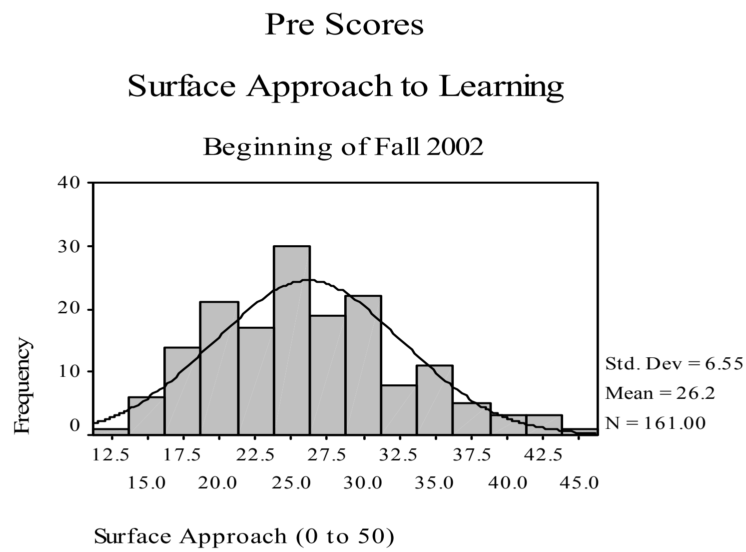

Figure 5. Histogram of pre-scores of the surface approach to learning.

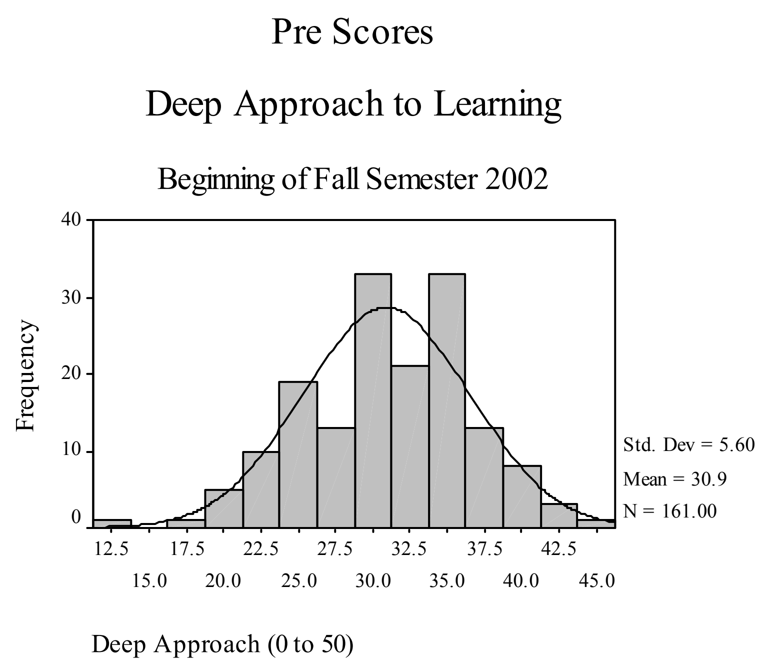

Figure 6. Histogram of pre-scores of deep approach to learning.

Question two is related to learning strategies of the students and was measured with the LASSI:

2. What strengths and weaknesses in learning strategies do entering freshman engineering students at Texas A&M University possess (bring with them)?

The information in Table 4 assists us in answering this question. First, none of the LASSI scales or strategic component averages are above the 65^{th} percentile (based on national norms with other college students) [65]. This data indicates that the freshman engineering students are not coming to the university with strongly established learning strategies. These scores below the 65^{th} percentile for all LASSI scales is not necessarily what one would expect from engineering program students.

The skill component containing information processing, test strategies and selecting main ideas indicates that the students score the highest in setting test strategies ($M = 64.33$). The data also indicates that the use of information processing ($M = 60.68$) techniques is not at the level one would desire for engineering students. Information processing is key because of the links that it creates to prior knowledge and to new information for future processing. The specific skills that are lacking are organization of the information and attaching personal meaning to the information, which can be accomplished through elaboration [64]. Many applications are available to incorporate information processing techniques directly into the classroom. (i.e. concept maps, Venn diagrams, fish charts, etc.) This highlights the fact that their skills in strategic study strategies can be improved.

The will component of anxiety, attitude and motivation indicates that attitude (M = 42.47) is a large factor among these freshman engineering students. Attitude has a great deal to do with the student's desire for success in school and has an impact on the motivation to persevere in studying, especially independently. Sometimes this is related to the fact that school and life goals do not match up. The anxiety and motivation scales again do not score above the recommended 75th percentile [65]. Student anxiety may be manifested in thought processes, emotions and cognitive worry, which can greatly divert a student's attention away from studying [64]. The motivation scale (M = 63.30) indicates the lack of desire to perform specific tasks and that the students are not accepting responsibility for completing these tasks for coursework. Some of these results surrounding anxiety, attitude and motivation are difficult to address in an engineering curriculum, but a process could be established to direct the students to the office for career counseling or to hold special sessions and offer assistance through appropriate tools and skilled instructors in these areas.

The self-regulation component is very closely linked to the learner taking ownership for their learning. The results indicate that the students are the weakest in self-regulation on self-testing (M = 52.47) and time management (M = 55.23) scales. The time management scale would indicate that they need help in managing their schedule/routine, but the self-testing scale says that they do not question, monitor, or evaluate themselves on what they are learning. This questioning of what they are learning could be in reading assignments, laboratory procedures, or classroom lectures and leads to the ability for the student to tie more personal meaning and a deeper understanding to the material. These are skills that may require building awareness for the student that they exist and then providing opportunities to practice them. The last two scales of the self-regulation results on the LASSI are concentration (M = 61.31) and study aids (M = 60.24). The lower scores on the concentration scale may indicate that the students are not really in tune with what it means for them to concentrate. For example, many of them continue to listen to music or run an instant messenger on the computer while they are studying and believe that they have strong concentration skills, when in reality they do not comprehend much of what they are studying. This could be addressed again by an awareness building of their true concentration and a renewed commitment by the student. Study aids are another tool that many of the students may not feel that they need or are not aware of the many types of study aids that exist.

The third question is addressed by both the LASSI results and the pre/post R-SPQ-2F results:

3. Does making the incoming engineering students aware of their strengths and weaknesses in learning strategies impact their approach to learning (surface versus deep)?

Eighty-eight students out of approximately one hundred and eighty possible completed the LASSI on a volunteer basis. However of the eighty-eight who completed the LASSI only eleven of them completed both the pre and the post R-SPQ-2F assessment. Although this is a very low sample number and statistical significance could not be determined the basic descriptive statistics were calculated. See Table 7.

	Deep (Mean) Pre	Post	Surface (Mean) Pre	Post	N
Fall 2002					
No Intervention	**30.36**	**25.55**	**26.80**	**26.66**	**161**
LASSI	**34.00**	**37.45**	**21.00**	**20.45**	**11**

Table 7. Descriptive statistics of pre/post LASSI and no intervention.

No large difference from the pre and post surface scores [pre] (M = 26.80 and [post] M = 26.66, no intervention and [pre] M = 21.00 and [post] M = 20.45, completed LASSI) however, it should be noted that the surface scores for those having completed the LASSI are approximately 22% lower than those who did not participate on the LASSI (~27 for the LASSI versus ~ 21 for no intervention). There was a fairly large increase in the pre and post deep scores of the R-SPQ-2F for those having completed the LASSI [pre] (M = 34.00) to [post] (M = 37.45) while those having no intervention decreased on the deep approach to learning scores [pre] (M = 30.36) to [post] (M = 25.55). It should be noted that the numbers for pre and post deep approach to learning are considerably higher than those who did not participate on the LASSI. Plus it can be noted that the students receiving no intervention and those receiving the journal intervention both decrease in their deep approach to learning scores while those completing the LASSI increased in their approach to learning scores. See Table 5, p. 45 to see the entire set of R-SPQ-2F data side by side.

The fourth and fifth questions are answered with the R-SPQ-2F data regarding the surface and deep approaches to learning as follows:

4. What is the impact of reflective journal writing of class reading assignments on the freshman engineering students' approach to learning?

The students completing journaling as an intervention tool [pre] surface (M = 24.64) and [post] surface (M = 23.68) did not see a statistically significant change in the surface learning approach. However, statistical analysis did indicate a significant change to the negative at the .05 significance level in a deep learning approach from the beginning of the fall semester 2002 to the end of the fall semester 2002 for those utilizing the journaling intervention [pre] deep (M = 32.64) and [post] deep (M = 29.00). The pre and post-scores on the surface approach to learning for the students that participated in the journaling were not significantly changed. And the pre and post-scores for the deep approach to learning for those participating in journaling were significantly changed at the .05 significance level in the negative direction. In other words the students showed a less deep approach to learning than when they began the fall semester 2002. This decrease in a deep learning approach is consistent with the students that also received no intervention [pre] (M = 30.36) and [post] (M = 25.55).

Although a norm does not exist for freshman engineering students for which comparison of the surface or deep approach to learning means could be made, it is of interest that those completing the journaling intervention were approximately 5% higher at the beginning of the semester (32.64 versus 30.36) and 8% higher at the end of the semester (29.00 versus 25.55) in the deep approach to learning means. Overall the journaling student scores decreased in the deep approach to learning, but as mentioned above, still appeared to have a deeper approach to learning than those who did not journal. The opportunity to journal was a volunteer option, so the higher percentages in the means of journaling student results of the deep approach to learning scores may indicate that these students already have an inclination toward a deeper approach to learning, and hence their desire to journal in the first place. Examples of journal entries that were completed by the students are listed in Appendix D.

The fifth research question is answered by looking at the pre/post R-SPQ results in the class with no intervention:

5a. Do current curriculum and pedagogy for the freshman engineering students promote deeper learning at the end of the first semester of the freshman year?

The statistical analysis indicates that there was not a significant change in the surface learning approach from the beginning of the first semester to the end of the first semester of the freshman year ($M = 26.80$ to $M = 26.66$) with the first semester students not receiving any type of intervention. Statistical analysis did indicate a significant change to the negative at the .01 significance level in a deep learning approach from the beginning of the first semester to the end of the first semester of the freshman year ($M = 30.36$ to $M = 25.55$) for those not receiving any type of intervention. The assumption here is that changes in the approach to learning in the classes with no intervention would be dependent on the current curriculum and pedagogy utilized in the classroom. Therefore, the results indicate that current curriculum and pedagogy for the freshman engineering students had a negative affect on the deep approach to learning at the .01

significance level. This result may be dependent on many activities inside and outside of the classroom. Some reasons could be related to the teaching context such as the assessment and evaluation tools utilized in the classroom are not teaching to increase a deep approach to learning. The results could also be tied to the course expectations or the institutional environment according to the impact of the external environment described in the learning theory.

5b. At the end of the second semester of the freshman year?

The second part of question five is associated with the data from the spring semester 2003. It is the only question utilizing data from the second semester of the freshman year and includes no interventions. The results indicate that both the change in the surface approach to learning [pre] (M = 25.88) and [post] (M = 28.26) and the change in the deep approach to learning [pre] (M = 28.09) and [post] (M = 26.62) are significant at $p < .01$. The difference is that the change in surface approach is increasing and the change to the deep approach is decreasing. These data indicate that the students are increasing their surface approach to learning (from little change the first semester to increasing the second semester) and continuing to decrease their deep approach to learning (the deep approach deceased both semesters) throughout their freshman year in the current engineering program. The opposite direction would be desire the desired direction for the students. It has been noted in previous studies; however that the trend is for the students to become increasingly more surface and decreasingly more deep in their orientation toward learning in most undergraduate courses [14].

The final research question is addressed by looking at the pre/post R-SPQ-2F and the retention of freshman engineering students into the second semester:

6. What is the impact of a freshman engineering students' approach to learning on retention from first to second semester of the freshman year?

Statistical analysis on the pre/post R-SPQ-2F and the retention data did not indicate significance at the $p < .01$ or $p < .05$ levels (pre-deep odds ratio = 1.025, $p < .444$, post-deep odds ratio = 1.050, $p < .065$; pre-surface odds ratio = .973, $p < .320$, post-surface odds ratio = .967, $p < .248$). Refer to the table on page 44 for side by side detail. The relationship of a deep approach to learning at the end of the semester did have significance at the $p < .1$ level. The odds ratio and calculated percentage indicated that for every unit increase in the deep approach to learning at the end of the semester there was an increase of retention by 5% and for every increase in one unit in the deep approach to learning at the beginning of the semester there was an increase in retention by 2.5%. Conversely for every unit increase in the surface approach to learning at the beginning of the semester there was a decrease in retention by 2.7%. The trend followed at the end of the semester with every unit increase in the surface approach to learning indicating a decrease in retention by 3.3%. This indicates that as the surface approach to learning increases, retention decreases and as the deep approach to learning increases, retention increases. Although the odds ratio is not significant at the $p < .05$ level for the surface approach to learning, the trend appears strong enough that one would want to reconfirm this relationship of both the positive trend toward retention for the deep learning approach and the negative trend toward retention for the surface learning approach in future studies.

CHAPTER VI

CONCLUSIONS/FUTURE WORK

The pre-R-SPQ-2F data in this study presents a baseline of surface and deep approaches to learning for freshman engineering students at a large, public, research one university in the United States. Further studies could extend this baseline to additional disciplines at the same university, to other large public universities in the United States, to smaller scale private universities in the United States and to universities in other countries. Extending the understanding of the approach to learning to other disciplines outside of engineering would indicate if approaches to learning have an impact on the career choice. The extension to other programs within the university would also help to establish the impact of the institutional environment on the approach to learning. Expanding the research to include other large public universities in the United States could help to determine if there is any geographic relationship to the approach to learning or if any generalizations can be drawn from how the students are learning at the secondary level. Taking the research to smaller private universities could help to establish if the approach to learning plays a role in the selection of the university (public versus private) of an incoming freshman student. The developers of the R-SPQ-2F have indicated an interest in comparing data from previous studies and this would allow the opportunity to compare the approach to learning of students attending universities in other areas of the world. The graduating engineers are encouraged to have the ability to work globally and it would be of interest to see if they are also going to have to prepare to deal with individuals with a different approach to learning. Especially since the learning outcomes here are focused on creating the lifelong learner.

The pre and post R-SPQ-2F data in this study indicate that students are not increasing their approach to learning in the first semester of their freshman engineering program. In fact, it indicates that they are actually decreasing their deep approach to learning during their first semester in freshman engineering and also decreasing their deep approach to learning during their second semester in freshman engineering. The study also indicates that the students are increasing their surface approach to learning during the second semester of their freshman year in the engineering curriculum. This result leads to several opportunities for future research: 1) the impact of prior knowledge of the individual students (are they bringing the skills necessary to succeed in freshman engineering?), 2) the impact of the teaching context in the class room (are teaching techniques geared toward surface learning?-from lecture materials to assessments-trying to teach too much content?), and 3) a better understanding of how the individual learning strategies impact the approach to learning (what is the impact of implementing targeted metacognitive techniques in the classroom?).

The journaling intervention did not indicate that it contributed to a deeper approach to learning; however the sample size was quite small. It is recommended that this part of the study be repeated with journaling as a requirement instead of a volunteer activity. Then one may see a more true impact of the journaling on the approach to learning. A great deal of valuable information was received from the journals especially as it related to the course text, so if one is looking for feedback on course materials this is a good mechanism.

The results on the LASSI were a bit of a surprise. This refers to the fact that no average of the 10 learning strategy scales for the freshman engineering students averaged above the 65^{th} percentile. One has the perception that with the high level requirements such as top rank in class and SAT scores of 1200 or better, that the learning strategies of these students would be very high. This however, does indicate a great opportunity for assisting the students with learning strategies and perhaps getting to that deeper approach to learning. Based on the fact that only a low number of those participating in the LASSI also participated on both the pre/post R-SPQ-2F no conclusion can be drawn directly on the approach to learning regarding the LASSI. The low number of responses on the pre and post-R-SPQ-2F scores of those students who did participate on the LASSI was quite interesting in that they showed an opposite trend of those not completing the LASSI. This included an increase in the deep approach to learning during the first semester of the freshman engineering curriculum. It would be worthwhile to repeat this study and determine if this trend could be substantiated. Future studies could be designed with more instructor interaction with the LASSI to support the individual learning strategies and then conduct assessments during class time to assess the deeper level of learning.

The results of the data regarding retention and the approach to learning indicated a very strong trend toward higher retention for students with a deeper approach to learning and lower retention for students with a surface approach to learning. More data will be available to either confirm or deny this trend in the fall semester of 2003 because the surface and deep approach to learning data has already been collected for the spring semester 2003 students. The intent is to follow-up this study with a look at the retention data for these students in the fall of 2003.

Since so much of the learning process is dependent upon the learner and their learning strategies, it would seem relevant to conduct some qualitative studies with the students to better understand how they see the learning process. Therefore, focus groups to get feedback directly from the students are another recommendation for future studies.

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APPENDIX A

Revised Study Process Questionnaire (R-SPQ-2F)

Please enter your student ID with no dashes in the box below.

Select a section

This questionnaire has a number of questions about your attitudes towards your studies and your usual way of studying.

There is no *right* way of studying. It depends on what suits your own style and the course you are studying. It is accordingly important that you answer each question as honestly as you can. If you think your answer to a question would depend on the subject being studied, give the answer that would apply to the subject(s) most important to you.

Please choose the *one* most appropriate response to each question. Select the circle that best fits your immediate reaction. Do not spend a long time on each item: your first reaction is probably the best one. Please answer each item.

Do not worry about projecting a good image. Your answers are **CONFIDENTIAL**.

Thank you for your cooperation.

1. I find that at times studying gives me a feeling of deep personal satisfaction.

   1 A. This item is *never* or *only rarely* true of me.
   2 B. This item is *sometimes* true of me.
   3 C. This item is true of me about *half the time.*
   4 D. This item is *frequently* true of me.
   5 E. This item is *always* or *almost always* true of me.

2. I find that I have to do enough work on a topic so that I can form my own conclusions before I am satisfied.

   1 A. This item is *never* or *only rarely* true of me.
   2 B. This item is *sometimes* true of me.
   3 C. This item is true of me about *half the time.*
   4 D. This item is *frequently* true of me.
   5 E. This item is *always* or *almost always* true of me.

3. My aim is to pass the course while doing as little work as possible.

   1 A. This item is *never* or *only rarely* true of me.
   2 B. This item is *sometimes* true of me.

3 C. This item is true of me about *half the time.*
4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

4. I only study seriously what's given out in class or in the course outlines.

1 A. This item is *never* or *only rarely* true of me.
2 B. This item is *sometimes* true of me.
3 C. This item is true of me about *half the time.*
4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

5. I feel that virtually any topic can be highly interesting once I get into it.

1 A. This item is *never* or *only rarely* true of me.
2 B. This item is *sometimes* true of me.
3 C. This item is true of me about *half the time.*
4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

6. I find most new topics interesting and often spend extra time trying to obtain more information about them.

1 A. This item is *never* or *only rarely* true of me.
2 B. This item is *sometimes* true of me.
3 C. This item is true of me about *half the time.*
4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

7. I do not find my course very interesting so I keep my work to the minimum.

1 A. This item is *never* or *only rarely* true of me.
2 B. This item is *sometimes* true of me.
3 C. This item is true of me about *half the time.*
4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

8. I learn some things by rote, going over and over them until I know them by heart even if I do not understand them.

1 A. This item is *never* or *only rarely* true of me.
2 B. This item is *sometimes* true of me.
3 C. This item is true of me about *half the time.*
4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

9. I find that studying academic topics can at times be as exciting as a good novel or movie.

1 A. This item is *never* or *only rarely* true of me.
2 B. This item is *sometimes* true of me.
3 C. This item is true of me about *half the time.*
4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

10. I test myself on important topics until I understand them completely.

1 A. This item is *never* or *only rarely* true of me.
2 B. This item is *sometimes* true of me.
3 C. This item is true of me about *half the time.*
4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

11. I find I can get by in most assessments by memorising key sections rather than trying to understand them.

1 A. This item is *never* or *only rarely* true of me.
2 B. This item is *sometimes* true of me.
3 C. This item is true of me about *half the time.*
4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

12. I generally restrict my study to what is specifically set as I think it is unnecessary to do anything extra.

1 A. This item is *never* or *only rarely* true of me.
2 B. This item is *sometimes* true of me.
3 C. This item is true of me about *half the time.*
4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

13. I work hard at my studies because I find the material interesting.

1 A. This item is *never* or *only rarely* true of me.
2 B. This item is *sometimes* true of me.
3 C. This item is true of me about *half the time.*
4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

14. I spend a lot of my free time finding out more about interesting topics which have been discussed in different classes.

1 A. This item is *never* or *only rarely* true of me.
2 B. This item is *sometimes* true of me.
3 C. This item is true of me about *half the time.*
4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

15. I find it is not helpful to study topics in depth. It confuses and wastes time, when all you need is a passing acquaintance with topics.

1 A. This item is *never* or *only rarely* true of me.
2 B. This item is *sometimes* true of me.
3 C. This item is true of me about *half the time.*
4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

16. I believe that lecturers shouldn't expect students to spend significant amounts of time studying material everyone knows won't be examined.

1 A. This item is *never* or *only rarely* true of me.
2 B. This item is *sometimes* true of me.
3 C. This item is true of me about *half the time.*

4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

17. I come to most classes with questions in mind that I want answered.

1 A. This item is *never* or *only rarely* true of me.
2 B. This item is *sometimes* true of me.
3 C. This item is true of me about *half the time.*
4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

18. I make a point of looking at most of the suggested readings that go with the lectures.

1 A. This item is *never* or *only rarely* true of me.
2 B. This item is *sometimes* true of me.
3 C. This item is true of me about *half the time.*
4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

19. I see no point in learning material which is not likely to be in the examination.

1 A. This item is *never* or *only rarely* true of me.
2 B. This item is *sometimes* true of me.
3 C. This item is true of me about *half the time.*
4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

20. I find the best way to pass examinations is to try to remember answers to likely questions.

1 A. This item is *never* or *only rarely* true of me.
2 B. This item is *sometimes* true of me.
3 C. This item is true of me about *half the time.*
4 D. This item is *frequently* true of me.
5 E. This item is *always* or *almost always* true of me.

submit

Submit

Adapted from:
Biggs J, Kember D, Leung DYP. (2001) British Journal of Psychology. 71: 133-149, Part 1 Mar 2001.
Last revised 24 September 2002

APPENDIX B

LASSI Assessment Directions
Becoming a Strategic Learner

Step 1: Learning and Study Strategies Inventory (LASSI) 2nd Edition
Please proceed to the following URL using your web browser:

http://www.hhpubco.com/LASSI/

Read the directions and enter the following information:

School Number: 77275
User Name: prwa
User Password: pf4y

Next enter your first and last name into the spaces provided. For the ID number, please enter your section number a space and then your ID number. Then enter your email address.

You will be asked to respond to 80 statements. After completing all the items and successfully submitting the results, a two-page report will be displayed listing your scores for each scale, together with your name, institution, date of administration, and an explanation of your results. Please print a copy of the results for your record.

Step 2: LASSI Instructional Modules

Review the results of your assessment and determine the scores of 75 and below. You may want to highlight these for future reference. The scores of 75 or below on any of the LASSI scales indicate an opportunity for you to improve your learning strategies in these areas. Completion of learning strategy self-paced modules is the next step. You may access these modules as follows:

http://www.lassimodules.com/

Please register using the following information:

School Number: 57270
School Key: yrfrt

Then enter your first and last name and in the ID field enter the section number, a space and your ID number. **When you have completed the registration process, you will be issued a user name and password. Since you will be asked to enter your user name and password each time you login, it is important that you keep a copy in a safe place.**

Completion of the modules (and this is monitored through an Admin Account) will receive extra credit at the end of the semester as follows:

75-100% Complete == 3 extra credit pts
50-75% Complete == 2 extra credit pts
25-50% Complete == 1 extra credit pt

Help sessions are a great time to work on your modules.

APPENDIX C

Individual Journaling Requirements

What is it?

It is a reading assignment journal based on your reading assignments in the Holtzapple/Reece textbook. You are asked to:

1) summarize, in your own words, the important elements of the reading assignment
2) list questions about the content of the reading material that is unclear
3) describe potential applications of the material to your own life (written in first person)
4) describe your own experience(s) relevant to the material in the reading (written in first person)
5) compare and contrast the reading material to other material in this or other courses

Why is it valuable?

Keeping this type of a journal has been proven valuable because it allows you to reflect on information that you have read and gives you a deeper understanding of the material. It has also been shown to increase quiz and exam scores of students in other engineering freshman classes. It will help to make you a better engineer.

What is expected?

a) include at least three of the five components listed above
b) maximum 2 page, minimum 4 paragraphs (single spaced) word processed document-submitted via email
c) submit before the beginning of class on the day the reading is assigned (Holtzapple/Reece text only)
d) remember--your own work in your own words

What is the payoff?

- 14-17 journal documents submitted == 3 extra credit pts
- 10-13 journal documents submitted == 2 extra credit pts
- 6-9 journal documents submitted == 1 extra credit pt

Extra credit points will be added at the end of the semester where the total possible points are 100. Journals will be assessed only as “meets expectations” or “needs improvement.” Comments will be offered to those labeled “needs improvement.”

What if I don’t want to do this?

Other options (2 page documents with same payoff as above) to the engineering journal include:

a) write a review of a professional journal article (ASEE, ASCE, ASME, IEEE, AICHE, etc.)

b) conduct a personal interview with professional engineer (on or off campus) Document Professional Engineer's license number
c) conduct a personal interview with an elected official (Mayor, Commissioner, State Representative, etc.)

Reflective journaling requirements "adapted from Burrows et al."

Sample Reading Assignment Journal – ENGR111 Fall 2002

Name	**Date**
Team	**Journal Number: 1/17**
Chapter Topic	

1) Chapter 1 Summary:

Engineers are people who solve technical problems. Engineers must consider more than just technical issues; this may include political and environmental issues. There are many different types of engineers including chemical, mechanical, electrical, industrial, aerospace, materials, agricultural, nuclear, architectural, biomedical and computer science. Many more than I ever realized.

Engineers work in many different areas. Some invent new products in research while others develop current products into better or different products. Production/operations engineers work in plants to help keep them running or tries to improve current processes and work flow in the plant. Design engineers design new products in detail and some even design entire plants. New buildings, bridges and plants require construction engineers to make sure they are built appropriately.

Universities are required to meet established quality measures by a board of accreditation. Each graduate is expected to be able to perform specific skills determined by this board.

Engineers must work for a few years before they can take an exam and get a license as a professional engineer. Each type of engineer can also belong to a professional society related to their discipline.

The engineering method is different from the scientific method. It really helps me to understand the 10 common steps that an engineer usually takes to solve a problem. I didn't realize there were so many different types of models used by engineers – qualitative, mathematical, digital, analog and physical.

Engineers require many traits not only those related to math and science. Some of these traits include interpersonal skills, logical thinking, communication, follow-through, etc.

2) Chapter 1 Clarity:

Chapter 1 seemed pretty straightforward except the part about the accreditation process. Why does an outside group come to the university and check out their processes? Wouldn't this be a responsibility of the university?

How does one acquire all of the traits to be a successful engineer? Are they taught in school? How about the traits of a creative engineer? How can one learn to be more like that?

3) Chapter 1 Potential Applications:

Seems a little goofy, but one application for me is to become an engineer. I could be the certified professional engineer and be licensed. I could also make it part of my goals to acquire some of the traits of a successful engineer. I could definitely learn to apply the engineering method during some of my classes in school and will likely use the different models. Especially math, I would think. Some of the creative traits might be used in some classes/projects too. The engineering functions might help me to know what type of job I would like to pursue when I am getting ready to graduate or when I try to get internships during college.

4) Chapter 1 Personal Experience:

My experience with engineers starts when I was in elementary or junior high and would see surveying crews working on the highways. My parents would tell me that they were engineers. When we talked about the rockets going to the moon they would again say that it was because there were engineers working to allow it to happen. In my mind, engineers were involved in building things, roads, bridges, buildings or rockets. I do not recall any friends or relatives that were engineers.

5) Chapter 1 Compare and Contrast:

This chapter and hence this class starts out very general with regard to the engineering profession. It is a bit difficult at this point to see how we will become problem solvers. Physics and calculus on the other hand begin working problems on the first day. This class is very structured with designed presentations and details on the computer. The professors in physics and calculus use the chalkboard. This class has members who are all headed toward the same degree (at least engineering). My English class has people from many different degree areas. Seems we have a different focus in the English class.

APPENDIX D

SAMPLE JOURNAL ENTRIES

1. Summary

Engineers are people who solve problems in the real world. They use their expertise of math and science to create a solution. Although the 1,551,961 engineers in America use several different mixtures of their knowledge and are required to perform several different tasks, all of the individuals are considered engineers. Several different types of engineers are mechanical, electrical, aerospace, civil, and nuclear.

The solutions that engineers create all must be under specific guidelines. A team could be under the pressure of a timed deadline or must watch their spending because of a restricted budget.

The engineer, after years of training, can become a professional. Once out of the training period, the engineer must keep his knowledge up to par. Without using his wide network of individuals that he created in school, he will become obsolete in a competitive world. As a professional, the engineer can become registered. Having this quality, he can become more competitive.

An engineers thinking process must be molded into specific guidelines. He must think qualitatively using his skills in Math. He must use all of his tools that are given to him for his disposal. New computers and information must be used for optimum performance. He must have many traits, one of the most important being creativity. By being creative, the engineer can create solutions that can be used effectively and efficiently in the real world.

2. Clarity

Chapter 1 explains every part in a very specific manner. On the other hand, when the authors talk about creativity, molding ones brain to do specific subconscious tasks is impossible. The brain's characteristics are only modified by constant change. One trying to change it specifically is illogical.

3. Potential Applications

Using the information from the passage could be very helpful. Trying to learn many different subjects to strengthen myself is a very good procedure. Although my major is mechanical, I will be working with many different types of engineers. By learning about their major, I would become more efficient.

4. Personal Experience

My only personal experience with engineers is with a good friend of mine. Living in a small town, he was the only engineer around. By listening to him talk and observing how he used his words to make a certain point come across to the listener, I have begun to see how an engineer must act and think.

5. Compare and Contrast

The material in this chapter is very different because engineering is new subject to me. The only connection is that I have always been a problem solver. When I wrote programs in C++ in high school, I had to think of the most logical and efficient way to solve the problem. I believe this class will enlighten my thinking.

Summary:

Engineering is an acient study of problem solving. It is not constrained to building bridges and large buildings. There are various fields of engineering: civil, mechanical, electrical, chemical, industrial, aerospace, material, agricultural, nuclear, architectural, biomedical, and computer. The number of engineers in each field varies, there are 467,000 electrical engineers and only 2000 agricultural engineers in the United States. What type of engineering you pursue and the salary earned in that field varies with the amount of education and experience you receive. An engineer must have many different qualities, he or she must have interpersonal skills, communication skills, leadership, competence, logical thinking, quantitative thinking, a continuing education, dependability, honesty, organization, common sense, curiosity, and creativity.

The third chapter of the book leads of by explaining the types of problems needed to be solved: research, knowledge, troubleshooting, mathematics, resource, social, and design problems. Each of these requires an approach process. First identify the problem; next is synthesis, the step where parts are combined to form a whole; analysis, looking in depth at each piece; application, identifying vital information; and comprehension, the solving of the problem with proper information. The book teaches the best way to not run into problems while solving problems. My personal problem is sign error which the book did address as an important step to check. There are for steps to solving a problem, understanding the problem, develop a plan, carry out the plan, and examine the solution.

Clarity:

I felt that chapter one was very easy to understand. It was filled with concrete facts and I had no real problems with its content. I ran into some small problems with understanding some of the problem examples out of chapter three but after a while understood what they were asking.

Potential Applications:

I hope to use chapter ones reading in the next few years to help me make important decisions such as which clubs to involve myself in, what field to study, and which major I should choose.

Personal Experience:

In the past my only knowledge of engineers was from what my parents, teachers, and friends mentioned in casual conversation. I have no family in the field of engineering. I knew very little about the engineering processes and the job opportunities that were available after obtaining an engineering degree. I hope after taking this class these things and many others will be even more clear to me.

In the next chapter, as mentioned earlier, I could relate to one of the problems often ran into when solving problems. My problem is that I often lose negative signs when solving problems.

Compare and Contrast:
I have many of the same people in this class that I have in classes such as math 151 and physics 218, but I am also taking poly sci 206. I have very few of the same people in my poly sci class as this one. Even though this is true, I feel that the two classes are some what similar. They both thus far have required a large amount of reading and are my last class of the day. Of course the educational value of this class is much more strongly tied to 151 and 218. I have heard that they are very different in the types of work that are assigned.

---

1) Summary:
This chapter summarizes the problem solving techniques possessed by engineers. It is necessary for them to posses these skills because off the array of problems that they face in the field. Whether the problems lie in finding certain resources or research and design, a successful problem solver is highly prized and well rewarded.
An engineer's approach is what makes him or her successful. The approach, which is both orderly and systematic, contains the elements of identification, synthesis, analysis, application, and finally comprehension, where the problem is solved. Many times, however, complications will surface and the procedure will have to be repeated (iterative procedure).
The skills needed to become a good problem solver include knowledge, experience, learning skills, motivation, and communication. Most importantly, is reductionism, the ability to logically break a problem into pieces beginning with a picture.
The final step to solving a problem is checking the answer. This can be done by reworking the problem in a different manner or by using estimation. Someone who is capable enough to make accurate estimations, however, is going to be a person who has been in the field and gained much experience. Creativity is key in all of this. New insight is what sheds light on dark things and exposes new and exciting ways to look at things.
In problem solving there are many different techniques, but according to Polya, one first you have to understand the problem, find the connection between the data and the unknown, carry out your devised plan, and then examine the solution obtained.

2) Clarity:
One of the things about this chapter was how and why the writers made it seem like engineers were destined to make mistakes, but at the same time doomed if they did. What is with the strict steps to find a solution? There are obvious paths to every answer.

3) Potential Applications:

This chapter is full of potential applications. From now on I plan to look at things in more of a systematic and characterizing manner. That way I am sure not to miss any important details. I also learned that the most effective way to solve a problem is to break it into pieces. These little details are those that will stay in the back of one's head every time a problem is encountered. I also plan to use estimation and creative analogies to solve problems in the future, and both of these are thoroughly described. Lastly, the ending sample problems got my mind warmed up to the necessary mindset to succeed.

4) Personal Experiences:
Up until now I have always thought of myself as a good problem solver. As I look at the certain types and approaches to problems, I realize that although I did not know the fancy names mentioned, I already have followed some of these approaches to these problems. An example of this is when I fixed my car. When I tried to start it I heard a strange noise. Immediately I was able to identify the approximate location and the parts involved in the problem. I them lifted the hood and was able to see the problem and devise a plan of action. After a little trial and error (Application) and a trip to the car part store everything was working again.

5) Compare and Contrast:
Having not really gotten into problem solving in class, aside from a definition or two, I can only anticipate the similarities and differences I will encounter in class as the semester progresses. As far as other classes, I do not think there has been a class in my academic career where there was not a problem to be solved whether it be how to keep the coloring in the lines or taking a difficult derivative. At the same time this chapter introduces new and very specific approaches and types of problems I had never been previously exposed to.

1.) Summary:

The first part of the chapter dealt with the profession of engineering in general. It stated that engineers are people who use science and math practically to solve problems. Engineers sometimes must even solve problems without understanding its theory. On top of that, engineers also try to minimizing damage to the environment by using energy efficient processes and reducing waste. Because the cost of labor in the US is so high, engineers must also develop methods to used machines in the place of human labor.

In technology development, engineers seldom work alone, they also associate with scientists, technologists, technicians, and artisans to accomplish tasks.

The next bit discussed the different “disciplines” of engineering in a little detail. The oldest is civil, then mechanical, and some of the more recent ones include electrical, chemical, industrial, aerospace, nuclear, biomedical and computer.

Engineers can also be classified by the work they do like research, design, production, testing, construction or consulting. All of these roles must work together to produce goods for the market.

The second section talks about the education and professional experience necessary before you can become an engineer. In college, engineers must learn certain criteria specified by the ABET (accredited board for engineering and technology). Then they must take tests, work for four years and obtain letters of recommendation before they can be licensed. They can also belong to a professional society in their field.

The final sections talk about "tricks of the trade" and how to solve problems using models and creativity. It also lists traits of a successful engineer like leadership, logical thinking, and curiosity. Creativity is also an important skill to engineers and they need to keep a "tool box" of ideas and knowledge they gather.

2.) Clarity:

This chapter was mostly introduction, but there were a few parts that confused me like the part about engineers needing to solve problems even without understanding its theory. That seems very risky to me, I don't understand how you can solve a problem without understanding it. I also didn't get the section about models and how incredibly complex they could get. It seems like they are just more work than they are worth.

3.) Potential Applications:

I especially liked the part where they talked about civil engineering because that is the discipline I plan to go into. But I also found the part about industrial engineering very interesting. It might be something I should look into finding more about. I could also join a professional society and begin filling my "tool box" of ideas. I also need to work on developing creativity. I can also see it helping me a lot to try to think about all the qualities and ideas of a good engineer when I'm solving problems. I know that would help a lot.

4.) Personal Experience:

My father is an agricultural engineer, so I have been brought up having mini-physics lessons told to me in answers to questions. He was on the engineering council at A&M, and one of my goals is to be on it as well. My uncle is an architect and he swayed me more towards civil engineering by talking about the design and construction of bridges to help me with one of my school projects. I found this so fascinating, I decided to look into it as a career.

5.) Compare and Contrast:

This class seems very laid-back compared to my other ones. They all lecture the whole class long. This gets tedious. Engineering is a lot more high-tech too, with all the computers around in the lab. It is nice to be able to get on the computer and access the lecture online for this class, but I'm also worried I'll forget to and not learn that part of it. However, in terms of study-work load, this one seems to be about the same. It will be different though, with graphics work added in, not just cut and dry math problems.

Summary:

Engineers are repeatedly described as problem solvers. They must have traits such as interpersonal skills, communication skills, leadership, competence, logical thinking, and creativity, among other things. Different disciplines of engineering are described, as are other related fields. Basic information was provided on civil, mechanical, electrical, chemical, industrial, aerospace, materials, agricultural, nuclear, architectural and biomedical engineering. An engineer must have a large understanding of physics, chemistry, and some even biology.

I was surprised to the date that the earliest form of engineering was established. Three thousand BC for civil, up until as early as the mid twentieth century for biomedical was very impressive. For a profession to be around for several thousand years and branch out continuously means good job security for me. Even with a possible shaky future in my very own disciple, I may be able to work and transition into another division of engineering. Because most have the same core curriculum and ideas, but different specialties, I can always continue to expand my knowledge and work in another field of engineering with specific training.

Clarity:

Chapter One was very clear. It just went on and on about the traits of engineers and the necessary creativity they must posses. Many of us already know what traits we have and why we have chosen the field of engineering, why does the book devote an entire chapter to this? Those of us who are still in the college know what it takes and are dedicated to accomplishing our goals. The chapter just seems very elementary.

I'm entering biomedical engineering, what specific traits are important to my certain field?
It is necessary to have all the traits to be successful?
How do you improve your traits or get the traits if you don't already have them?

Application:
The chapter and its contents will help me focus on certain traits I need to acquire or work on in order to be successful in my field of engineering. I will be able to apply the different types of models discussed to my different engineering courses to come and my professional career. The section entitled, "Registered Professional Engineer" informed me of the procedure required by states to license engineers. This will be most helpful if I want to become a Professional Engineer, as will the information about the standardized tests required.

Personal Experiences:
I have grown up my entire life around engineers and medical professionals. My dad is a mechanical engineer with ChevronTexaco and my mom is a physical therapist. My brother graduated from Texas A&M in 2000 with a mechanical engineering degree and currently works for BP. Other members of my family are civil engineers and doctors. I always had the impression engineering only involved oil and gas. That's all I was ever exposed to. I grew up wanting to work in medicine, especially physical therapy, but I looked into biomedical engineering. It opened my eyes to different disciplines and taught me I didn't have to work with oil to be an engineer. I want to use my talents and my nurturing nature to help others with my degree in biomedical engineering.

---

1. Summary

Engineers combine mathematics, science and economics to solve problems while facing technological advances that push the engineer to learn new techniques. To best prepare engineering students, our professors will teach us to use creative problem solving skills rather than attempting to teach us every detail or fact we will need.

Engineers are a part of a technological design team that impacts society everyday. Several diciplines(mechanical, chemical, biomedical, etc.) within engineering field have formed from civil engineering. However, no matter what their diciplines, engineers can perform many tasks (research, design, sales, etc.). Since engineers are important to society, their education is regulated by ABET and their liscences are regulated by the state. Engineers use a design method in order to formulate models that can be used to solve problems. Engineers use synthesis and analysis to solve problems. During synthesis and analysis, estimation can be used because we almost never have complete information to solve a problem definately.

Problem solving can be broken down into the following steps: (1) understand the problem, (2) think about the problem, (3) design a plan, (4) execute the plan, and (5) check your work.

2. Clarity

Chapter one and three were very clear. The first chapter discussed the importance of engineers on society and the various disciplines in teh engineering field. Chapter three discussed the importance of problem solving and the design method that helps engineers sove problems daily.

3. Potential Applications

In chapter one, engineers are described in detail, including characteristics or traits of successful engineers. This will help me in the future when I am an engineer because the traits I will try to attain during the next four years. The problem solving techniques shown in chapter three will help me develop problem solving skills necessary for the job.

4. Personal Experience

I have had little to no experience with engineers. I have seen the survey crews on the road and I know that engineers have played a vital role in the increase of technological advances in the past fifty years. Just look at how far we've come as a society in the past fifty years- with several advances in medicine as well a computer technology and many other fields. We can even clone animals.

5. Compare and Contrast

The first chapter began with very general information about engineers and what they do. So I was rather skeptical that I would be able to use this information to become a great problem solver. However, chapter three helped to dismiss my worry because it was all about problem solving and the various ways of looking at a problem in order to solve it.

Summary:

The hard courses we take are giving us the skills we need to succeed as an engineer. The one thing engineers seem to be lacking is communication skills.

There are three basic steps in preparing for a presentation. They are topic selection, research, and organization. There are many ways to obtain research on topics.

When getting organized for your presentation, think about whom the audience is. Once the audience is established, you can determine what points to bring up. There are several strategies to making a good presentation such as chronological strategy, spatial strategy, debate strategy and several others. Every strategy should include an introduction, body, and conclusion. The introduction is where you win the audience over. The body is where you hit the key points and the conclusion is where you seal the deal. Visual aids help keep the presentation enjoyable.

Some people experience speech anxiety. There are several techniques to calm speech anxiety.

The way the presentation is presented plays a big role in winning the audience over. There are certain places you should look, stand, point, etc., during the presentation.

In order to have an effective presentation, we have to have good writing skills. Good writing skills are essential to an engineer. We want our writings to be exactly clear so there are no questions about the point of the writing.

Clarity:

Most of Chapter 6 was very clear to me. I wonder though why some people experience speech anxiety and others do not. Is it just something personal or maybe hereditary? I understand the need for good communication skills and for good writing skills.

Personal Application:

I believe I can apply this to everything in life. For all documents I need good writing skills. Being an engineer will require many presentations so these tips will help me out greatly in my engineering career.

Personal Experience:

My personal experience with communication skills has happened in the last year or so. I was in an organization called BPA and the team I was on went to Nationals. We all had to communicate thoroughly with each other so we would all understand our part. Also, I have worked on my communication skills by doing many leadership projects where I had to present presentations to large groups of people.

Compare and Contrast:

None of my other classes have taught me how to give a good presentation or what the necessary skills are to help me give a good presentation. In English, however, I have learned the importance of having good writing skills.

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1)Summary

An engineer is one who takes current technical knowledge and uses it to benefit society. Basically, an engineer takes what is at hand and converts it into something useful. Engineering has a long history including many current disciplines such as: civil, mechanical, electrical, chemical, industrial, aerospace, materials, agricultural, nuclear, architectural, biomedical, computer, and military. Research, development, design, production, testing, construction, operations, sales, managing, consulting, and teaching engineers all have different roles that help to bring the finished product to society to be used.

To be a professional engineer, you must pass certain exam requirements, have the skills, live by ethics, and be licensed through ABET. Each college has certain minimum requirements to be an engineer.

Engineers use many skills to accomplish their tasks, and may use different mind-sets, methods, and models for each. However, there are several
constants: the engineering design meathod, interpersonal skills, communication, perseverance, honesty, logical thinking, and creativity. Laws help an engineer to deal with the probable world.

An engineer is by definition a problem-solver and therefore comes up against several types of problems such as: research, knowledge, troubleshooting, mathematics, resource, social, and design. An engineer will use a problem-solving approach. First he or she will identify the problem, second synthesize, third anaylize, fourth apply, and last comprehend. This may lead to a solution. To keep everything error free find out and write down all you know about a given situation including a picture, assumptions, and units.

2)Clarity

Do all engineers have high traits in the areas that make a good engineer? Why do engineers have several national standard organizations to say what is correct about engineering, but the English language has nothing of the sort short of Webster's? What does professional autonomy really entail? Is there a best way to go about getting the correct degree combination to become a director of engineers one day? How can one bridge the gap between creative and organized thinkers? Is there a way to directly access your subconscious without dreaming or sleeping? What credentials are companies looking for? Should estimating be so inexact a science? What do you do when several primary objectives must be met is design and it is beyond your personal capabilities?

4)Personal Experience

I am one of those individuals who has always considered engineering as one of my top choices. Why? My passion for designing things, fixing things, tinkering, and problem-solving drove even my civil engineer father absolutely nuts, to say nothing of my classmates or teachers. Not only do I enjoy this type of challenge, but I have a combination organized/creative mind that will not let me rest on my laurels. I am a long range planner, so knowing the skills, attributes, goals, and mind-set of an engineer are very useful for me. Each situation is individual and must be handled with creativity and logic, including my own.

Summary:
Being an engineer is not an easy career. There are many obstacles on the engineering path. First, in order to be an engineer you have to be good in mathematics, physics, chemistry, and the other natural sciences. However, an engineer not just has to master those studies, she/he has to be such a good speaker and writer.

In the process of communication, a good body language and being good speaker makes anyone a well-educated person. In fact, an engineer has to have an excellent preparation in oral and writing skills.

In addition, the engineers have being always well prepared to give presentation in front of public. So, an engineer has to follow these three steps: topic selection, research, and organization.

After the selection of the topic, an engineer has to research many resources as he/she can including technical journals, books are written by authors who are familiar with a field, conference proceedings, encyclopedia articles, government reports, patents, course notes, popular press, internet sites, and many more resources. Then, after the research you have to know your audience; moreover, the engineer has to prepare a speech, he/she has to studied and apply a good strategy such as a chronological strategy, a spatial strategy, general-to-specific strategy, problem-to-specific strategy, problem-to-solution strategy, and motivational strategy.

Three basic parts make oral presentations: Introduction, Body, and conclusion. Each one is very fundamental in an oral presentation. Also, the engineer can reinforce his/her oral presentation by including visual aids such as word charts, tables, charts and graphs, photographs, schematics, maps, and physical objects. Moreover, the visual media can make a nice impact upon you audience. There are many media including transparencies, slides, computer projections, handouts, butcher paper, and black boards.

For the speech, a good body language and a bold and strong voice can cause such a good presentation. In fact, most of the information provided in the oral presentation is obviously oral, so the engineer has to be calm to manage the presentation and finally succeed on the message she/he tried to explain.

For writing, the engineer has to be very consistent and neat while he/she is writing. The engineering style of writing is technical. The technical writing is accurate, brief, clear, and easy to understand. Another three important factors in the engineering style of writing are organization, punctuation, and good structural sentences. These three factors help the engineers to have a good writing skills and habits.

2) Clarity:

Chapter 6 was extremely useful to me because it explained and covered most of the writing topics I needed to know. But, it was also a little confusing about the use of complex sentences. Why an engineer cannot write complex sentences?

3) Personal Experience:

My personal experience was when I came from Mexico. I did not speak any English at all. Also, I had a very difficult time on improving my English, but the point is that I started reading books and I improved my body language in a great deal. Less than three months I could speak and write the essential English I needed in order to survive. Also, I discovered just how with this chapter, an engineer has to be good at all aspects and always be perseverant in what an engineer wants.

Summary

Chapters one and three dealt mostly with the basics of what an engineer is and what it takes to be a successful engineer. It started with a brief description of what an engineer, and then described the specific functions of all the different engineering disciplines. The text also points out all the subdivisions of these disciplines including testing engineers, development engineers, and research engineers. The rest of the chapter was about the education and skills that engineers need to be successful. The chapter ended with an section about how important creativity is for engineers. Creativity is the most important skill for an engineer that is not taught in school. Creativity is something that you must be develop on your own and practice it if you want to be successful.

Chapter three was devoted to the importance of good problem solving skills. It began with a section about all the different kinds of problems engineers encounter, and the different processes that you must go through to solve them. It showed many examples of the right way to solve problems. It emphasized that you must write clearly and write your calculations so that someone else can read them. The chapter ended with a set of problems designed to test your creativity.

Questions

I thought most of the information in these chapters was clear and concise. However I would have liked it if the engineering disciplines were described in greater detail. I also do not understand why the end of chapter one was a mass of random math and physics problems. I did not see the use for that.

Potential Applications

These chapters were very valuable to me because I am not quite sure of which discipline I should get into. The part of chapter one where all the disciplines were described and compared helped me to decide which areas I want to peruse. I am still not sure but I have a better idea. I also benefited from the creativity problems at the end. I have always been creative and these problems were a good test for me.

Compare Contrast

This book has a much different style than any textbook that I have used. In the first chapter the book addressed the requirements for certification and post graduate work. This makes me believe that this book will concentrate more on the uses and applications of problems than just doing meaningless work.

1) Summary:

A good engineer not only know how to solve problem, but he or she need to have good communication skill. The communication skills incorporated both oral and writing skills. In writing skill the engineers can communicate by words or graphic.

In giving an presentation or writing, engineers must have preparation. First the engineers must select a topic. After the selection of topic, the engineers have to so research to obtain information about the topic from technical journals, books, conference proceedings,
encyclopedia articles, government reports, patents, course notes, internet sites, and press articles. After the preparation procedure, the engineers must organize the information to form an proper outline for the audience.

In oral presentations, there must be an introduction to the topic. The introduction must be interesting to capture audience attention. The body of the presentation must be clear and easy to understand. In the conclusion, engineers will summarizes the key point. Having visual aids like graphs schematics, physical objects, etc will be helpful in an oral presentations. When giving speeches, the engineer must keep eye contact with the audience, don't use distracting phrase, and learn how to deal wit speech anxiety.

In writing presentations, the engineers want to be accurate, brief, clear on the topic, and easy to understand. Write the paper like an essay for any other class but be clear and use correct grammar, words, and punctuations.

2) Clarity:

Since there are so much writing involve in engineer, will it be helpful to take extra writing class? If yes, what kind of writing class? Do technical writing class teach this type of writing?

Will the engineer students do a lot of oral and writing presentation? If writing is some important in engineering, why doesn't the college take out some core curriculum and put in some writing and oral classes?

3) potential Application:

After reading this chapter, I find two applications for me. I think I will try to improve my writing skills by taking writing assignment seriously and try to apply some of the writing techniques mentioned in the chapter. The other application is for me to present or state my ideas clearly with simply words and graphics.

4) Personal Experience:

I have trouble with my writing skills from the time I came to the United States till now. I been trying to improve my writing skills by reading books and writing as much as possible. By writing this journal, my writing skills my writing and type skills are improving. I hope to master my writing skills by the time I graduate from A&M University.

1) Summary

Computers have made the life of an engineer a litte easier. The history of computers have evolved over time with the help of many people. Computers use binary, octal, or hexadecimal number systems. For binary combine to three bits and octal combine to four bits.

Engineers are expected to solve problems by using algorithms. Computers help to solve complicated algorithms. Computers store memory through a flip flop process. The part of the computer that uses this memory to perform operations is the central processing unit.

Hardware is such as the printer, disk drives, and networks. The computer includes input, storage devices and output. There is an internal and external type of disk drive. A local area network allows computers to be able to communicate with other computers.

A structured code is preferred while programming a computer. The top-down design is to state the problem clearly, describe the input and output information, work the problem by hand, develop a general algorithm for the problem, and test the solution with a variety of data sets. A flow chart describes the sequential order in which steps are done.

2) Clarity

I have always been taught that computers are always right and if they mess up it is the users fault not the computer. I found it interesting that the book stated "If we accomplish nothing else in this book, we hope to teach you to distrust everything that comes from a computer."

3) Potential Applications

It is important to remember that formulas must be typed in the correct, unique form to receive the correct answer. By reading this chapter, it gave me a better understanding of computers and how they work. I use computers everyday and it is essential for me to understand as much as I can.

4) Personal Experience

I'm glad that the computers are set up so that we don't have to really understand very much of the internal process to be able to use them. It is a lot easier to click the mouse button then to learn DOS commands.

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2. Questions about reading material

Why does the book refer to RAM and ROM collectively as “memory” when they are very different?

Why does the book discuss CD-ROM’s and not CD-R’s pr CD-RW’s?

The book does not make the “flip-flop” concept very clear.

On figure 4.9 the book tries to show how although spaghetti code can be shorter it is undesirable because of how confusing it is. The calculations in the spaghetti code figure are more complex than those displayed for structured code and therefore the spaghetti code displayed is inherently more complex and confusing. The reader is unable to see how much space would be taken to follow structured code and is expected to accept the concept that structured code is more confusing blindly. I do not accept anything blindly.

4. Own experiences

I found that I know a lot more than the book considers important about computer hardware. I have explained to many different people the basic way that computers work and they were always able to understand what I was talking about. I think that if I didn't already understand how computers work than after reader chapter 4 I would be more confused than when I started.

5. Compare and Contrast.

This chapter, just like many other chapters in the book contain a lot of unnecessary information, such as the history of computers. By unnecessary I do not mean unimportant because all information is useful somehow; what I do mean is that this information is information that is unnecessary to learn to become an engineer. The book describes archaic technology when the world has abandoned using said technology for obvious reasons.

The chapter also follows the book with leaving out information that I consider very important to becoming and engineer. Just like in the chapter that discussed different types of engineers(which breezed over many of the fields) this chapter breezes over the basic hardware principles such as RAM and ROM and how things such as the aforementioned are used in computer processes

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1) Summary

Engineers use tables and graphs to relay compound information. Independent and dependent variables are used to specify the cause and effect of the information, respectively. In a table, the independent variables are located in the left columns and the dependent variables are located on the right columns.   Graphs are used to represent the tabulated data in a clear manner. The independent variable is located on the abscissa (x-axis) and the dependent variable is located on the ordinate (y-axis). The numbers on both tables and graphs must have units on them. Proper multipliers and symbols must be used to avoid costly mistakes. Both tables and graphs must also have appropriate titles.

Linear equations, power equations, and exponential equations can be depicted on both tables and graphs. In a linear equation, $y = mx + b$, the m is the slope and the b is the y-intercept. In a power equation, a log can be taken of both sides to make it linear. The equation may then be plotted on a log-log graph or a rectilinear graph, although the slope of log-log graph is futile. When a log is taken of both sides of an exponential equation, it can be graphed on a semilog graph.

On a graph, the data can be graphed within the points (interpolation) or extended beyond the points (extrapolation). A curve can be approximated using a straight line with linear interpolation.

2) Clarity:

Some of the graphing methods are not clear to me. The logarithm methods could be explained a little better. If a student didn't have a strong background in logarithms, they would be lost. Also, the power equations and the exponential equations were poorly defined. Do they have anything to do with derivatives and integrals?

3) Potential Applications:

When I become an engineer after college, I will have to use tables and graphs in presentations. Most professionals use tables and graphs on a daily basis, whether they are in a report they are writing or a memo from the boss. The possibilities are endless.

4) Personal Experience:

In most classes I have taken since elementary school, I have dealt with charts and graphs. In math classes, I have plotted them; in English, I have done reports about them; in social studies classes, I have made presentations of them. Education today covers graphs and tables extensively in order to prepare young people for their careers and the rest of their lives.

5) Compare and Contrast:

As I previously stated, I have used tables and graphs in about every class that I have taken. In physics, we are graphing velocity, acceleration, and projection. In calculus, we are finding the limits and derivatives of graphs. In English, we are using tables in reports about case studies.

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1) Summary:

Engineers use Tables and graphs communicate information. Independent variables and dependent variables are use in table to explain the cause of inputting a number and result of the input. Tables operation is columns where the independent variables are on the left and the dependents variables are on the right. On top of the columns, there are heading that indicate what the variables are and what are the units. Tables are useful to input data in to the computer or calculator. A graph is a graphic representation of the table data that is easy to read and interpret. A graph has a title on the top and each axis is identified with label and units. Engineers typical use the rectilinear to regress data instead of semi log graph and log-log graph. It is best to graph data that are linear on a rectilinear graph, exponential on a semi log graph, and power on a log graph, because the data will appear to be a straight line on the graph which is easy to read and interpret. Interpolation is extending between data points, and extrapolation is extending beyond the data point. Interpolation is use to find the relationship between two points and extrapolation is to find the relationship with one data point and point not in the data point.

2) Potential Application:

Know how to graph like an engineer instead of a mathematician will help me become a better engineer. The kinds of graphs I graph in math are plotting the equations. In the engineering field, we plot graph according to the data table. This make a big different. Now that I know how to graph like an engineer, I think I will put it to use to help me get better with graph. Who know, I might get hire from a group of engineer because I can graph properly.

3) Clarity:

What other kind of graphs will does a mechanical engineer know? Do engineer use pencil or computer to do the graphing? What kind of software do engineers use to graph with? If so, what is it and do engineers have to use that kind of software? It is OK to use of software to graph.

Summary:

The position, velocity, and the acceleration of an object are all connected. In order to move from position to acieration you must take the second derivative. Likewise, moving the other direction in order to find the velocity from the acceleration one must use antidifferentiation. In one dimensional motion the position function x=x(initial)+v(initial)+(1/2)at^2 may be manipulated to fill any of the previously mentioned. In two and three dimensional motion the x and y axis act independently, and are therefore calculated separately.

Newton's first law states that an object will remain in its state of rest or of uniform motion in a straight line unless it is compelled to change that state by force impressed on it (v=constant). However, if an object is dropped under the influence of earth's gravity, the velocity is not constant.

Newton's second law states that for an object to have its motion changed there must be a net force acting on it. Also a proportionally larger force is needed to move a heavy objects than to move a light object, and force causes objects to accelerate in direct proportion to the magnitude of the force (F=ma).

Newton's third law is best described in Newton's own words: "To every action there is always opposed an equal reaction; or, the mutual actions of the two bodies upon each other are always equal, and directed in contrary parts." This means that forces always exist by the interaction between two or more bodies and it is impossible to have one independently acting force.

Newton's Law of Gravitation states that every particle of matter in the universe attracts every other particle with a force that is directly proportional to the masses of the particles and inversely promotional to the square of the distance between them.

Clarity:

Everything er concerns topics that I have already studied or am in the process of. There were a couple of things that made no sense. For example, the description of the relativistic transformations and the discoveries of various notes physicists.

Potential Application:

Although these are already topics of study, this book uses a different approach. I think this will be useful because it gives me a different perspective enabling me to further understand concepts. I especially like the section on three dimensional motion its separate components based on direction.

Personal Experience:

When I was little I wanted to be Albert Einstein. Despite going through 12 years of schooling his ideas remain as abstract as they did when I was little. Hopefully with my continued education in the field I will be able to comprehend more of what the genius had to offer.

Compare and Contrast:

Although the information in this book is the same at what I am learning in Calculus and in Physics it is somehow different in how it is directed more to the potential applications for engineers. This being said although the concepts remained the same I found new meaning in the concepts.

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1. Summary:

Chapter ten explains that Newton's laws and much of his other work forms the basis of physics and calculus, which are essential to engineering. This includes concepts such as vectors, velocity, acceleration, one- dimensional motion, gravity-influenced motion, multidimensional motion, relative motion, and the formulae which accompany each topic, thereby allowing engineers to solve problems involving these ideas.

A discussion of the theory of relativity explains that velocities and other motions can be calculated in reference to different boundaries in order to influence "true" motionless reference results. This concept is further expanded by discussing that the relative velocity of light can be calculated based on interference patterns that fiddle with light wave peaks. Relativistic transformation is based in time dilation and length contraction which simply alters the frames of reference involved in calculations.

The topic of force is outlined, explaining strong force, weak force, gravity, electrostatic force, magnetic force, static friction, kinetic friction, and drag. Newton's first law states that an object in motion will keep moving until acted upon by the forces of another object. His second law states that net force equals mass times acceleration. The book comments that direction) positive or negative must be established in calculations. Newton's third law is the classical statement that bodies act upon each other with equal forces.

Relativistic momentum states that as energy is applied, mass changes. It is based on the concept that rest mass and kinetic energy combine to form total energy and influence mass.

There are several problem types in this chapter, outlining how to use Newton's laws to solve the above mentioned topics and several others.

Planetary motion is also explained by a formula that relates changes in time to position and velocity.

3. Potential Applications

Apparently, the above topics are essential to my engineering career. Motion, force, and other Newtonian topics allow one to solve basic problems which are constantly encountered in engineering. In order to find solutions to these problems, the concepts which govern them must be understood, so one application of this to my life, is that I need to learn how to use these ideas. I have never had physics before so this is pretty new.

5. Compare and Contrast

Compared with what we are now learning in physics class and from the physics textbook, the information provided in this chapter is presented in a condensed, over-simplified manner. In some cases, I think it would have been better not to mention some concepts like relativity or planetary motion unless a disclaimer at the beginning of the book stated that one must be well- versed in those ideas before continuing to read. It was a good review of some ideas, but the reading neglected so many different ranges of applications that some of the information made no sense. This chapter is much more technical than others, and it makes me afraid that I am not well-prepared for this class.

Summary:

There are many different vocabulary words used when analyzing motion, each with its own precise definition. Velocity (the time rate of change of a position of a body) and speed (a scalar describing the magnitude of the velocity vector) are commonly used to mean the same thing, but they, in fact, are very different. The position is a place or location within a reference frame. A vector is a quantity with a magnitude and direction. Displacement is the change in

position. Distance is the nonnegative scalar describing the length of a path. Average velocity is the change in position per change in time. Instantaneous velocity is the limit of the average velocity as change in "t" approaches zero. Speed is tactually the magnitude of this instantaneous velocity. Average acceleration is the change in velocity with time. Instantaneous acceleration is the limit of average acceleration as change in "t" approaches zero.

The theory of relativity is Einstein's theory, which states that there is no preferred frame of reference and the speed of light in free space is constant regardless of frame. Einstein's theory explained the Michelson-Morley experiment. In this experiment, the use of the light wave properties were used to "clock" the time it took to travel each path. The relative velocity could be calculated by using interference patterns that result from the alignment or misalignment of the light's wave peaks. Their interferometer was sensitive enough to see the effects of velocities ten times lower than the orbital velocity of the earth around the sun. This process was done because light travels so quickly and could not be timed with a clock.

A force is an influence on a body that will cause it to accelerate in the absence of any other counteracting forces. There are four fundamental forces: strong force (acts only in short distances and holds atomic nuclei together), weak force (involved in radioactive decay), electromagnetic force (which is composed of both electrostatic force and magnetic force), and gravity force (attractive force between two objects that have mass). Other forces include friction (both static and kinetic), drag (frictional force exerted on a body as it moves through a fluid), and spring force (results when a spring is compressed or stretched). The coefficient of static friction is the ratio of frictional force and perpendicular force at the instant motion begins. The coefficient of kinetic friction is the ratio of frictional force and perpendicular force when there is motion.

Newton's first law is "every body persists in its state of rest or of uniform motion in a straight line unless it is compelled to change that state by forces impressed on it". This is the same as the law of inertia (an object in motion will maintain its velocity in absence of any applied forces). Newton's second law deals with the manner in which forces change velocity of an object. The time rate of change of momentum is proportional to the net force. Newton's third law is "for every action, there is an equal and opposite reaction". It is impossible to have a single, isolated force. Newton's laws also tell us that momentum (mass times velocity) is a constant in the universe.

1. Clarity:

Chapter ten is pretty basic in all of its content. The only part that confused me is the Michelson-Morey experiment. I do not completely understand it. I understand the conclusions, but unfortunately, I do not know enough about light properties to understand it fully. I feel that I need additional information on this subject or more of an explanation.

2. Potential Applications:

This chapter describes how this universe works. Therefore, one potential application to my life is my understanding of this universe. I need to know about these theories and experiments in order to understand these concepts. I also will use this information in further math and science courses through out my schooling here at Texas A&M. I will also probably use these concepts and equations later in life.

3. Personal Experience:

Personal experience with the laws of motion include many of the high school classes, in which I was taught some of these concepts. Last year I took both physics and calculus. I used many of these equations in solving the problems in these classes. I also did a project over Isaac Newton and his theories while I was in middle school. Therefore, I was already familiar with these concepts.

4. Compare and Contrast:

The information that I learned from this chapter is also what we are being taught in physics. Right now, in physics, we are learning about the laws of motion and force. I also have discussed some of this information in calculus. In calculus, we have been taught about vectors and their properties. Over the past few weeks, I have solved many types of problems that relate to the material covered in this section.

<u>Summary:</u>

The chapter defined different terms used with the idea of motion. Velocity is a vector, while speed is scalar. The mathematical formulas and limits were given for average velocity, instantaneous velocity, speed, average acceleration and instantaneous velocity (one-dimensional). Examples were given on finding components of vectors as well as calculating unknowns. Multidimensional motion was also covered, as were long examples.

The importance of reference frames was stressed. They can exist in one, two, or three dimensions.

Different types of forces were listed. Fundamental forces are found in nature. They are gravity force, electromagnetic force, strong force, and finally weak force. The strong force happens only at very short distances and holds atomic nuclei together, while the weak force is involved with radioactive decay. Electrostatic force and magnetic force make up the electromagnetic force. The electrostatic force is an attractive force when two objects are charged differently and is a repulsive force when the two objects have the same charge. Gravity is an attractive force between two objects that have a mass. Other types of forces engineers study are friction, drag, and spring forces. Static friction is present when one force is equal to the applied force, so there is no motion. Drag is a type of friction force, but it is when a body moves through a fluid, such as a gas or liquid. Spring force is from a compressed or stretched spring.

Newton's first lay is also known as the law of inertia. It states that if an object is at rest, it will stay at rest unless any forces act upon it. Newton's second law has to do with forces changing the velocity of an object. It says that a net force changes the momentum of an object. His third law states that "isolated forces cannot exist; the force on one body is equal and opposite the force on the second body". The book gave examples of force problems as well.

Newton's laws say that momentum is constant in the universe. Momentum is mass times velocity, it is a conserved quantity. More examples are given applying Newton's law to everyday life, just as dropped balls and projectiles.

The final thing discussed was planetary motion. The perihelion is the point where the earth is nearest the sun.

Clarity:

For the most part, the chapter was pretty clear. When it was explaining Newton's laws, the main points were a little hidden. You continued to read, but the law was not cleraly written. I had to look towards the back of the chapter under "summary" to clarify their point.

Chapter ten was a review from physics and from different application problems seen in Calculus. I just wish we had this all at the same time, it may drive the point home a little better. Instead we have it one week in physics, another in calculus, and now finally we have it in Engineering. I was surprised to see integration in this chapter, even though it's part of the information presented, it hasn't been mentioned in Math 151 as of yet.

Application:

The formulas and the concepts in chapter ten will help me in my future math courses, as well as in physics and in my engineering career. Newton's laws apply to everyday life and to problems I will have to fix as a future engineer. The formulas involving position and velocity will help in making brakes work faster and cars safer. My understanding of different forces and the differences between them will help me as well.

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1) Summary-

This chapter discusses Newton's Laws and their applications. For any engineer, or freshmen engineering student, mastery of Newton's Laws is the one of the most important factors that can affect how well they will perform the duties of an engineer. Chapter 10 is sectioned into definitions that Newton uses, the theory of relativity, forces, Newton's First Law, Newton's Second Law, Newton's Third Law, and then some examples of his laws at work.

The chapter describes in greater detail what we have already learned in physics. It does however give good examples of the applications of the laws. For instance it shows how position, velocity, and acceleration are related, velocity is the derivative of position and acceleration is the derivative of velocity, meaning that acceleration is the second derivative if position. The section on planetary motion shows how to calculate the motion of the earth around the sun from a certain point.

2) Clarity-

The chapter is very clear on the whole except for the section on care and feeding formulas in which it gives no clear explanation of what the subject matter is. Also I think that the majority of the chapter is redundant due to the fact that we have already seen the information in our physics classes in high school and college.

3) Personal experience-

While working at an engineering and testing company for the past three summers I rarely saw any engineers using the laws, I think maybe because I was always in the test lab instead of the air-conditioning with the engineers. I also believe that a lot of the calculations were done by CAD and FEA programs instead of the engineers themselves. As a technician we never had to think about the law applications of what we were doing. I think what I have taken from this chapter is that I will have to think about what the application would be when I am working next time.

1.) Summary

Estimating isn't an exact science, rather it is a feel for the correctness of the information at hand combined with the current assumptions. You can use analogies to help you get a feel for what you are actually looking at. Scaling up from one to many takes a known given amount and applies it to an unknown larger amount. How reasonable something is allows you to place limits on what you are given. Since estimating is not an exact science, extrapolating can be very useful.

In engineering numbers there are many types of notation and rules. The U.S. Standard Notation uses a dot to show the base magnitude and commas for powers of ten to the third in either direction. Everywhere else is the opposite, particularly Europe. The accepted convention is to have the U.S. system with spaces instead of commas. Many numbers will not work with any of these because of their extremity, therefore we often use scientific notation. Remember, when using scientific notation or not the leading zero is not dropped! The accuracy of measurements is how close they are together while the precision is how close they are to their true value. Random errors are those we have no way of preventing including reading things the exact same way and expecting the exact same result. Systematic errors indicate that there is something wrong with the measurement method. Uncertainty is from random errors and the lack of precision. Error is the difference between true and reported measurements. For either, divide it by the best value to obtain either fractional or percentage of what you wish to measure. Significant figures says that all values recorded except the last digit must be exact, and that the last may have slight error. Only round in a problem when you have reached your final answer. Multiplication or division causes you to use the least number of "sig figs" while addition and subtraction require the highest of the lowest digits.

2.) Potential Applications

The one thing that this chapter shows is how critical accuracy and precision of measurements and the communication of those numbers with others is. What if a 0.5 gram ingredient was written as .5 and was mistakenly put in to the mix as 5 grams? You would have problems there. Variance and known error are also significant to consider with the exactness some applications may require. Another way to explain engineering might be to say that we have a more measured look at the world around us. That is what allows our successes and helps to keep us from failure. One failure did occur on a space satellite not too long ago because the engineers at NASA were using a combination of SI and American units and didn't realize it until the satellite failed.

3.) Personal Experience

During my chemistry class in high school we were told everything about significant figures except what they were good for. It is nice to know that the malevolent "sig figs" are actually useful no matter how troublesome it is to continually use them. I still don't particularly like them, but I can see the necessity now after I've learned so much about them. High school should really give good examples as to why the are useful before teaching them to us, motivation is a powerful tool.

SUMMARY:

Engineers have their own designing method. It consists of synthesis, analysis, communication, and implementation. Through synthesis, the engineer simplifies many different factors into an integrated whole. Through analysis, he uses various skills to quantify the outcomes of several options. In communication, the engineer gives written and oral presentations. Implementation is the actual follow-through of the plan. Sometimes the engineering method must be repeated many times in order to get the desired results.

One of the first tasks for the engineer is to identify a problem. Next, he makes a design team to complement each others' skills. Third, the team identifies their limitations. These may include time, money, legal, or other type of restraints. The team also decides how to make their product succeed. The fourth step is to find a solution to the proposed problem. There are several techniques in going about this including the Nominal Group Technique and the Delphi Technique. Then, the team decides which solutions are good and begins to search for the absolute best solution. After the solution is decided upon, the engineers work to achieve that solution.

POTENTIAL APPLICATIONS:

The engineering design method seems to be a thorough and efficient way of problem solving in any instance. It provides plenty of careful planning and many "plan B's", which is extremely important in succeeding at a task. I can use the method in other classes and in regular life situations. It will be very helpful in my occupation though. It can even be helpful in interpersonal relationships.

PERSONAL EXPERIENCE:

It seems I have been using the engineering design method (or something very similar to it) for many years now. I'm always thinking up several ways to solve problems and knowing my limitations and what steps I have to take to get to the next step. I've used such systems in school and in interpersonal relationships as well as regular life situations. I am quick to identify a problem, and then once I'm absolutely certain about the problem, I think of ways to hit it from all directions and which steps would lead to a better series of steps, which in the end will lead to success. I always have backup plans too and even backup plans to backup plans. It's almost a game to me it seems.

Summary Chapter 5 & 14

Chapter 5 is a chapter that covers the introduction to design. It discusses what an engineer must take into consideration when design an object for a company. Some of these constraints and criteria that one must ponder on include: Budget, Time, Competition, etc. The engineer must first brainstorm and get his/her ideas on paper. They then, must go back and exclude the ideas which go against the main criteria (cost, materials, etc). This chapter provides many examples throughout, which helps the reader to fully understand the steps one must consider in order to create the best possible solution. We will of course not be able to comprehend everything in our studies here, so we must be able to grasp hold of increasing knowledge out in the real world.

Chapter 14 talks about the different kinds of unit systems. As an engineer, we must have a wide array of knowledge concerning the unit systems, since there are so many. First and foremost, we must learn how to do conversion factors. We must also learn the mathematical rules governing dimensions and units as it discusses in 14.3. In 14.4.1 absolute and gravitational system of units is mentioned. Absolute systems define mass (M), length (L), and time (T). Force (F) is determined from the equation of Newton's second law. Gravitational systems define force (F), length (L), and time (T), which will lead to finding the answer for mass (M). Coherent and noncoherent systems of units are introduced next in this chapter. Coherent systems are systems that have no additional conversion factors needed. Noncoherent systems are just the opposite. If we were to plug in the units from the AES into an equation such as F=ma, we would get the wrong units, therefore propelling us to the wrong answer. Chapter 14 continues to provide numerous examples explaining how to properly place and find certain units when solving a specific problem.

Clarity

Chapter 5 is overall fairly easy to understand. The certain criteria an engineer must consider when faced with a problem are basically self explaining. The different examples and pictures were both helpful and interesting to look at, such as the robotic arm and the designs and drag coefficient problems for the GM EV1. Chapter 14 became a little more in depth as I read through it. It must be carefully studied to fully get an idea of conversion units and how they work. Hopefully though, we won't be expected to be a professional in both of these chapters right away. Only by working out assigned homework and actually doing problems ourselves, will we be able to fully grasp the needed skill in this field.

Personal Experience

Chapter 5 appealed to me more than chapter 14 simply because it talked about designs and what GM must factor in when deciding which kind of model car would not only appeal to the public, but also appeal to natural forces such as drag. Working for GM and doing stuff like that would interest me alot. But I guess if I want to pursue that, I must be able to learn Chapter 14 too. Still I will not be able to retain these lessons, until I am able to try it, mess up, learn from my mistakes, by my own. Hopefully the lecture today in about 40 minutes will clear up whatever doubts and uncertainty I have concerning the necessary procedures an engineer must complete in order to succeed.

CHAPTER 2 JOURNAL ENTRY

SUMMARY: The engineering profession is comprised of highly educated employees with moral obligations to themselves, their employers and to society. Engineers are obligated to follow a set of behavioral standards which guides their actions and beliefs as practicing engineers. Many professionals have a set code of ethics for engineers to follow which encompass the rules and guidelines for etiquette in the workplace. Etiquette is how one acts around others. Engineers must be courteous to whomever they work with. Since engineering is a profession not based on the individual, daily interaction must be governed by etiquette. If etiquette is violated, the consequences are not severe, however, engineers must always try to respect those with whom he or she works with. The law also governs the actions of engineers. It is logical that an engineer must follow laws and understand the penalties associated with violating the legal rights and privileges of people and society. Morals, which are personally acquired from family, religion and other life experiences, also plays a huge part in recognizing the rights of human beings. Sometimes, it is hard to distinguish between conflicts of legal and moral standards. To settle the conflicts, engineers must be conscious of how to arrive at a legitimate resolution. Moral conflicts are the hardest to resolve, for they encompass differences in opinion.
Conceptual issues are problems that arise when morality is agreed upon, but the course of action is unclear. Application issues arise when it is questionable whether or not an act violates the law. However, the most distinct and easily-resolved conflicts involve factual issues. Factual conflicts are easily solved with further investigation and

matter-of-fact evidence. Both in the professional world of engineering and in society itself, we have moral theories which provide a framework for making moral and ethical decisions. Ethical egoism is defined as a decision-making process, which tends to favor self-interest. Though it is seldom used for selfish means, ethical egoism is closely tied to individual circumstances. Moral decisions, which involve trying to benefit greatest number of people is referred to as utilitarianism. To make a utilitarian decision, some engineers use the happiness objective function, which compares the harms, benefits and importance of each possible decision to maximize the satisfaction for the greatest number of people. When using the utilitarian method, it must be understood that not everyone will benefit, and that there must be some sacrifices for the benefit of the whole. Another type of moral theories involves human rights. In any decision, it must be understood that there are people in society are guaranteed certain rights, which are guaranteed protection at all cost. Utilitarianism and rights analysis lie at two opposite extremes. Utilitarianism does the most for society with little regard for the individual, while rights analysis protects the individual regardless of the impact on society. When these two moral theories diverge, it is reasonable to use the utilitarian approach unless an individual's rights are seriously violated. Engineers are expected to obey their own code of ethics in the workplace. A few rules that he/she must follow are 1) protect public safety, 2) be respectful, and 3) do not accept bribes. Often engineers find themselves in a situation where their fellow employees are breaking the rules. The engineer is in a moral dilemma to 'blow the whistle' on his teammates and risk losing his job, or try to confront the situation himself and attempt to correct what they are doing wrong. Resource allocation is also an important aspect of engineering. Though we will never live in a risk-free society, it is a constant battle for engineers to lessen the risks that the average person faces in everyday life. By keeping in mind risks and safety when designing new products and processes, engineers can better protect society, which is one of their top priorities.

CLARITY: I thought this chapter was a little hard to understand compared to the others. I understand it is difficult to teach someone ethics in twenty pages, but I think with better organization this chapter could be more effective. The introduction to etiquette in engineering was pretty straightforward, and it is just common courtesy to act appropriate on the job. I think that goes for any profession, not just engineering. Even average citizens must be conscious of the legal, moral and ethical standards of society. I don't understand why the 'Settling Conflicts' section was in the chapter. I don't think that engineers actually sit down and analyze why a cop's radar gun might be 5 mph fast. I just don't see the application of this material to professional engineering. I do understand the ethical egotism and utilitarian sections, because those involve personal decisions engineers have to make themselves. The examples in this chapter were very helpful, although the section over resource allocation was nothing but an example, and it offered no concrete explanation. I though the case studies were very interesting and added a lot to the chapter, but as a whole, I do not think that the chapter was as effective as it could have been.

PERSONAL EXPERIENCE: I don't know if it is just me, but this chapter really opened my eyes to the real world of engineering. I mean, I didn't expect there to be conflicts over bribery. Moral and ethical issues would never be a problem for me, I guess because I was raised with a good background in personal principles. It troubles me that there could exist corruption within the field I want to work in. I don't know how I would handle my teammates overlooking something just to pocket some extra money for themselves. This chapter was a reality check, in that the so-called 'world of engineering' is not some utopian society where everyone gets along and has a good time. Sure there will be times like that, but I am not at all looking forward to dealing with those who do not possess the moral and ethical beliefs that I have. As far as etiquette goes, I am aware that it is necessary in any profession. But I have learned from interacting with my classmates that some of them DO lack the necessary logical thinking and people skills that are so very necessary in the engineering field. Everyday I am thankful that I can communicate effectively and that I possess the 'other' skills that are so valuable to employers. But I do know that a simple chapter will not be able to teach someone ethics. It comes from within.

Summary:

Engineers must be very familiar with units and must be able to convert units with ease because mistakes in unit conversions are the most frequent cause of errors in engineering calculations. Whenever we make a measurement, it is always made with respect to a standard. Reported measurements must always have two parts, a number and the units. Without the units, the number has no significance.

When switching between unit systems, it is necessary to use a conversion factor, which although they are not numerically equal to one, they equal one when the units are considered. When converting numbers, you must pay extra attention if the dimension is raised to a power because many mistakes occur in these types of conversions aswell.

To add and subtract terms in calculations they must have the same dimensions. However, when multiplying and dividing the dimensions are treated as variables that cancel accordingly. In scientific equations, the arguments of transcendental functions must be dimensionless, but in empirical equations, the arguments of transcendental equations may have dimensions, but the equation is only valid if you use the units employed to develop the equation. Also, for any equation to be valid, it must be dimensionally homogenious, meaning that the dimensions on the left-side must equal the dimensions on the right.

The unit systems can be divided into two major categories, coherent and noncoherent. If a system is coherent, no additional conversion factor is required if the units within that system are used exclusively. Noncoherent unit systems, like the American Engineering System , require conversion factors that are other than one. Absolute and Gravitational systems are subdivisions of coherent systems. In absolute systems mass, length, and time are defined and force is derived. In gravitational systems force, length, and time are defined while mass is derived. In both cases force and mass are derived from Newton's second law, $F=ma$.

A datum is a reference point used when making a measurement. We may select any datum that we wish so long as the datum does not change in the middle of the calculation.

One form of measurement that we are not yet very familiar with is pressure. Pressure is a force on an area. Gas pressure results from the impact of gas molecules on its container wall. Hydrostatic pressure results from the weight of liquid or gas. There are three types of pressure that are generally reported: absolute, gage, and differential. For absolute, the reference pressure is a perfect vacuum while in gage pressure the reference point is the atmospheric pressure. The difference between two pressures is called differential pressure. Gage pressure + atmospheric pressure = absolute pressure.

A another form of measurement is temperature. A temperature scale is formed by placing two reference points on a mercury in glass theromometerand evenly subdividing them into temperature intervals.

Dimensional analysis is widely used in engineering to solve problems about which there is little fundamental information. Simply by looking at dimensions, we can tell much about how quantities are related.

Clarity:

I thought that the begin of the chapter was very clear, but become progressively harder to understand as the chapter went on. It was unclear to me why they switched from talking about dimensional analysis to specific measurements like temperature and pressure and then back to dimensional analysis. Their thoughts seemed unclear and unorganized. Also, I did not understand how mass could be a derived quantity.

Potential Applications:

As an any other problem solving techniques that this book has taught us, this topic will be easy to apply to math, science, and engineering. Especially right now in physics, we are required to do many unit conversions to get the correct and compatible units in our answers.

Personal Experience:

My personal experience with converting between units really began in tenth grade in Chemistry. It was in this class that I was first introduced to factor label, the method we were taught to convert between units.

Compare and Contrast:

Each chapter that we learn makes this engineering class seem to tie in better with my other classes such as calculus and physics. This chapter especially relates very much to physics as we are constantly required to change and convert units.

APPENDIX E

Research Data from fall 2002:

	DA-Pre	DA-Post	SA-Pre	SA-Post		LASSI	JOUR
1	39	45	20	32			3
2	38	42	21	19			1
3	38	41	28	15		1	3
4	43	41	31	29			
5	31	38	34	19			3
6	45	37	30	24			
7	42	37	18	26		1	
8	40	36	18	18		1	3
9	26	36	33	21			1
10	33	36	19	23		1	
11	32	35	35	23			
12	37	34	21	19		1	3
13	22	34	17	17		1	3
14	31	33	30	17			
15	34	33	28	29			
16	31	32	30	23			
17	34	32	23	19			
18	32	31	22	28			1
19	35	31	24	19			
20	32	31	21	22			2
21	33	30	25	36			
22		30		26			
23	37	30	15	32		1	
24	41	29	27	24			1
25	30	29	30	36			
26	24	28	22	15			
27	22	28	31	29			3
28	23	28	22	28			3
29	30	28	25	20			
30	33	28	27	17			
31	32	27	19	26			
32	26	27	31	31			
33	29	27	24	30			
34	35	27	19	23			
35	24	27	18	22			
36	31	26	21	21			
37	37	26	22	28			
38	32	26	22	25			
39	29	25	26	21			3
40	20	25	34	21			
41	38	25	17	23			

	DA-Pre	DA-Post	SA-Pre	SA-Post		LASSI	JOUR
42	23	25	18	27			
43	20	25	35	37			
44	38	24	28	28			1
45	26	23	29	19			
46	29	22	35	30			
47	27	22	25	28			3
48	41	22	24	23			1
49	34	21	20	19			
50	29	20	26	27			
51	26	20	23	19			2
52	22	19	25	25			
53	18	37	45	24			
54	38	35	27	31			
55	34	35	16	22			
56	31	35	27	23			
57	33	34	26	21			
58	35	34	28	29			
59	40	34	17	28			
60	37	33	39	38			
61	40	33	20	29			
62	32	33	26	24			
63	31	32	28	26			
64	34	32	29	22			
65		32		19			
66	35	31	28	26			
67	29	31	42	34			
68	30	31	31	28			
69	37	31	28	23			
70	34	31	25	20			
71	34	30	16	30			
72		30		28			
73		30		30			
74	32	30	23	22			
75	34	30	17	20			
76		29		25			
77	34	28	28	32			
78	34	28	29	23			
79	36	28	21	24			
80	40	28	25	25			
81	33	28	22	28			
82	35	27	28	27			
83	29	27	38	26			
84	24	27	43	26			
85	23	27	41	28			
86	30	27	31	37			
87	35	27	17	29			

	DA-Pre	DA-Post	SA-Pre	SA-Post		LASSI	JOUR
88	38	27	28	22			
89	34	26	16	21			
90		26		27			
91	30	26	22	21			
92	34	26	18	28			
93	28	26	35	28			
94	29	26	14	15			
95	33	26	25	36			
96	24	25	29	30			
97	26	25	37	28			
98	27	25	35	32			
99	35	25	29	30			
100	34	25	21	21			
101	28	25	27	22			
102	30	25	41	35			
103		24		21			
104	27	24	21	29			
105	24	24	13	19			
106	39	24	17	18			
107	28	24	34	29			
108	32	23	24	29			
109	28	23	21	20			
110	33	23	21	26			
111	28	22	38	35			
112		22		23			
113	30	22	35	20			
114	35	22	17	27			
115		22		30			
116	26	22	16	31			
117	19	22	23	17			
118	36	21	24	21			
119	29	21	31	35			
120	22	21	32	34			
121	27	20	34	25			
122	32	20	29	33			
123	23	20	32	21			
124	31	20	25	31			
125	31	19	30	34			
126	33	19	27	36			
127	29	19	17	22			
128	22	19	23	18			
129	30	19	28	32			
130	36	19	18	24			
131		19		36			
132	34	19	30	36			
133	28	18	31	24			

	DA-Pre	DA-Post	SA-Pre	SA-Post		LASSI	JOUR
134	24	17	30	24			
135	30	17	25	28			
136	29	15	37	35			
137	24	15	26	33			
138	24	15	24	25			
139	35	15	21	25			
140	20	11	42	42			
141	13	10	28	34			
142	37	38	24	16			
143	37	38	22	33			
144		37		22			
145		35		26			
146	29	34	21	25			2
147		33		26			3
148		30		29			
149		30		26			
150	34	30	26	20			3
151		28		31			
152		27		18			
153		26		29			
154		26		26			
155	22	25	30	31			
156		25		26			
157	29	25	32	29			2
158	34	24	23	26			3
159		24		25			3
160	34	24	20	18			3
161	33	23	30	30			
162	26	23	22	28			
163	32	23	32	31			3
164	34	23	26	20			
165	35	22	32	32			2
166	25	22	25	32			
167		22		32			
168	32	22	19	20			2
169	30	21	26	27			
170		21		24			
171	30	21	24	28			3
172	43	21	20	24			3
173		20		25			
174	21	20	32	34			
175	28	20	32	28			
176	25	20	28	29			
177	26	20	36	42			
178		19		29			
179	25	19	22	21			

	DA-Pre	DA-Post	SA-Pre	SA-Post		LASSI	JOUR
180		19		19			
181		17		30			
182		17		27			
183		14		26			
184		20		21			
185		23		26			
186	27	50	25	22		1	
187	34	44	19	19		1	
188	33	37	26	12		1	
189	31	33	25	22		1	
190		31		26			
191	34	29	38	29			
192	30	25	23	20			
193	28	22	24	32			
194		20		25			
195		19		21			

DA-Pre = Deep Approach at the beginning of the semester fall 2002.
DA-Post = Deep Approach at the end of the semester fall 2002.
SA-Pre = Surface Approach at the beginning of the semester fall 2002.
SA-Post = Surface Approach at the end of the semester fall 2002.

LASSI = The student participated in the LASSI assessment.

JOUR = The student participated in journaling during the semester. Journaling numbers vary according to the number of journals submitted.

Research Data from spring semester 2003:

	Pre-DAP	Post-DAP	Pre-SAP	Post-SAP
1	38	27	29	33
2	24	26	17	27
3	34		32	
4	26	25	31	32
5	30	33	24	31
6	27	31	37	36
7	25		29	
8	36	38	20	22
9	29	28	32	27
10	24	21	22	28
11	27	22	30	37
12	34	30	23	30
13	33		33	
14	28	34	24	26
15	25	17	26	43
16	18	21	28	34
17	23	29	15	18
18	41		21	
19	28		21	
20	31	29	34	29
21	34	33	24	18
22	27	28	27	29
23	22	29	28	28
24	18		31	
25	18	19	22	20
26	25	32	22	33
27	27	29	26	25
28	30	32	30	30
29	27	20	38	32
30	22	29	31	31
31	28	23	30	30
32	26	20	34	31
33	25	33	43	20
34	21	18	21	29
35	27	24	27	34
36	29	22	19	20
37	28	25	37	37
38	26	26	25	27
39	34	30	23	23
40	29	27	29	23
41	29		24	
42	29		29	
43	25	26	25	21
44	27	23	29	31

	Pre-DAP	Post-DAP	Pre-SAP	Post-SAP
45	23	23	26	25
46	29	25	25	18
47	34	27	24	41
48	33	33	33	33
49	20	24	30	32
50	26	21	24	32
51	24		21	
52	20		30	
53	28	20	41	42
54	25	20	26	36
55	26	33	31	30
56	31		24	
57	21	23	17	32
58	35		20	
59	23	19	24	26
60	28	31	28	24
61	24		37	
62	28	27	31	33
63	32	20	13	17
64	28		35	
65	31	19	15	23
66	28	20	30	36
67	31	33	27	30
68	22	27	15	20
69	23		26	
70	28	30	18	20
71	38	23	16	12
72	36	32	24	29
73	29		23	
74	22	24	22	28
75	26	25	34	39
76	34	31	24	28
77	30	33	34	30
78	33	37	22	27
79	36	46	22	20
80	39	32	20	19
81	31	28	26	34
82	21	21	33	36
83	22	25	34	31
84	24	21	32	22
85	33	35	18	19
86	22	20	36	31
87	28	29	30	32
88	15	14	20	30
89	22	18	31	36

	Pre-DAP	Post-DAP	Pre-SAP	Post-SAP
90	26	29	25	27
91	30	13	31	40
92	24		32	
93	22		17	
94	27	29	33	29
95	28	24	27	43
96	25	21	23	17
97	39	38	21	20
98	14	12	35	38
99	30	32	31	29
100	24	19	33	32
101	30	27	26	35
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103	29	21	28	38
104	34	30	17	21
105	30	17	27	37
106	33	20	37	32
107	26	31	22	29
108	28	20	33	36
109	35		28	
110	32	21	22	24
111	30	31	15	13
112	22		40	
113	35	32	20	20
114	38	32	20	21
115	15	12	30	39
116	28	30	18	16
117	30	16	36	17
118	34	26	32	36
119	33		21	
120	30	28	26	31
121	23	26	27	38
122	31		31	
123	27		28	
124	18	18	20	23
125	28	34	25	29
126	28	16	19	25
127	27	23	29	31
128	41	39	23	27
129	21	21	29	35
130	14	14	31	40
131	38	38	26	24
132	31	27	24	27
133	35	28	18	30
134	22		29	

	Pre-DAP	Post-DAP	Pre-SAP	Post-SAP
135	31		23	
136	31		23	
137	22	30	22	28
138	24	23	33	31
139	25	21	30	23
140	24	27	31	31
141	32	27	29	23
142	26	25	20	31
143	42	41	20	30
144	33	28	29	32
145	30	32	35	30
146	41	37	31	27
147	34	26	21	30
148	24		32	
149	17	20	28	24
150	33	19	32	35
151	36	43	20	28
152	37		18	
153	23	22	28	26
154	27	23	26	32
155	31	22	20	23
156	26	34	23	24
157	29	33	22	27
158	35	28	16	20
159	33	29	11	17
160	27	27	26	25
161	35	36	15	19
162	28	30	26	30
163	35	30	32	33
164	17	27	18	31
165	34	30	20	25
166	40	37	18	22
167	24	29	29	31
168	26	26	25	23
169	26	24	25	24
170	21	20	24	24
171	36	28	32	30
172	34	30	20	30
173	31	30	21	30
174	31	26	21	19
175	34		15	
176	27	23	30	22
177	30	28	23	35
178	30		26	
179	21	14	30	35

	Pre-DAP	Post-DAP	Pre-SAP	Post-SAP
180	24		29	
181	26		29	
182	29	26	34	35
183	31	34	19	19
184	15	37	21	28
185	30	28	17	23
186	23	29	22	24
187	20		25	
188	33	33	18	20
189	27	29	23	32
190	36	40	23	22
191	31	31	31	32
192	18	13	20	44
193	32		28	
194	24	20	31	32
195	36	28	20	22
196	45	31	24	29
197	40	34	19	21
198	13	20	42	39
199	14	15	27	25
200	22	25	34	32
201	21	18	28	28
202	27	21	26	36
203	28	28	30	31
204	42	45	16	14
205	26	27	23	24
206	27	24	23	21
207	26	30	26	25
208	24	19	22	29
209	32	33	25	26
210	13	13	32	37
211	30	26	20	27
212	26	36	26	30
213	39	37	21	27
214	28	29	26	30
215	31	24	26	26
216	20	15	28	35
217	23	28	25	27
218	26	20	26	38
219	21		19	
210	25	18	31	26
211	38		22	

See descriptors on following page.

Pre-DAP = Deep Approach at the beginning of the semester spring 2003.
Post-DAP = Deep Approach at the end of the semester spring 2003.
Pre-SAP = Surface Approach at the beginning of the semester spring 2003.
Post-SAP = Surface Approach at the end of the semester spring 2003.

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HONORS AND AWARDS

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Graduate Research Assistant-non teaching, September 2002-August 2003
Graduate Research Assistant-non teaching, January 2002-August 2002
Graduate Research Assistant-Teaching, ENGR400 September 2000-December 2001

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Implementation Leader, Workforce Planning (1995-1999)
Operations Manager, Polyolefin's Research and Development (1994-1995)
Human Resource Manager, Research and Development (1991-1994)
Training, Diversity, Compensation and Recruiting Manager, Engineering and Construction Division (1989-1991)
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RESEARCH INTERESTS

The use of learning theory which focuses on the necessity of prior knowledge, learning strategy awareness and use, and teaching to a higher level of thinking for optimum learning utilizing metacognitive techniques.

CONFERENCE PUBLICATIONS

Fowler, D.A., Maxwell, D.A., and Froyd, J. E., (2003) Learning Strategy Growth Not What Expected After Two Years through Engineering Curriculum, ASEE Conference Proceedings, Nashville, TN.

Maxwell, D.A., Morgan, J. and Fowler, D.A. (2003) Developing A Multi-Author Web Site to Support Large ACL Engineering Classes, ASEE Conference Proceedings, Nashville, TN.

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Froyd, J.E. and Fowler, D.A. (2003). How do People Learn to Learn? Share the Future Conference, Tempe, AZ.