

2009

A comparison of the effectiveness of two alternative instructional strategies for teaching basic construction surveying concepts

Gabriel N. Trahan Jr.

Louisiana State University and Agricultural and Mechanical College, gtraha1@lsu.edu

Follow this and additional works at: https://digitalcommons.lsu.edu/gradschool_dissertations



Part of the [Human Resources Management Commons](#)

Recommended Citation

Trahan Jr., Gabriel N., "A comparison of the effectiveness of two alternative instructional strategies for teaching basic construction surveying concepts" (2009). *LSU Doctoral Dissertations*. 602.

https://digitalcommons.lsu.edu/gradschool_dissertations/602

This Dissertation is brought to you for free and open access by the Graduate School at LSU Digital Commons. It has been accepted for inclusion in LSU Doctoral Dissertations by an authorized graduate school editor of LSU Digital Commons. For more information, please contact gradetd@lsu.edu.

A COMPARISON OF THE EFFECTIVENESS OF TWO
ALTERNATIVE INSTRUCTIONAL STRATEGIES
FOR TEACHING BASIC CONSTRUCTION SURVEYING CONCEPTS

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The School of Human Resource Education and Workforce Development

by
Gabriel N. Trahan Jr.
B.A., University of New Orleans, 1977
M.B.A., University of New Orleans, 1987
December 2009

ACKNOWLEDGEMENTS

I would like to extend a special word of thanks to the members of my committee. Dr. Machtmes, I appreciate all the assistance you have given throughout this endeavor and your willingness to listen to the many questions I posed during class. Thank you for your timely words of encouragement during this educational venture. Dr. Harvey, Thank you for your insightful comments and willingness to be on this committee with your busy schedule. Dr. Verma, Thank you for the insightful comments and the willingness to explore this area of instruction. Dr. Lou, Thank you for your willingness to explore this area of instruction and your thoughtful probing questions which have added needed perspectives to this research.

Dr. Burnett, Words cannot express my appreciation for your contribution to my educational endeavor. As a mentor, I know no one who could have challenged me more to search deeper for explanations as to the results determined in this project. I would also like to say Thank You as a friend for your willingness to carve out the time to assist in challenging some of the ways I view things and bringing those thoughts together for the successful conclusion to this first step!

TABLE OF CONTENTS

ACKNOWLEDGEMENTS	ii
LIST OF TABLES	vi
ABSTRACT	viii
CHAPTER	
1 Introduction	1
Rationale	1
Purpose Statement	6
Objectives of the Study	6
Significance of the Study	8
2 Review of Literature	10
General Education	10
Introduction	10
Pedagogical Philosophy	12
Pedagogical Development	15
Engineering Education	19
Engineering Pedagogy	19
New Engineering Education Paradigm	21
Leadership Training	24
New Curricula	29
Development of Authentic Experiences	31
Teachers as Leaders	33
Surveying Education	34
Construction Management Education	45
Future Learning Challenges and Opportunities	54
3 Methodology	65
Introduction	65
Population and Sample	65
IRB Procedures	65
Research Objectives	66
Data Collection	68
Measuring Instruments	68
Experiment	70
Week One	70
Week Two	71
Week Three	71
Week Four	72
Week Five	72
Research Design	73
4 Results	75

Objective One	75
Age	75
Academic Classification	76
Overall College GPA	76
GPA in Construction Management Courses	77
Grade Achieved in Prerequisite Construction Management Course	78
Grade Achieved in Required College Level Calculus Course	78
Objective Two	79
Pretest	79
Posttest	80
Objective Three	81
Pretest	81
Posttest	83
Objective Four	84
Objective Five	85
Pretest	86
Posttest	87
Objective Six	89
Pretest	89
Posttest	90
Objective Seven	91
Objective Eight	92
Posttest Total	94
Posttest Distance	96
Posttest Elevation	98
Posttest Office	100
Posttest Angles	102
Posttest Field	102
5 Summary and Conclusions	103
Purpose	103
Objectives of the Study	103
Procedures	105
Findings	106
Objective One	106
Objective Two	107
Objective Three	107
Objective Four	108
Objective Five	109
Objective Six	110
Objective Seven	111
Objective Eight	111
Conclusions	112
Instructional Content	112
Instructional Context	116
Instructional Research	119

REFERENCES	125
APPENDIX	
A CONSENT FORM.....	132
B PERCEPTUAL ABILITY SURVEY.....	134
C ACHIEVEMENT TEST	135
D PLAN FOR ADMINISTRATION OF EXPERIMENT	142
E FIELD EXERCISES	145
VITA.....	150

LIST OF TABLES

1. Comparison Table of ABET’s Outcome Based Criterion and Potential Lessons of Experience.....	25
2. Age of Students Enrolled in a Junior Level Construction Surveying Course at a Research Extensive University	75
3. Academic Classification of Students Enrolled in a Junior Level Construction Surveying Course at a Research Extensive University.....	76
4. Overall College GPA of Students Enrolled in a Junior Level Construction Surveying Course at a Research Extensive University.....	77
5. Overall College GPA of Students Enrolled in a Junior Level Construction Surveying Course at a Research Extensive University.....	77
6. Grade Achieved in Prerequisite Course by Students Enrolled in a Junior Level Construction Surveying Course at a Research Extensive University.....	78
7. Grade Achieved in Required Calculus Course by Students Enrolled in a Junior Level Construction Surveying Course at a Research Extensive University.....	78
8. Pretest Achievement Overall and on the Five Defined Foundational Surveying Concepts of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University.....	80
9. Posttest Achievement Overall and on the Five Defined Foundational Surveying Concepts of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University.....	81
10. Comparison of Pretest Overall Achievement Overall Score and Sub – Scores on the Five Defined Foundational Surveying Concepts by Method of Instruction Used in Teaching a Junior Level Course in Construction Surveying at a Research Extensive University.....	82
11. Comparison of Posttest Overall Achievement Overall Score and Sub – Scores on the Five Defined Foundational Surveying Concepts by Method of Instruction Used in Teaching a Junior Level Course in Construction Surveying at a Research Extensive University.....	83
12. Comparison of Pretest and Posttest Achievement Overall Score and Sub – Scores on the Five Defined Foundational Surveying Concepts of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University.....	85
13. Comparison of Pretest Overall Achievement and Sub – Scores on the Five Defined Foundational Surveying Concepts by Time of Day Used in Teaching a Junior Level Course in Construction Surveying at a Research Extensive University.....	86

14. Comparison of Posttest Overall Achievement and Sub – Scores on the Five Defined Foundational Surveying Concepts by Time of Day Used in Teaching a Junior Level Course in Construction Surveying at a Research Extensive University.....	88
15. Comparison of Pretest Overall Achievement and Sub – Scores on the Five Defined Foundational Surveying Concepts by Class Size Used in Teaching a Junior Level Course in Construction Surveying at a Research Extensive University.....	90
16. Comparison of Posttest Overall Achievement and Sub – Scores on the Five Defined Foundational Surveying Concepts by Class Size Used in Teaching a Junior Level Course in Construction Surveying at a Research Extensive University.....	91
17. Relationship between Pretest Self Perceived Ability in Surveying and Pretest Achievement Overall and on the Five Defined Foundational Surveying Concepts of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University.....	92
18. Relationship between Selected Predictor Measures and Post – Instructional Overall Achievement of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University.....	94
19. Multiple Regression Analysis of Post – Instructional Achievement Overall Score and Selected Predictor Variables of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University.....	95
20. Relationship between Selected Predictor Measures and Post – Instructional Achievement Sub-score on Foundational Concept “Distance” of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University.....	96
21. Multiple Regression Analysis of Post – Instructional Achievement Sub-score on the Foundational Concept “Distance” and Selected Predictor Variables of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University.....	97
22. Relationship between Selected Predictor Measures and Post – Instructional Achievement Sub-score on the Foundational Concept “Elevation” of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University.....	98
23. Multiple Regression Analysis of Post – Instructional Achievement Sub-score on the Foundational Concept “Elevation” and Selected Predictor Variables of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University.....	99
24. Relationship between Selected Predictor Measures and Post – Instructional Achievement Sub-score on the Foundational Concept “Office” of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University.....	100
25. Multiple Regression Analysis of Post – Instructional Achievement Sub-score on the Foundational Concept “Office” and Selected Predictor Variables of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University.....	101

ABSTRACT

The purpose of this experiment was to compare the effectiveness of two alternative instructional strategies for teaching basic construction surveying concepts. The basic concepts of construction surveying, office, field, angles, distance and elevation must be thoroughly understood before complex construction surveying applications can be performed. Instruction in applied science courses such as construction surveying is constantly being impacted by advances in technology. Technological developments require an evolving pedagogy incorporating change while maintaining the integral basics. The dynamics of change require an instructor to maintain basic construction surveying concepts consideration while developing authentic experiences which can be incorporated into the new technologies.

This experiment was performed using two different instructional formats, integrated and separated, for instructing study participants in basic construction surveying. The integrated format presented the related collaborative instructional components, theoretical and practical, during the same class while the separated format presented the related instruction, theoretical and practical, in a traditional manner with separated lecture and lab. Pre and post achievement tests were given to all four intact classes used in this experiment for measuring the study participant's pre-instruction and post-instruction knowledge.

The experimental results indicated that the designed curriculum was effective in teaching the basic construction surveying concepts. The two alternative instructional treatments, integrated and separated were both found to be statistically similar. Additionally, class time and class size were determined to have no measurable effect on achievement. This research provides applied science instructors the flexibility to design courses which can be used for a variety of different situations. Based on the results of this experiment, traditionally large classes can utilize the separated lecture-lab format with the expectation that student achievement will be the same

for the small classes which can be instructed using the integrated format. These findings can also be used as the basis for a distance education class which can present the lecture portion in a self directed web-based format while keeping the lab portion in a context which utilizes the typical instructor student lab.

CHAPTER 1

INTRODUCTION

Rationale

The construction industry in the United States is a very important basic component of economic development. Construction makes up approximately five percent of the gross national product totaling over 1 trillion dollars each year based on United States Census Bureau data (Bureau of Economic Analysis, 2008). This industry brings together many areas of resources ranging from materials required in the building process to large quantities of human resources for the assembling of the designed project. Most construction venues require many special ancillary services for maintenance of projects on schedule along with placing components in the proper position for both structural and aesthetic reasons. Placement of the building components, such as structural steel, in the correct position is performed by a surveyor trained in the usage of special equipment needed for this operation.

Construction is a multi-faceted process involving many different disciplines for completion of most projects. The normal cycle involves a general contractor who, upon successfully acquiring a project, must bring together all the needed resources to complete the contract. The sub-contractors and specialty trades utilized on most projects start with site preparation and complete with a punch list of noted deficiencies needing attention. Surveying is one trade required in all phases of construction which necessitates special measurements. Professional surveyors must locate property corners for correct positioning of a project. Construction surveyors “field engineers” take this location and set points in the ground used by initial site contractors for foundation material, followed by form contractors who actually build the slab placing the foundation at a correct elevation. Once the slab is formed steel and concrete contractors construct the support structure for interior finishes. These contractors all use

information provided by the construction surveyor to place construction components in the correct place. Various other contractors also are dependent on the surveyors to give them the correct positional information. This positional information, allowing the correct formation of the two dimensional drawing to a three dimensional structure, can be thought of as “dimensional control”. Definition of the word “surveying” as found in the Webster dictionary is to look over and measure (Merriam-Webster, 2009). Construction surveying, one of the nine major sub areas of surveying, requires a construction surveyor to perform both tasks of looking over a work site along with measuring the relative positions required for the correct placement of construction components. This correct positioning can be thought of as dimensionally controlling points such as the intersection of two walls.

Construction surveying is one of the specialized areas in the multi-dimensional realm of surveying and depends on the surveying profession to provide training and trainers for generation of field engineers. Nationally, there is a shortage of both surveyors and instructors (Schultz, 2007). This shortage resulting from major changes in the licensing process along with society’s limited view of the surveying profession has hampered recruitment of new surveyors. This shortage of surveyors coupled with a continuing change in equipment creates a dilemma for the surveying profession. The shortage of instructors and the rapid change in equipment also presents a pedagogical problem for the survey industry (Schultz, 2007). Traditional methods of education must be improvised in ways to maintain the required theoretical information while addressing the rapid change in the practical component. The evolution of this new paradigm must be approached with the goal of maintaining a synchronized system for incorporating meaningful change into the pedagogical process. This change will be achieved by industry and academia working together on the formation of this paradigm. Effective methods of education in the area of engineering and construction have targeted a constructivist or experiential mode of

instruction (Beliveau & Peter, 2002). The proactive nature of the curricula currently found in the realm of engineering/engineering technology is one which should be used by construction educators for new ideas. Organizations such as the National Science Foundation (NSF) has sponsored studies seeking new pedagogical ideas needed to keep the United States abreast of technology. Developed ideas in such articles as “How to Learn” and “Moving Forward” are two important texts which promote the enhanced skill set required of present and future graduates (Bransford, Brown, & Cocking, 1999; National Science Board, 2007). Training in many applied science disciplines has been accomplished through formal education and on the job training. Classes in many applied science areas like engineering which require a lab component supply the practical component while lectures have provided the theoretical part. The vast advances in technology have made it increasingly hard to maintain a balanced composition of the collaborative components, required concepts and practical experience. Job training must provide authentic activities with essential information for trainees to glean from their individual experience. Knowledge gained from well planned experiences incorporating theory and practice provide the ingredients for a more in-depth analysis (Beliveau & Peter, 2002).

Academia and higher learning institutions are predominantly theory-based given the large amount of time spent on research and minimal time on practical applications. Traditional instruction promoted by surveying academics has utilized the strengths of the institution using tenured instructors and older conventional equipment which worked given the minimal change in methods and equipment from 1950 to 1990. Vast changes in instrumentation resulting from advances in computers have introduced new equipment with different operating procedures (Aramala, 2000). Many of these procedures were not easily correlated with entrenched theory resulting in a revamped or new paradigm. Many lab classes need revamping due to the vast changes impacting most disciplines. Instructors in engineering and surveying have found the

need to increase student involvement by making the lab classes more engaging while challenging the students with querying activities. These activities should cause a reflection on results for further synthesis of ideas from individual lab experiences (Felus, 2007; Naberezny & Ghilani, 2005).

Effective educational methods must be able to provide the required balance of both theory and practice for the student. This balance, in the last ten years, has started a shift to a more experiential mode of learning (Burtch, 2005). Today, it is not only important to impart relevant information for answering a question, but leading edge pedagogies must also train students to ask the most relevant questions (Beliveau & Peter, 2002). This proactive method is viewed as a constructivist model which works well in most surveying examples due to an inherent critical practical component involving equipment. This practical component when presented with the correct theory offers the student the ability to learn in a proactive environment given the correct field exercises for supporting prior lecture material. Generation of experiences which incorporate valuable content such as basic concepts in a plethora of authentic contexts will provide the recursive impact required for learning (Beliveau & Peter, 2002). While devising these experiences instructors must maintain a balance of theoretical information and practical examples. The experience should thread these components together for the construction of new knowledge. Technology has presented a challenge to instructors by supplanting the results more important than the concepts (Burtch, 2005). Teachers must synchronize enhanced theory as technology develops new equipment resulting in modified methodology.

Educating the next generation of construction field engineers must embrace new patterns of instruction incorporating innovative ideas for attaining this balance of theory and practice (Burkholder, 2005). Interviews with leading surveyors and construction surveyors have assisted in the identification of some elementary concepts related to this field offering both a theoretical

and practical component. This group of concepts is found in the introductory sections of basic surveying textbooks (Crawford, 2003; Kavanaugh, 2007). These concepts consist of the following: angles, distance, elevation, office and field. Angle, distance and elevation are the variables which define the spatial relationship (relative positions between two points) while office and field define the current theory and needed practical components. Using these concepts with important theory and current technology provides the synchronization of change required for the education of a field engineer (Naberezny & Ghilani, 2005).

Integration of the best methods will produce a more educated and effective construction surveyor as well as enhancing recruitment of new trainees. Also, by incorporating insight from key industry people, the industry may generate future instructors in the surveying area. The dimensional control needed for the correct positioning of points between the various construction components are most often successfully accomplished by trained construction surveyors familiar with the method of operation required to competently use surveying instruments. Methods and procedures needed for this equipment usage are often acquired on the job resulting in a pure practical education. This process overlooks the theoretical component needed for most operations. This lack of theory removes part of the transaction relationship with the practical resulting in the field engineer's limited synthesis of the jobsite surveying experience. The collaborative nature of the many disciplines on a job site required to complete most projects demand a field engineer to be versed on the theory of the process and the practical usage of equipment for positive results (Lowe, Ashworth, & Williams, 2008; Williams & Liu, 2003). Determination of the best combination of the collaborative components, theoretical and practical, will provide instructors an improved method of surveying instruction.

Traditionally lectures and labs have been offered in a format which the two have been separated due to large lecture classes being taught by a professor and while associated labs were

broken into smaller groups with related activities handled by graduate assistants. Labs have been used to present the practical side of class such as surveying. Technical advances have placed an inordinate amount of emphasis on the practical while minimizing the theoretical. This movement has been likened to technical training as opposed to education (Burtch, 2005). Social and technical changes were addressed by the National Science Board in 2007 through the generation of “Moving Forward”. This article noted the need for a real world curricula addressing change. Members of the Georgia Tech conference posed the usage of teaching the practical part of the engineering pedagogy by using professors of practice. These professors of practice would be experts in their disciplines providing the practical side of the pedagogy (National Science Board, 2007).

Purpose Statement

The purpose of this study is to determine which method of presenting basic construction surveying concepts is more effective. Method one presents a theoretical component followed by an immediate practical exercise while method two provides the same material with separation of practical and theoretical components (separation will normally be one class period). Determination of a difference between these two methods will provide the most effective collaborative mix for presentation of basic construction surveying concepts.

Objectives of the Study

1. To describe the students enrolled in a junior level course in construction surveying at a research extensive university on the following personal and academic demographic characteristics:
 - a. age
 - b. academic classification
 - c. overall college GPA
 - d. GPA in all construction management courses completed
 - e. grade achieved in prerequisite construction management courses, and

- f. grade achieved in the required college level calculus course
2. To describe the Pre and Post achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying at a research extensive university.
 3. To compare the achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) in a junior level course in construction surveying (as measured by a teacher made achievement test) of students who are taught using an instructional approach in which theoretical and practical components are merged with students who are taught using an instructional approach in which the theoretical and practical components are separated.
 4. To compare the Pre and Post achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying at a research extensive university.
 5. To compare the achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying (as measured by a teacher made achievement test) by the time of day that the instruction was delivered.
 6. To compare the achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying (as measured by a teacher made achievement test) by the class size (defined as number of students enrolled).
 7. To determine if a relationship exists between the pretest achievement, overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation), and the pre-instructional self perceived ability in surveying (as measured by a researcher designed perceptual ability questionnaire) of students enrolled in a junior level course in construction

surveying at a research extensive university.

8. To determine if a model exists explaining a significant portion of the variance in post-instructional achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) from the following personal, academic, and perceptual characteristics:

- a. Self-perceived surveying ability
- b. Age
- c. Class status (defined as freshman, sophomore, junior, or senior classification)
- d. Overall college GPA
- e. GPA on all Construction Management courses completed
- f. GPA on prerequisite Construction Management courses
- g. Grade achieved in required college calculus course
- h. Experimental treatment (integrated or separated)
- i. Class size (defined as the number of students enrolled in the course)
- j. Time of day that the instruction was delivered.

Significance of the Study

The development of a basic course to train new construction surveyors for construction layout will be a major benefit to the construction industry. Current on the job training produces a layout person with a limited skill set lacking in basic theory and practical experience. The expected results will provide new trainees a balanced program of theory and practical experience required for the development of a more in depth skill set. The anticipated findings will also assist in the instruction of college students understanding of dimensional control required in construction. The basic concepts of angles, distance and elevation will be presented through a group of authentic practical exercises while office and field components are posed through theoretical examples of the construction process as it relates to construction layout. This transactional relationship as posed by Dewey of the theoretical examples and practical exercises are the foundation for generation of the experience needed for the construction of knowledge by a student (Innes, 2004).

It is critical for construction surveyors to understand the basic concepts of surveying. The integration of these concepts provides foundational information for the recognition of accuracy, precision, mistakes and errors. These four variables are important measurement principals which must be understood for the correct positioning of construction projects (Crawford, 2003) (Estopinal, 2008) (personal communication). Surveyors must be able prepare layout of a building by planning their field strategy in the office making note of any discrepancies in the plans. Regardless of whether discrepancy is large (mistake) or small (error), recognition of needed corrections increases the likelihood of correct positioning (accuracy) with reliability (precision) of measurements.

The following situation poses one project which portrays all measurement principals being compromised due to major disregard for the basic surveying concepts. Poor planning (office) along with use of an incorrect elevation set the stages for a school project in southeast Louisiana being repeatedly setback with major reworks. The incorrect point caused the slab to be set at a low elevation along with the misplacement of anchor bolts used to anchor prefabricated steel. The slab had to be reworked to attain the correct elevation and the anchor bolts needed to be replaced for the fabrication of the steel structure. If the basic concepts of office, field, angle, distance and elevation had been observed the major discrepancies (mistakes) would have been minimized. Errors cannot be fully removed from a project but poor planning will increase the odds of mistakes. This need for knowing what to look for is the idea Beliveau and Peter (2002) were trying to make in their article of instruction which teaches the ability to preempt problems. A thorough understanding of these basic concepts develops the expertise to foresee and forego major issues.

CHAPTER 2

REVIEW OF LITERATURE

General Education

Introduction

Construction education is an area of applied science which incorporates many different schools of thought given the varied disciplines forming the foundation of this national industry. The holistic term construction encompasses a large spectrum of specialized areas which range from residential to large industrial projects. Each construction venue has a basic set of required skills found in all construction projects while some specialty construction segments necessitate specific skill sets (Beliveau & Peter, 2002). This multidimensional focus requires a curriculum broad in scope with elementary knowledge capable of being enhanced (Bransford, et al., 1999). Curricula must utilize a student's foundational information as a platform to increase their mental capacity (Lee, 1999).

The epistemological value of a curriculum is weighted in the ability of instruction to assist students in tailoring their desired skill set (Innes, 2004). The varied philosophies offered to academia are multifaceted in their range of concepts and abilities. The inherent features of construction require two dimensional plans being manifested into a three dimensional object. This process offers a real time laboratory for developing and evaluating efficient curricula capable of meeting industry needs (Estopinal, 2008) (personal communication) (Patterson, 2008) (personal communication). The new experiences that students encounter will be analyzed from existing individual math and science skills sets. This analysis will allow each student to generate new knowledge for future activities. Construction layout activities will require the exploratory skills posed with math's logical deduction and science's empirical induction for addressing situations. New learning will result from the new understandings generated from these new

projects. Instructors must develop activities which incorporate the obvious strengths offered by these associated disciplines (Pang & Good, 2000). Developed activities should foster real world type queries in addition to the generation of verifiable results. The verification side of prepared activities is often found in many prepared activities which are lacking in their ability to cause students to dig deeper for reasons (Wilson, Fernandez, & Hadaway, 1993). Math activities which are viewed as reformed must cause a student to search within their individual skill sets (Wilson, et al., 1993) for the generation of solutions going beyond the normal algorithms. This ability to present a student the opportunity to generate the big idea (Van de Walle, 1999) can be tied to the synthesis which takes place in Bloom's taxonomy (Lee, 1999). Science skills are exploratory in the sense that students look at all observations for obvious recursive patterns within the assigned activities. Teachers must instill in instructional activities the need to utilize these patterns of problem solving and querying as the goal for a student to satisfy the end result, an answer (Pang & Good, 2000).

Universities must develop cultures capable of change which embrace new ideas offering enhanced pedagogies (McDuffie & Graeber, 2003; Noble, 1999; Utschig & Schaefer, 2008). This proactive mindset is not easily found. Academics are often times resistant to different schools of thought. Kreber (2003) in her paper tried to distinguish between the terms scholarly teaching and the scholarship of teaching and learning. Scholarly teaching is recognized as pedagogically sound courses while the scholarship of teaching and learning is associated with the transfer of best methods amongst educators (Kreber, 2003). Major research papers supported Kreber's findings as to the lack of communication within academia. Reports including the Boyer report, *How People Learn*, and *Bridging Research and Practice* presented a formative argument for the need of transference of proven methods for improved teaching (Bransford, Brown, & Cocking, 1999; Donovan, Bransford, & Pelligrino, 1999; Kenny, 1998). This sharing of

knowledge must be offered to institutions willing to embrace change. Institutional environments must be conducive for establishment of new ideas.

Pedagogical Philosophy

The National Science Foundation (NSF) has taken the lead in the search for best pedagogical practices in critical education areas. Programs such as Innovations in Engineering Education, Curriculum and Infrastructure (IEECI) promote the development of new methods with intentions of passing these findings on for usage or further development (Kemnitzer, 2008). This promotion of best practice through the NSF grant process will assist in creating proactive contexts for change. Recent grants issued by the NSF reflect this push toward a culture change including a study funded in 2007 which utilizes graduate teaching assistants using a curriculum incorporating ideas from the report *How People Learn* to an opposing one using a traditional mode of teaching. The idea behind this study is to identify and verify the advantages of using this new pedagogy in college instruction (Cox & Diefes-Dux, 2007). Inclusion of the ideas fostered in *How People Learn* has not been embraced by many academics (Goel, 2005).

Curricula must embrace proactive pedagogical methods capable of utilizing the varied knowledge base of their disciplines including construction (Beliveau & Peter, 2002). This information base is dynamic with both industry and academia creating meaningful additions. College instructors must incorporate change to keep students current while also developing ways to present new features. This collaborative demand of the abstract and objective components requires the teaching side of the education equation to search for the most effective mix (Beliveau & Peter, 2002; Innes, 2004). Efficient pedagogies will increase the prospect of a student's learning. Many studies have been investigated on the learning side including "Bloom's Taxonomy of Learning" (Lee, 1999).

“Bloom’s Taxonomy” noted by Lee (1999) portrays the process of learning evolving through six stages which are:

- 1) Knowledge
- 2) Comprehension
- 3) Application
- 4) Analysis
- 5) Synthesis
- 6) Evaluation

The epistemology of knowledge requires that information which is used for generating knowledge be valid in nature (Merriam-Webster, 2009). Presentation of relevant information should be accomplished by an instructor in ways students can have clear understandings. This comprehension can be enhanced by direct association with real world activities. Authentic activities must be discernible by students so individual inquiries can be performed for in depth analysis of new material (Innes, 2004; Lee, 1999). Continued analysis allows for a dialectic synthesis of incorporated activities so one can better evaluate problems (Beliveau & Peter, 2002). This stepwise development of an idea presents the cognitive process offered by the taxonomy (Lee, 1999).

Instructors can also use the taxonomy for the preparation of teaching material. Knowledgeable incorporation of new information must be understood for effective generation of meaningful applications, such as practical labs. This creative composition will allow the academician to reverse the last three steps of the taxonomy after posing the defined course practicum (Lee, 1999). Instructors can evaluate presented material resulting in a dialectical synthesis by analyzing results. This analysis may generate changes having a more potent educative experience (Lee, 1999). Teachers who have the desire to be researchers in new pedagogies for their field of instruction must have also be capable of including educational ideas for in depth curricula investigations (Dancy & Beichner, 2002). Curricula involving

collaborative components such as lectures and labs must be intuitively integrated. Traditionally this integration has involved the separation of these theoretical and practical areas for logistical reasons. Universities routinely have large lecture components with multiple labs allowing for flexible scheduling. This disassociation of material creates an area for research as to the successful transaction required for the generation of a worthy experience.

Pragmatic views have been found widely throughout American culture. Education has been impacted by a philosophy, American Pragmatism, which has been described as “transactional realism” (Innes, 2004). This transactional statement has been tied to many of John Dewey’s ideas about education. Dewey’s philosophy is extensively weighted in the idea that knowledge is constructed. This construction is affected by both psychological and social factors (Innes, 2004). Bloom’s taxonomy poses the formation of knowledge following a designed pattern ranging from basic knowledge to a deep understanding with the ability to expertly use this knowledge (Lee, 1999). As individuals interact with their environment, information is incorporated in a manner we call learning for usage in situations which require a recognition of a problem or a stimulus. This awareness of a condition or an experience is defined as knowledge (Merriam-Webster, 2009). Formation of knowledge manifests itself as individuals increase, which Dewey refers to as, their adaptive capacity to handle more complex situations in a confident organized manner. Dewey likens this increase in capacity as growth which he correlates to education (Innes, 2004). Instructors of courses having practical components such as lab classes must devise experiments which incorporate real world applications for development of authentic experiences.

Dewey had many thoughts as to education and the formation of knowledge. The basis of his principle is tied to the recognition of a problem then the process which drives further inquiry for a solution (Ozmon & Craver, 2003). This inquiry should be the basis for the formation of an

experience which is defined as the transactional relationship between the abstract and concrete components of that experience (Innes, 2004). It has also been described as a transaction between existing knowledge and the situation which generates the experience. This experience is normally constructed as an active process under a constructivist philosophy (Lee, 1999).

Instructional material must generate experiences which challenge the students. These challenges should foster an in-depth query on the student's part for developing new knowledge. Labs should be designed to require student's active participation in the process (DiBiase & Wagner, 2002)

Pedagogical Development

Construction of knowledge is critical but the collaborative components creating that experience need to be balanced for an effective product. This created example should be both credible and authentic (Beliveau & Peter, 2002). Students learn by doing which is the focus of a constructivist idea through the promotion of hands-on activity (Lowe, et al., 2008). Applied science courses are composed of theoretical and practical components which require an instructor to precisely inventory all accessible variables to be utilized for the generation of an experience. Instructors must give in-depth thought to the development of a proactive, engaging activity to move the learning equation from the comprehension to the application phase (Lee, 1999). Recognizable activities which use prior knowledge, abstract component, supported with new information are more influential as a learning tool when the practical side of the exercise is applied. This scaffolding of knowledge is needed in the enhancement of a student's skill set (Innes, 2004). Lab projects which require an interactive engagement of the student have proven to be more efficient in the learning process (Felus, 2007; Welch, 2000).

Creation of activities capable of transferring the needed information is the primary focus of a generated experience (Innes, 2004; Van de Walle, 1999). The transactional relationship must be successfully transmitted in the application to carry over to the analytical stage of the learning

taxonomy for usage at a higher level of cognition. By furthering the query to a level of analysis, students will synthesize this information generating new ideas, thus increasing the prospect of a higher level of organization. This heightened level of organization gives rise to increased understanding which allows for a deeper evaluation of the experience. Higher levels of organization have been noted by Dewey as a characteristic of an expert (Innes, 2004; Lee, 1999). Experts in various disciplines must be utilized in ways to enhance students' learning experiences. Professional experience learned on the job is immeasurable. Areas such as construction management can include many related disciplines of construction, engineering, and business for the generation of an authentic experience. A recent NSF grant to Virginia Tech University, awarded in 2007, focused on the usage of industry professionals along with students and professors for developing ideas for a successful incorporation of interdisciplinary information for generation of enhanced pedagogy (McNair, Terpenney, Goff, Paretto, & Borrego, 2007).

Most of the courses found in construction management offer themselves to specific disciplines for information. The construction surveying course is a specific area directly impacted by the surveying and engineering disciplines. The ACCE "Document 103" encourages the inclusion of industry professionals on faculty staffs for instruction of construction classes (American Council for Construction Education, 2006). Teachers must be versed in both domain (subject material) as well as pedagogical knowledge (Dancy & Beichner, 2002). For any designed experience to successfully build on prior knowledge, teachers must know what experiences are needed for the generation of a transactional relationship between existing and new knowledge (Innes, 2004). Industry involvement must be included in many activities to generate a effective experience (Chapin, Rondebush, & Krone, 2003).

Collaborative courses such as those in the applied science must have a definitive connection between the theoretical and the practical. The word "Habit" has been used to describe

what others might call grounded theory. This grounded theory or understanding is the result of a very good fit of information on the scaffolding which has occurred from previous learning experiences (Innes, 2004). The increased knowledge one “constructs” generates an increased level of understanding which allows an individual to evaluate situations with an increased level of expertise (Innes, 2004). Increased competency attained through this cycle of learning is the goal of the model offered in *How People Learn* (Bransford, et al., 1999). The collaboration of practical and theoretical can also be integrated within related disciplines. The multidiscipline construction industry can be joined with other segments such as the architectural, engineering and surveying for the expansion of student’s skill sets (Holley & Dagg, 2005; Kay, 2003; Ryan & Callahan, 2007). Integrated courses have shown positive results in the student’s learning by allowing them to include other ideas within the group along with the invaluable understanding of other disciplines impacting their future projects. Usage of multidiscipline teams within related areas such as construction increases the perspective of an experience due to the multiple views being incorporated in the experience.

Teachers are trying to simulate the same growth process by emulating examples of applications which can build on one another to generate the increased knowledge that occurs in the learning cycle (Bransford, et al., 1999). This increased adaptive capacity from scheduled exercises allows students to become more confident in making decisions. By instilling confidence with excellent applications, teachers have addressed the transference of knowledge giving rise to the assessment part of the educative experience. The process of judging this transfer is critical for any experience. Poor assessments of an individual’s performance will effectively diminish the enthusiasm required for learning (Bransford, et al., 1999). Instructors have acquired a deep dependence on the lecture as their mode of instruction with little exposure to a more active or practical means of teaching. These new areas of instruction require a revised

means of judging a student's performance. Previous means of testing such as rote memorization must be modified in ways which allow for an in-depth assessment of this new knowledge acquired by students (Bransford, et al., 1999; Millett, Payne, Dwyer, Stickler, & Alexiou, 2008). Innovativeness in the applications area must be matched on the assessment side because students inherently figure out what is required for a good grade (Bransford, et al., 1999; Innes, 2004). Dewey has likened teachers as artists through their instructional ability which results in creation of a learned student. If an instructor is capable of designing an excellent program of material, presentation and assessment, then a masterpiece in curriculum has been produced (Innes, 2004). The NSF has funded projects from the "IEECI" program to determine the impact of the new pedagogies including some based in the constructivist paradigm. The University of South Florida has undertaken a project through a 2007 grant for the determination of the impact of reconstructing classes within the industrial engineering department based on the constructivist model (Reeves, Hernandez-Gantes, & Blank, 2007).

Collaborative courses in the applied sciences which have a mix of lecture and lab components offer a vast array of research opportunities when considering the transaction between theoretical and practical areas. Traditional methods in this area routinely separate the lecture and lab components for a variety of reasons often dealing with the resources available. Professors teach large lecture classes with segmented labs smaller in class size instructed by graduate assistants. Current studies like the Purdue University study are probing methods of increasing the effectiveness of graduate teaching assistants by measuring class achievements through the usage of assistants trained in different styles (Cox & Diefes-Dux, 2007). Other instructors have improvised by combining the lecture-lab format to get a more efficient transaction between the theory and practical information (DiBiase & Wagner, 2002; Kay, 2003). Innovation can come in many forms but the experience needs to be proactive and engaging

motivating the student to query results reflecting on other peers' ideas resulting in an increased ability to evaluate an activity.

Engineering Education

Innovation and creativity have long been recognized as basic components of the engineering pedagogy found in American engineering schools. These dynamic principles have been instilled by the existing educational paradigm used for accrediting most engineering curricula. During the period from the 1950's to early 1990's the paradigm became so efficiently cloned that employers and The Accreditation Board of Engineering and Technology "ABET" recognized a missing skill set on the part of graduating engineers (Kenyon, 1993). This period can be correlated to other disciplines which also had become complacent in their ability to educate the American student (Kenny, 1998). It has been noted that universities have become very conservative in their approaches to education (Goel, 2005). The inward search of "EC2000" by ABET brought to the forefront this lost focus resulting in the generation of 11 goals for an outcome based curriculum. These 11 criteria were posed as being the cornerstone of a new paradigm replacing the old system of valuing programs almost exclusively on resources (Kenyon, 1993; Lattuca, Terenzini, & Volkwein, 2006; Senior, 2001). The outcome based ideas posed usage of group instruction with more faculty input for the generation of a more student centric curriculum. Incorporation of teams in practical projects increases the perspective individual student's use for generation of new knowledge.

Engineering Pedagogy

Engineers are a specialized group of individuals specially trained in science, math, and technology. This focused learning is gained at the expense of courses which provide a basic understanding of contemporary business practices (King, 2006; National Science Board, 2007). Employers of this talent pool recognized the narrow focus of the potential employee who

possessed a high degree of technical knowledge but little ability to adapt or understand some of the human side of a skill set required in most work sites after graduation. This recognized shortfall in the skill set generated a definite need for a more rounded education. This additional education should be supplied from a liberal arts perspective to give the engineering graduate a more balanced knowledge base which includes sociological concepts (Kenyon, 1993).

Many employers noted the deficient skill set of graduating engineers. This limited knowledge base made it hard for engineers to advance beyond their specialized areas due to this narrow skill set. These skills which needed enhancing are often times found in many leadership programs. Leadership training at both the college and work level should provide a group of assignments each offering an expansive experience entailing all three components of the Creative Center for Learning “CCL” leadership development model - assessment, challenge and support (McCauley & Velsor, 2004). ABET’s recognition of the stakeholders’ need for a revised curriculum led to the generation of Engineering Criteria 2000 “EC2000” encompassing 11 outcome based skills for future accreditation assessment (Lambert, Terenzini, & Lattuca, 2006). These criteria were part of an overall plan to revamp the engineering curriculum academics and the organization from an accreditation perspective (Volkwein, Lattuca, Harper, & Domingo, 2006). Recognition of this void from an education and leadership perspective needs to serve as the basis for change. For any plan to be implemented, awareness of the problem must be recognized by the stakeholders capable of creating the plan and atmosphere for its successful installation, i.e., a culture change (McDuffie & Graeber, 2003; Noble, 1999). Generation of this plan can be systematically evaluated by not only evaluating the need but also looking at the steps (history) that created the need. The ability to form groups in lab classes makes them an obvious area of research. Inclusion of querying exercises in a group format has proven to be more effective than traditional style classes using exercises requiring only verification of results. The

ability to manipulate curricula like lab classes offers researchers many variations for a more optimum model (DiBiase & Wagner, 2002; Overlook, 1994; Suits, 2004)

Engineers after World War II were in high demand resulting from the expanded post war economy and opportunities facing the country with an abundance of potential students resulting from all the discharged soldiers. The scheme to fill all slots in engineering generated a bifurcated system at two levels of curriculum, engineering science and engineering technology (Kenyon, 1993). The resulting engineering accreditation process used at that time was based on inputs such as the size of the physical plant and academic credentials offered by the staff with minimal consideration of the results. This mindset became so well entrenched one could consider each school a perfect clone (Lambert, et al., 2006). This paradigm was so efficient it failed to recognize its deficiencies for a long time till around 1992 when employers posed the lack in engineering graduates of needed skill sets (Kenyon, 1993).

New Engineering Education Paradigm

The nation's focus on generating efficiency in all areas of society set the stages for the resulting accreditation paradigm which in the long run proved to be an obstacle to change (Kenyon, 1993). Education in all disciplines was impacted by this industrialization never seen before. Resulting skill set deficiencies were noted on many fronts in American society as the glut of college graduates was not prepared to tackle the problems employers needed solved. The mandate by President Truman after World War II to educate the masses was very successful as many flocked to colleges seeking advanced education. The offering of this education was good except that this paradigm was fashioned after an industrial assembly line in the instruction of a student. This mindset works in the production of finished goods but not in teaching a student (Kenny, 1998). The obvious disconnect of the system with the student is not new. Dr Hamilton Holt a president of Rollins College in the early 20th century commented on the lack of learning

he acquired in his undergraduate education (Goel, 2005). This disconnect still prevails as professors' modes of instruction lack the depth of presentation which can foster analysis, synthesis and evaluative abilities in students (Kenny, 1998). Innovation is needed for generation of new ideas but change should be for positive reasons. The cloned system which operated like an assembly line must integrate new innovative ideas allowing each university the opportunity to include individual strengths in the redesigned paradigm.

This resulting product "Engineering School" was not the goal of an original accrediting group Engineering Council for Professional Development "ECPD" which stated in their mission statement "No hard and fast prescriptions are laid down for the curriculum" and recognized it had no authority to improve restructuring or standardization in engineering colleges (Kenyon, 1993). This statement as posed by Kenyon (1993) was further clarified by ABET which reiterated the same idea in a clause of EC2000 known as the "Anti Ossification Clause" (Kenyon, 1993). Both statements were intended to prevent the same result, an elimination of innovation in the learning process. Specialized areas of the curricula failed to explore or be impacted by external factors including society. Engineering schools prior to 1992 had become so insulated to change that stakeholders backed EC2000 hoping to generate a more learned graduate capable of handling current work assignments. Technology has been the catalyst of a significant change in the practical aspects of education. Labs being the primary vehicle in practical instruction will be an area which will become more reflective of new applications related to the new technology.

The resistance of engineering schools to curriculum changes, and graduating engineers' deficiencies led to the recognition of a major need for change of the accreditation process. The accepted method prior to 1992 for an engineering program's approval was dependent on inputs, focusing on available resources with no regard for the product produced, i.e., the student. Deep

organizational introspection by ABET generated the 11 criteria which shifted the focus to an outcome-based assessment linked to the ability of the student in these chosen criteria (Volkwein, et al., 2006). The resulting program EC2000 was a comprehensive model which looked at all basic internal components of ABET's accreditation process (Lambert, et al., 2006) focused on the following four variables for ideas:

- 1) Shift in program curriculum and characteristics
- 2) Changes in faculty members' practices and values
- 3) Valuing student-related learning experiences
- 4) Development of student analytical and group skills

This list was mentioned by Lambert et al. (2006) in their presentation of one report to ABET as being very important considerations for the generation of the 11 outcome based criteria which served as one milestone for the development of a new accreditation process (Lambert, et al., 2006). This process of removing an old way for a new paradigm is not easy. Gradual transition has been the way most organizations foster assurance and confidence that new proposed methods will bring about the desired results. Results from the Penn State study by Lambert et al. (2006) showed that the comparison of self reporting surveys of 1994 and 2004 engineering graduates reflect an opinion that the usage of the outcome-based system produced an "active, collaborative pedagogical change" (Lambert, et al., 2006) having the largest effect on student's group skills. Creation of authentic experiences within the constructivist mindset is needed for the successful development of an outcome-based system. John Dewey's view of education involved the increase of a student's "adaptive capacity" (Innes, 2004). This adaptive capacity is the increase in knowledge viewed as the growth involved in learning. The increased knowledge is constructed from the transactional relationship between the abstract and concrete components of the authentic experience created by the instructor (Innes, 2004). The analysis and synthesis of each experience is intended to increase the individual's evaluative expertise which translates into new

knowledge (Lee, 1999). Authentic experiences should be thoroughly researched with both academia and private industry providing essential input on information required for an effective learning activity.

Leadership Training

This new mindset of an outcome-based evaluation would be the “Ultimate test of the quality of an academic program” (Volkwein, et al., 2006). “The more programs work to create a climate conducive to difference and discussion of difference the more students develop skills that are essential to their success in the engineering profession” (Lambert, et al., 2006). This formation of the 11 outcome-based criteria was a major acknowledgement by ABET and employers that engineering graduates were lacking important skills in 1994. These skills which the stakeholders compiled and reduced to the 11 criteria have a very large people skills theme when looked at holistically. The social skills sought by EC2000 are found in many leadership programs such as the Center for Creative Leadership “CCL”. “CCL” composed a list called the “Potential Lessons of Experience” which served as a template for the book written by McCall, Lombardo & Morrison (1998; pg 7) titled “The Lessons of Experience”. In this, list the authors state five major themes which impact an individual’s development as a leader focusing on the learning experiences gathered. The following list is the major themes compiled by “CCL”:

- 1) Setting and Implementing Agenda
- 2) Handling Relationships
- 3) Basic Values
- 4) Executive Temperament
- 5) Personal Awareness

Included in each of these themes was a list of particular experiences. Following is the researcher’s self-generated list of correlations between the ABET Outcome list and the Potential Lessons of Experience list portraying the reasons for including leadership training in the engineering curriculum. This list of comparisons is compiled in the following Table 1.

Table 1

Comparison Table of ABET’s Outcome Based Criterion and Potential Lessons of Experience

“ABET’s 11 Outcome Based Criteria”^a	“Potential Lessons of Experience”^b
a. Apply math, science, and engineering	Setting and Implementing Agenda Technical / professional skills
b. Design and conduct experiments	Setting and Implementing Agenda Handling Relationships
c. Design a system to meet needs	Setting and Implementing Agenda Executive Temperament Strategic Thinking
d. Teamwork	Handling Relationships Dealing with people over whom you have no authority
e. Engineering problem solving	Setting and Implementing Agenda Technical / professional skills
f. Understand professional and ethical responsibilities	Basic Values Basic management values
g. Communicate effectively	Handling Relationships People related situations
h. Engineering in global and social contexts	Handling Relationships People related situations
i. Lifelong learning	Personal Awareness Balance between life and work
j. Knowledge of contemporary issues	Personal Awareness Balance between life and work
k. Use modern engineering tools	Setting and Implementing Agenda Executive Temperament Strategic Thinking

^a This list was taken from “Engineering Change: A Study of the Impact of EC2000”, (Lattuca, et al., 2006).

^b The bold list in the right column was taken from “*The Lessons of Experience: How Successful Executives Develop on the Job*”, (McCall, Lombardo, & Morrison, 1988).

This comparison will engage one’s thought as the awareness and challenges were used by stakeholders to generate needed changes in the developmental process as support gathered around a new paradigm. The usage of the leadership paradigm is one which has a high positive

correlation between the variables used in leadership training, life long learning and engineering education. The 11 outcome based variables are all correlated to the main areas noted in the previous table (Lambert, et al., 2006; McCauley & Velsor, 2004). Educational researchers are always looking for effective means to convey information in an efficient way. The leadership paradigm is one which has an extensive successful record of creating an authentic experience. This basic model should provide an array of options to build a meaningful hybrid of ideas for creating an authentic stimulating experience (Kenny, 1998). The outcome based criteria is one which can be generated through the usage of practical lab projects. These projects should incorporate the tools of math and science for the generation of the “Big Idea” (Van de Walle, 1999). The experience generated through a querying based lab experience has been shown to be vital in the construction of new knowledge in applied science courses (Suits, 2004).

This change in the accreditation opened the door for a “new paradigm” (Kenyon, 1993). John White, Dean of Georgia Tech College of Engineering in 1992, commented before EC2000 that the current ABET policy “...inhibited innovative and creative curriculum ideas” (Kenyon, 1993). Leadership development is recognized by many, as posed by “CCL” authors in the Potential Lessons of Experience list, to be comprised of occurrences each impacting an individual’s learning. From this learning leaders develop a personal style which can define their abilities. The Volkwein (2006) study commissioned by ABET produced a list of eight student experiences of which five are correlated to ideas contained in both the book by McCall et al. (1988) and McCauley & Velsor (2004). Following are the five selected learning experiences presented by Volkwein:

- 1) More active engagement in their own learning
- 2) More interaction with instructors
- 3) More instructor feedback on their work
- 4) More involvement in engineering design competitions
- 5) More emphasis in their programs on openness to diverse ideas and people

List gathered from (Volkwein, et al., 2006)

Results show “today’s engineering graduates are engaged in more collaborative learning activities in the classroom, interacting more with faculty, and engaged in more co-curriculum activities such as engineering design” (Volkwein, Conclusion section, 2006, ¶ 2). These exercises in learning are found throughout the leadership development process. Leadership has been likened to a life long process given the dynamics of forever being impacted by new experiences. This experience in which education is very important serves as a critical component of a student’s education. EC2000 through its 11 outcome based criteria has served to enhance the student’s experience thus increasing the opportunity to learn. Factors such as faculty initiatives, external funding to improve teaching and learning, along with employer feedback have served as a means to gauge the learning process (Volkwein, et al., 2006). Volkwein (2006) noted in his multivariate study nine areas of learning outcome which showed significant difference when comparing 1994 and 2004 engineering graduates. The largest differences which were noted in the ANCOVA analysis between the 1994 and 2004 graduates as reported by Volkwein (2006) presents the intuitive significance for leadership development found lacking in earlier curricula as follows:

- 1) Use experimental skills to analyze independent data
- 2) Function as groups and engage in teamwork
- 3) Communicate effectively
- 4) Understand professional and ethical obligations
- 5) Understand the societal and global context of engineering solutions
- 6) Recognize the need and engage in life-long learning

List gathered from (Volkwein, et al., 2006)

Academics have noted in increased numbers the need to redesign outdated methods of instruction. The new design must be a robust pedagogy recognizing the elements concerning all the stakeholders in the engineering discipline noted by Volkwein (2006) in his survey of

graduates. The connectivity of many posed concerns shows the same distinct areas where leadership and engineering pedagogies converge. This convergence can serve as a template for modification for ideas academics might be considering. The full extent of this generalization should be used by academics as S. Jackson (2003) posed in her speech that Dartmouth, Smith College and Northwestern University all have incorporated parts of the leadership classes into their engineering curricula.

The generation of a new pedagogical paradigm was the result of some historical occurrences such as World War II which generated the older model of “Big Science” as the chosen theme. The war generated a large need for research and development which was highly sought after by academics and universities. This focus on big science and the large money expenditures generated a highly specialized field of individual areas of engineering. This specialization stymied the growth process and minimized the amount of new evolving curriculum to address the new scenarios that faced the nation. This inability to change caused some of the responses recognized by ABET from the employers of engineering graduates. The major shift in the 80’s was the attention of the booming economy. The global community and the free market expansion of that period required employers demand a better product from engineering schools, namely engineering students capable of working in the new global economy (Kenyon, 1993).

This new paradigm of a more balanced graduate, tainted so to speak by a liberal arts mindset, was needed by most employers with an expanded leader development skill set (Kenyon, 1993). These multi disciplined engineers needed not only to be knowledgeable in designing things but the things they designed needed to also provide well thought out solutions. To truly understand the variables needed in a solution the engineer had to understand business laws and

regulations, society and all the things tied to a decision (Kenyon, 1993; King, 2006; Volkwein, et al., 2006).

New Curricula

The curriculum had become so honed that the culture change would take a high degree of introspection and arm twisting to bring about the needed changes. The engineering curriculum lacked content and strategy (Kenyon, 1993). Engineering programs were stockpiled with large amounts of required math, science and engineering classes with little room to fit new courses which would round out the student. The engineer at that time was a very unique person capable of designing buildings but incapable of dealing with imperfect human beings and their related social issues (Kenyon, 1993). This new paradigm was driven by the changes ABET had targeted in the generation of its 11 outcome based criteria (Lambert, et al., 2006).

Current engineering curriculum needs to include more liberal arts courses so it can possess the needed content that students can understand social, cultural, and intellectual facets of issues facing humans such as ethics, environmental, economic and energy (Kenyon, 1993). The engineer as a knowledgeable employee circa 1994 was presented by Colby Chandler in the following statement, “It is constantly necessary to remind young Kodak professionals that they are not in the business of making film for cameras, rather you are in the very important business of helping people easily and inexpensively create memorable pictures” (Kenyon, 1993, p. 4) .

ABET not only classifies things in pure engineering but poses a related area called engineering technology, which was a part of the bifurcation posed by the Grinter Report after World War II (American Society for Engineering Education, 1994; Kenyon, 1993). The definition of engineering technology by ABET is:

“Engineering Technology is that part of the technological field which requires the application of scientific and engineering, knowledge and

methods, combined with the technical skills in support of engineering activities; it lies in the occupational spectrum between the craftsman and engineer” (Kenyon, 1993, P. 3).

Technology educators of the Industrial Technology Education Association “ITEA” have a very positive record for having a dedicated group of academics devoted to teaching students a complete skill set which includes some of the more recognized variables associated with leadership training. Mr. Don Maley a noted academic and leader, has had annual meetings in his honor with leadership as a central theme as posed by T. L. Erikson (2005) and Mark Sanders (2006), relating the role of a teacher as a leader. Teachers as educators have a very integral role as a mentor in imparting knowledge to their students and the industrial arts teacher has provided many of the needed basics to their students which are important basal components of leadership development (Kemnitzer, 2008; Sanders, 2006). Learning as presented in the engineering curriculum must provide both the basics of engineering and also foster examples which can be used as growth experiences for leadership learning. Technology educators as presented by Sanders (2006) have a wealth of insight of the position held for mentoring. Sanders (2006) points out teachers are motivated by passion, unafraid to take on controversial issues with a deep sense of compassion and the ability to take on risks.

Teacher impacts on students are noted at all ages and due to the expansive coverage of leadership development, learning at all ages helps mold a person’s development. Leadership initiatives have been started at the state level with a notable program in Massachusetts called “Curricular Framework for Science Technology/Engineering” (Sanders, 2006). This state program K-12, sponsored by American Society for Engineering Education “ASEE”, poses another idea to continue the shift of the paradigm. This type of education must upgrade the pedagogical design and is defined by Sanders (2006) as “Purposeful Design” resulting in desired

learning outcomes. Outcome-based learning is the central theme of the redefined paradigm presented in EC2000. The 11 criteria focus on the outcomes generated by the student as he learns the curriculum.

Development of Authentic Experiences

The experiences academics create are the works of art described by Dewey that instructors need to construct (Innes, 2004). The authentic activity that must be generated has a higher chance of transferring the required information for the increase in adaptive capacity sought by Dewey's pragmatic philosophy. The Scholarship of Teaching and Learning "SOTL" presented by Goel (2005) in his paper presents the need for educators to make the classroom experience a student-centered event. The focus of developed experiences should be group activities engaging students in ways to promote an increase in query and evaluation. The Eisenhower Leadership Development Program at Texas A&M, started in the spring of 1994 fits that dimension as an institution possessing the needed resources to accomplish exemplary leadership training. The program is composed of four different colleges, liberal arts, business administration, engineering and agriculture/life science (Welch, 2000). This diversification enhances the learning experience for students by offering differing views brought from the different colleges. Student's participation in this program is built around a framework of understanding leadership, development of an individual leadership skill set, and an awareness of social issues tied to leadership decisions. Class activities were interlaced with speakers, discussion, games and group practical exercises. As Welch (2000) presents in his article, group activities were specifically set up to expose the students to the following experiences:

- 1) Work as a team
- 2) Resolving conflict
- 3) Working for a client
- 4) Meeting deadlines
- 5) Conducting research

6) Presentation of reports

List compiled from (Welch, 2000)

This group of program experiences fit the mold presented by Goel (2005) in the ways that students learn from a well designed curriculum.

The outcome based projects chosen by the school offer real world, real time experiences teaching a student leadership skills. These projects allow the interdisciplinary groups to interact with clients while offering the full dynamic experience of the process of researching and constructing alternatives. In addition students play key roles in this endeavor, gaining invaluable experience. This experience instills in the student a satisfaction and accomplishment as each takes active roles in one of the service learning projects (Welch, 2000).

The characteristics found in the Eisenhower Program are globally recognized as meaningful components of any developmental program. As posed by McCall et al. (1988) many things are integral to an effective program, but for individuals and organizations a plan should accentuate characteristics which are opportunistic, individualistic, long term, self motivating, and on time. Opportunistically the Eisenhower Program has relevant worthwhile programs offering real world service learning. Individually each student on a team is able to offer his discipline's strength for a successful conclusion. Long term aspects are met by the diversified balance of over 115 projects in four years (Welch, 2000). Self motivation is attained because it is the primary responsibility of the team to offer real well thought solutions. The on time component is reflected in group solutions which are used by clients with good results generating a positive experience for the program. These projects replace simulation and provide the basis for the ultimate real world outcome based learning. The leadership styles of the students are a variable all members can look back as direct learning experience attributed to group dynamics.

Teachers as Leaders

The definition of a leader has been called by many an effective “Social Change Agent” (Welch, 2000). Teachers fit this role as a change agent and most present meaningful challenges to students for development of their leadership traits. This ability to recognize effective teaching in the leadership area of “Life Long Learning” provide the basic template for change required to create the authentic experiences used in the individuals increased adaptive capacity (Innes, 2004).

W.C. Howard (2005) posed in his article, “Leadership is the process of communicative verbal and non verbal that involves coaching, motivating, inspiring, directing/guiding and support counseling others (P. 2)”. Howard (2005) poses four characteristics presented by Warren Bennis that all group leaders have in common:

- 1) Direction and meaning
- 2) Generate trust
- 3) Prefer action and risk taking
- 4) Communication of hope

Leadership is a combination of many things but Howard (2005) presents the idea that an individual’s genetic makeup along with all experiential stimuli produces a skill set which every leader possesses. This skill set comes in many varieties which generate different styles of leadership (Howard, 2005). This combination of a basic capacity to learn with the environmental stimuli are both integral components found in the Bransford (1999) article on “How People Learn” and constructivist philosophy of education.

As Kenyon (1993) stated in his article, “The phrase education for the living of a life and earning of a living is not two processes, but are one single integral endeavor which should be an acknowledged goal of all engineer’s education”. The group experience used by the Eisenhower Program provides a very good example for tackling open ended questions for the synthesis of

viable solutions (Welch, 2000). The Lambert et al. (2006) article poses that the EC2000 outcome based criteria has the potential to be used in other professional and academic areas for enhancing life long learning.

Practical projects such as those found at Texas A&M offer an effective model for the development of engineering labs. The Grinter Report in the 1950's posed the importance of the labs in engineering education. Usage of an effective querying lab program has been determined to be very effective in the education of a student (Suits, 2004). Incorporation of engaging authentic labs has shown measurable results as compared to traditional labs which used a verification process of result determination. Verification exercises often lack the components needed for the development of critical thinking skills (DiBiase & Wagner, 2002). Incorporation of experiences which promote the querying components of science and the logical deduction of math will provide the student enriched experiences capable of generating new knowledge (Pang & Good, 2000).

Surveying Education

Surveying is an applied science with a vast history back to ancient times. Early surveys such as the layout and construction of ancient structures used crude equipment with tested methods for the times to achieve their end results. The pyramids surely define a well done job given the time and the technology available (Brock, 2006). The royal scribes were trained in the art of surveying utilizing the age old methods of an apprenticeship which historically was the way surveyors trained new people. This system has only recently been rearranged with the requirement of a college degree or course work being added to the new system of licensure (NCEES). This system of practical experience has become more pronounced as the presence of computers has shortened the time horizon on training. Employers can have personnel in the field in a matter of days trained in the basic operations of current equipment. These operations require

little thought usually resulting in major problems due to the lack of understanding surveying methods needed by a field person (Patterson, 2008) (personal communication). This disconnect is a result of an incomplete skill set. Theoretical training has been totally removed in many cases for preparing novice field personnel in the basics. This lack of understanding results because the methodology developed in many ways since the time of the Egyptians is missing. A basic understanding of the process of error propagation has been removed from the training paradigm (Estopinal, 2008) (personal communication).

“The historical role of higher education is on the brink of being compromised” (Burtch, 2005). The incorporation of digital technology has impacted all facets of life including surveying. Theoretical concepts used by surveyors for a long time have become subservient to new technologies as these new tools require considerably less basic methods and the education process becomes more of a training exercise. This process has led to the mindset that a college degree is unnecessary for this type of work because most graduates lack the technical skills required by the surveying profession. This shortsighted view has led to the thought, teach the mass to push the proper buttons to accomplish the needed services that the new technology offers without all the concepts one must acquire for a college degree. This rush to a quick fix has been tempered by the need to be able to think through some situations button pushing will not resolve. Surveying education needs to embrace the new technology carefully discarding menial concepts which are mere tedium. “Technology has a shorter life cycle than the typical college student’s tenure in a baccalaureate program” (Burtch, 2005). Traditionally, lab classes have supplied the practical component of the surveying curricula. Technology has presented many challenges to academics as to integrating the new equipment into the existing classes. Penn State has revamped basic courses by retaining the basic concepts and incorporating the new technology while maintaining an educative emphasis. Insightful incorporation of the new technology within the

effective instruction of basic concepts allows the instructor to maintain the learning process at an educative level. The ability to educate the student versus a technical training session is provided by effectively presenting the theoretical basics in ways the student can understand more than just results. Usage of revamped synchronized lecture lab projects presents the instructor a means to provide engaging, group activities which have been determined to be effective educative methods (Felus, 2007; Suits, 2004; Welch, 2000).

College level surveyor training is in a state of evolution given the immense introduction of electronics with digital equipment replacing many conventional types (Aramala, 2000). The practical field side is in need of a means to synchronize the new equipment with the required theory. Revamped theory needs to be offered when methods are radically changed such as the measuring of a distance with an Electronic Distance Measuring “EDM” device as opposed to a steel tape. Both methods of measuring a distance incorporate different levels of knowledge for the successful completion of this task. The lack of clarity as to good methods for each leads to the introduction of unintentional errors and mistakes (Estopinal, 2008) (personal communication). For example, extreme heat will elongate a steel tape blade by normal expansion while heat does affect distances electronically but in different ways such as the sighting of a prism through heat waves (Crawford, 2003). Technological advancements require users to be knowledgeable in multiple areas. The inability of instructors to effectively teach students is often times traceable to the academics limited perception of how these new computer based offerings are needed in classrooms today (Hatipkarasulu, Liggett, & Padilla, 2008). Academics must effectively include these new technologies with related methods to effectively teach students. Generated lab experiences must be dynamic and realistic in scope with the required pedagogical components which promote learning (Felus, 2007).

Technology has affected the surveying profession in the same fashion as most other areas using digital type equipment causing a metamorphosis of traditional methods. Equipment available today has caused both surveyors and survey educators to rethink many aspects of preparing new personnel for this profession (Greenfeld & Potts, 2008). Equipment manufacturers have to be involved in any transition surveying makes to incorporate this new technology positively. California State Polytechnic University Pomona's "Mapping and Science Center of Excellence" has established a venture with Trimble Instrument Co. and Intergraph. This group of academia and business has installed 200 computers and 23 Image stations from 1996 – 2000 resulting in some significant changes in the curriculum at the university (Turner & Neto, 2000).

This relationship of business and academia is one which has both positive and negative aspects. Looking solely at the possibility of using cutting edge technology is necessary for most current instruction but limits must be considered pertaining to availability of instructors and the degree of independence academia must relinquish in this endeavor. Regional consideration must be recognized for course content and objectives. Evaluation of needs must look to local industry and government for specific areas of current demand. Local surveyors should also be included in development of successful courses due to their ability to identify trends based on immediate and future projects. Emphasis needs to be placed on these multiple connections so important information is factored into decisions regarding curriculum and course content (Turner & Neto, 2000). Change occurs faster than academia can incorporate into the curricula. Recognition of this situation has generated the term "professors of practice" (National Science Board, 2007). The idea of professionals instructing practical areas which are changing faster than the traditional paradigm can handle. This idea has many potential benefits and appears to be gaining acceptance as a possible solution (Ghilani, 2000; McNair, et al., 2007; National Science Board, 2007).

The current curriculum must be evaluated in ways to bridge this major advance in equipment (Aramala, 2000). Academia must embrace industry in ways to enhance courses in a synchronized manner incorporating change to create experiences which provide the most impact. Organizations such as the Geomatics Industry Association of America “GIAA” can provide the latest in technology and information the Instrument Industry offers for the incorporation of new technology in a planned manner. Measurement of basic variables such as angle, distance, and elevation must be considered in the same way regardless of technology (Ellingson, 2006). Office and field methods have maintained a static pedagogy as the basic measurement variable when considering things such as accuracy, precision and tolerance (Ellingson, 2006). Computers and software advances require revision in training so the office and field can incorporate the newer methods. Industry leaders provide the professional experience academics often lack in the generation of new ideas for the effective introduction of this new technology (Estopinal, 2008) (personal communication) (Patterson, 2008) (personal communication). Traditional labs have presented the practical side of surveying in academic settings. Labs for a long time were fairly static in their makeup due to small changes in equipment and methods until the introduction of the new technologies.

Surveyors such as David Patterson and Steven Estopinal, both past presidents of the Louisiana Surveyors Association, have vast experience in all facets of surveying. Interviews with both have generated a need for the solid presentation of basic measurement principles as foundation for any curriculum tied to the major areas of surveying (Estopinal, 2008) (personal communication) (Patterson, 2008) (personal communication). Recognition of these basic measurement variables (angles, distance and elevation) with office and field components provides a grouping of five concepts which are building blocks for any pedagogical offering. These core concepts are also found in many of the elementary surveying books used by college

instructors including Wesley Crawford's book "Construction Surveying and Layout" 3rd edition. The Penn State model developed by Naberezny and Ghilani (2005) was improvised to incorporate the new pedagogical ideas of groups and querying experiences. The new plan was also designed to keep the basic concepts due to the importance of understanding foundational ideas for the development of new knowledge (Naberezny & Ghilani, 2005).

Construction Surveying is one of the major areas of surveying as defined by National Council of Examiners for Engineering and Surveying "NCEES". Dimensional control and spatial relationships are two attributes which highlight construction surveying and layout. Structures require that two dimensional plans designed by engineers be built to their exact three dimensional finished forms (Crawford, 2003). The vast number of component parts found in most construction projects must be placed in their correct position dimensionally. Each part has a designed spatial relationship to other components which field engineers must meet to get a project done. Usage of equipment (practical knowledge) and the ability to read and interpret plans (theoretical knowledge) bring these two collaborative features into "transactional realism" described in the constructivist philosophy of education (Innes, 2004). David Patterson (2008) remarked in his interview the importance of understanding the construction process and being able to use the latest surveying equipment for construction. The generation of authentic experiences from multiple contexts has proven to be more efficient in the transfer of desired informational content from an instructional standpoint (Beliveau & Peter, 2002).

Surveying is one of the main areas tested on the American Council for Construction Education "ACCE" certification test (American Institute of Constructors Constructor Certification Commission, 2005). The incorporation of surveying as a primary area of consideration in construction education requires a pedagogical model be designed for a basic course. This basic class provides information used for advanced layout classes and other

construction courses such as highway construction. The availability of instructors, university resources and industry assistance are major considerations in the style of class offered. Some universities offer very basic courses while others can create advanced classes, all being defined by the availability of resources. Nationally construction management programs like Purdue have a very robust construction surveying program due to the presence of Wesley Crawford, author of Construction Surveying text, while the surveying department at Purdue has been combined within the Civil Engineering department due to diminished resources and students. A national shortage of instructors and courses has brought about many ideas to address the need for surveyors (Gibson, 2007). This shortage of personnel has been noted by construction companies in their search for trained layout people (Patterson, 2008) (personal communication). Paul Holley, Auburn University, has developed a digital textbook used by some Construction Surveying classes. This unique way of teaching basic operations offers a new means to present this course (Holley, 2005). Discussion with Steve Estopinal (2008) (personal communication) shed light on the importance of basic surveying which he extensively covers in his text book "A Guide to Understanding Land Surveys". The traditional college lab in the area of applied science has used the separated lecture lab format. Hybrid formats which integrate the lecture and lab together to determine whether a measurable difference can be recognized have been utilized in the area of chemistry by Warren DiBiase (2002) and physics by Terrence Overlook have exhibited insightful differences. Dibiase's classes had measurable differences when the lab lecture was integrated as compared to a traditional format (DiBiase & Wagner, 2002).

Surveying is a unique discipline playing an important role for the delivery of finished projects. Construction management courses are robust in preparing students for the process of understanding and being capable to make decisions on jobsites (Beliveau & Peter, 2002). This

foundational pedagogy can be utilized by surveying in ways differently than a natural series of courses dovetailing each other.

The surveying class should be considered foundational from the standpoint that services provided by field engineers prepare a site for design layout with initial primary control points. These primary control points provide the layout person the ability to maintain a project's progression to its completed dimensions accurately from the initial site survey to the exiting punch list. The pedagogy of a construction student must build foundations and generate an understanding of the process as it flows from inception to completion. Surveying requires a thorough understanding of mathematics, trigonometry, and the construction work flow (Genovese, 2007). The position in the curriculum most construction schools place surveying is in the sophomore or junior year where a student's aptitude is capable to incorporate this information into the overall curriculum. S. Estopinal (2008) (personal communication), D. Patterson (2008) (personal communication) and L. Budden (2008) (electronic communication), previous president's of the Louisiana Surveyors Society, all concurred as to the makeup of the construction surveying course for instructing construction students as well as the planned assessments ability to gauge their basic knowledge.

The ACCE (American Council on Construction Education) certification test should be used as a template for designing most assessment instruments needed in studies for gauging achievement on studies tied to learning in the construction management realm. Surveying is one of the main areas tested in the certification test and could be used as a template for generation of an assessment tool for measuring learning such as in the construction surveying area. This assessment will gauge the skill set for the area tested such as the area of basic surveying. The skill set for an elementary understanding of construction surveying needs to be presented in a manner so all facets of construction can be covered by the basic pedagogical paradigm.

Discussions with both interviewees S. Estopinal (2008) (personal communication) and D. Patterson (2008) (personal communication) along with an in depth review of construction survey books by Wesley Crawford, “Construction Surveying and Layout 3rd Edition”, and Barry Kavanaugh, “Surveying with Construction Application 6th Edition”, present a group of conceptual basic areas of information. Students must understand these basic concepts for a successful completion of the advanced sections of these books. These concepts should be considered as foundational concepts encompassing the field surveying associated with construction. Angles, distances and elevations are three basic variables which can be described as the positional components of defining the spatial relationships of points and lines. These three concepts can be viewed as components on the practical side of construction while the planning and design of these points and their placement can be correlated with field methods and office practices which must be performed prior to any point placement. The field and office concepts provide the abstract side of the construction equation. This transactional relationship (constructivist mindset) is used by the construction surveyor to generate the experience, as posed by John Dewey, for constructors to deliver the finished product which is a completed construction project (Innes, 2004). David Patterson (2008) (personal communication) conveyed the importance to the end user from both an office person (cad operator) and a field person (layout person) perspective as to the need of a thorough understanding of the basic concepts for effectively performing their jobs. Steve Estopinal (2008) (personal communication) commented on the critical thinking needed to understand the theory of these areas and the ability to adapt to the practical portions of these concepts. The knowledge found in these five areas must be understood fully by all students for the required increase in adaptive capacity to move an individual’s knowledge beyond the basic introductory material to the more advanced application portion of learning. The utilization of this growth as posed by John Dewey allows the individual

to further his education experience as he constructs his expertise incorporating new knowledge into his skill set (Innes, 2004). This dialectical transaction is what can be considered a life long learning experience.

Curriculums offered by college departments where surveying is the major emphasis have had to take thorough evaluations of resources for course development due to the dual need of educating and recruiting (Crossfield, 2005). This focus has elicited variables previously overlooked as to methods of instructing students in surveying. Student enrollments in most departments such as Purdue's geomatics have declined resulting in cutbacks or merging with related areas such as civil engineering. These reductions have further required some innovative instruction such as distance education classes similar to ones offered by East Tennessee State University "ETSU" (Ali, Nave, & Clark, 2005; Clark, 2004). The surveying department at "ETSU" has offered web based and web enhanced courses. The requirement of a practical component to most surveying classes has generated a hybrid grouping of classes noted as web enhanced due to the student's mandatory attendance for lab classes. This diversity in curriculum along with diversity in student body challenge universities to generate new ideas for ways to educate. Distance education is a natural offering for the non traditional student. Effective classes will increase the prospects of this group being incorporated more into the university as well as the surveying profession. The challenge of distance education classes requiring lab classes poses unique issues as to the presentation of critical practical components. Traditional lectures are easily handled through the resources offered by the internet for the variety of web based curricula currently offered. The practical components of a collaborative lecture lab class require students to spend time in a context conducive to presentation of the curricula's authentic experiences. Comparison of the two methods used in this project will provide insightful information as to the effects of separating or integrating the lecture and lab components.

Nontraditional students are another pool of potential surveyors requiring serious consideration to address this human capital shortfall. Andragogy, the education of adults, must be looked at uniquely due to the various genders, cultural and differences posed by this pool of recruits. “Nontraditional students may not be best served through traditional pedagogies” (Wurm, 2005). Programs designed to reach these adult students must encompass an equitable learning environment along with an effective learning environment (Smolka, 2002; Zheng, 2005). These students must be included in the development of effective routines. Special needs can only be fully incorporated into nontraditional curriculums with a current needs analysis generated by that segment. Educators who proactively solicit the special needs of this pool of students are more likely to deliver a meaningful learning experience. Adult students are usually more autonomous and self directed resulting in an educator being more of a facilitator as opposed to directed learning. Further research must be done to better determine the typical student’s characteristics which will assist in defining the best mix of methods to teach this special segment of individuals (Wurm, 2005).

The internet provides an outlet to provide the nontraditional students an innovative way to be instructed. This method of long distance education provides a challenging environment for the delivery of a college course. Since Penn State’s initial offering many colleges have succeeded in generating a learning experience using computers and the internet. In 1998 Penn State offered a course called “Surveying Measuring Analysis”. This course covered the traditional time period of 15 weeks, with materials developed for the entire course to be completed at home. Due to many surveying classes requiring numerous manipulative presentations (labs) a course of this type can prove to be a challenge. Instructors have many more working schemes provided today than 10 years ago but because many nontraditional students have full time jobs innovativeness are required to deliver courses to address special needs. Surveys of student assessments can give

universities the needed information to better prepare these courses over time. The evolution of this medium will continue to take a very prominent role in the academic world. This expanded use of the internet must be used in a proactive positive manner for the delivery of instructing and teaching. Surveying is a technologically expanding area so change should be welcomed as both a necessity and opportunity (Clark, 2004; Ghilani, 2000).

Construction Management Education

Construction surveying provides a good template for most construction management courses due to its broad application as an applied science. The construction curriculum usually is a collaborative mix of theory and practical components with different percentage compositions. This collaborative mix provides the constructivist philosophy of education a variety of courses to experiment using different pedagogical ideas for determining the best learning situation. The usage of prominent surveyors and academics for generation of both instructional material and assessment tools will provide a multidiscipline view for the generation of new pedagogical ideas. This valuable interdisciplinary insight has been noted a valuable tool in the teaching process (Bransford, et al., 1999). Determination of the more viable means to complete the transaction of the theory and practical for the generation of new knowledge, noted by Dewey as an increase in adaptive capacity, will be of major importance in the development of the evolving pedagogy in this relatively new area of college curricula (Innes, 2004). Usage of new media such as the digital text book developed by Paul Holley (Holley, 2005) for teaching basic surveying represents a new way to connect with students. If studies show these media are more efficient than traditional classes, they should be considered for usage in similar types of disciplines. The critical thing to keep in mind for development of these new ideas is that authentic practical applications must be challenging and motivating (Lowe, et al., 2008).

Instructional methods are being impacted by new technology continually (Aramala, 2000). New ways must be found to incorporate this technology for the creation of meaningful lectures and labs (Felus, 2007). Digital media presents opportunities to connect with the current generation of students on a level they understand (Hatipkarasulu, et al., 2008). As posed by Hatipkarasulu (2008), instructors must utilize new technology to complete the transaction with students for the creation of an effective class. Technology advances require instructional methods capable of adapting to change while maintaining an engaging context for motivating students with prepared practical activities (Felus, 2007). The prepared activities must use technology in ways to challenge students to use their math and science skills for evaluating authentic experiences (Suits, 2004; Van de Walle, 1999). These arranged experiences should foster groups and individuals to analyze the experience for further processing. This synthesis process generates the new knowledge for deeper understanding of the learning experience. The mathematical skill of logical deduction will give students the ability to recognize patterns of usable information while science's empirical induction will cause an exploratory investigation of recognized observations. The investigations using math and science seek consistency from different directions (McDuffie & Graeber, 2003) but the added effect of their integration for exploring give a student a more in-depth view of the recorded observations (Pang & Good, 2000). The increased understanding generates the ideas which Dewey has referred to as the tools used to construct new knowledge. This increased knowledge provides students with the adaptive capacity for enhanced skill sets with life long learning (Innes, 2004). Construction surveying is an area offering a vast area of instructional manipulation for researching alternatives for determination of the best ideas. The collaborative components, theory and practical, have been taught in different ways with little research done to determine any differences (Slattery, 2009) (electronic communication). Dianne Slattery has presented construction surveying in the

traditional format with separated lecture and lab classes as well as an integrated format similar in design to the treatment posed in this project with related lecture and lab material being presented during the same class.

Construction surveying is an area composed of math and science which can utilize the exploratory skills found in each for the generation of unique ideas (Williamson, 2008; Wilson, et al., 1993). These constructed ideas will offer the student an enhanced ability to evaluate the authentic activity for a deeper understanding of immediate situations as well as related construction activities. The five concepts posed as building blocks in the area of surveying should be presented in different contexts of the authentic activities so the student can perform an iterative analysis for the formation of an expert evaluation. Participative and recursive patterns of analysis will develop the experiential spiral of knowledge posed in Beliveau and Peter (2002) and enhanced understanding found in Bloom's Taxonomy (Lee, 1999).

Courses can provide many ways of presenting information such as lecture, power point presentation and group projects. These offerings must try to incorporate ways to provoke thought and further synthesis of material presented. This synthesis can be promoted by discussion during or upon completion of activities which increases the understanding of the importance of presented material (Lee, 1999). Designs of many classes offer the instructor a means to control the reflective process. The separation or integration of collaborative components such as lecture and labs present the student with a different reflective experience. The synthesis process can also be accomplished through the usage of a journal. By journaling a student is capable of recalling the more enlightening things posed in a class activity (Walker, 2006). Journals come in various forms as students log the important ideas or empirical information which has occurred with an experience. The reflection process is important because it promotes the transactional exchange needed in an experience for generating the growth in understanding needed for construction of

new knowledge (Beliveau & Peter, 2002). The field book used by surveyors is an example of a journal which can be utilized in a curriculum for reflection of activities after the activity has occurred. Students can mentally reflect on the activity if notes are kept in a format easy to understand. For an activity to offer both logging and intuitive reflection, instructors must place sufficient time in the design of an experience. The sought experience should be a scaffolding one building on prior ones while also offering an increase in the skill set (Innes, 2004).

Construction surveying offers a means to reflect on the work and activities recorded in the journal. Journal writing has been shown to be a very effective means of instruction, providing students the analysis synthesis process found in Bloom's Taxonomy. The usage of a journal during an activity has been called "reflection in action" by S. Walker (2006) in her article dealing with journals and athletic training. This reflection in action furthers the synthesis needed in the process of creating new knowledge for heightened levels of understanding (Lee, 1999). The field book (journal) used in most surveying lab classes provides the student a document with personal notes of each lab activity. This journal is the tool students should use for individual reflection on their experiences (Naberezny & Ghilani, 2005).

The constructivist view posed by Beliveau and Peter (2002) describes the needed pedagogical changes required in construction management classes. These changes can be correlated to the philosophy by John Dewey through the usage of an iterative recursive authentic experience for building new capacity on existing knowledge (Beliveau & Peter, 2002). This planned spiral of education is one which follows the Bloom's Taxonomy of taking existing basic knowledge, enhancing it with additional information through a transactional realistic activity for usage as a building block for new knowledge. The increased adaptive capacity gives students a larger perception of an experience resulting in what Dewey calls "growth" while Bloom's denotes this as increased evaluation abilities (Innes, 2004).

Construction Management education is very diverse due to the many disciplines which participate in a project during its production (Holley & Dagg, 2005; Kay, 2003; Ryan & Callahan, 2007). This diversity in scope requires responsible parties for each phase of a project be capable of both planning and anticipating issues during the entire experience (construction project). The ability to anticipate unknowns in the context of an active jobsite requires a very high level of understanding often called expertise (Beliveau & Peter, 2002). The level of learning required for attaining this expertise is usually not found in college level curriculum given the scope of limited resources or instructors abilities (Bransford, et al., 1999; Goel, 2005). This increased level of experience required by instructors demands the development of teaching strategies which challenge students, raising their level of inquiry so they can think critically when the need arises (Lee, 1999)..

Recognition of this level of learning places a demand on the instructor to have a detailed understanding of many processes not covered in textbooks. This extra input must be derived from the impacted industries such as construction for a thorough picture of the activity being presented (McCuen, 2007) (Patterson, 2008) (personal communication). The incorporation of specific information unavailable to academia on a real time basis creates a more authentic timely experience. Instructors must be careful that the information being utilized is of value. The real value of information is that it can be incorporated in the educative experience in such a way as to enhance a student's skill set (Lee, 1999). Designed experiences require instructors be versed in both domain and educative knowledge (Dancy & Beichner, 2002). The need for both areas is due to each domain experience being presented in a proven pedagogical context.

The need for a timely incorporation of information, theoretical or practical, requires some mode of synchronization for maintenance of basic information critical to the synthesis of new knowledge. Massive quantities of information are being generated today with varying degrees of

usage. Usage needs to be assessed as to its fit into a curriculum's design in ways to enhance a students' understanding of the material being offered. This decision of importance is made by an instructor based on his understandings and perceptions of the information being offered. The examples instructors create sometimes incorporate concepts or equipment requiring more expertise or time available for a realistic experience (Clark, 2004). These resources usually are readily available by an impacted industry such as construction eager to enhance a potential employee's skill set (Chapin, et al., 2003). Impacted industries organizations such as CIAC (Construction Industry Advisory Council) found in Baton Rouge work with academics for the development of a robust curriculum. These offerings help fill the gap in resources academia must overcome (Bransford, et al., 1999; McNair, et al., 2007). Industry plays a dual role in impacting a construction management surveying class. The construction industry demands a finished product, i.e., a learned student while the instrument companies offer new solutions to old problems. This new equipment has been embraced by construction companies resulting in academia's need to incorporate change in a meaningful manner (Aramala, 2000). David Patterson (2008) (personal communication) commented in his interview that the basics must be known thoroughly before the newer technology can be used efficiently (Williams & Liu, 2003). Efficiency, accuracy, and ease of operation are some of the leading reasons for contractors to incorporate this expensive equipment into their inventory of tools. On the other hand schools must maintain a revolving offering of equipment which Burtch (2005) noted changes quicker than an undergraduate's term in school. The evolution and cost must be considered by most colleges in ways to both enhance a student's skill set with a set group of equipment. A symbiotic relationship between the stakeholders, industry and academia, must be developed so this expensive equipment with its related technology will be presented to instructors in ways that realistic authentic experiences can be created for the student (Schultz, 2007). The new

technology generates new or improvised methods to handle new practical applications. Theory must be modified to address the new applications while lab exercises must be designed to incorporate revisions to the theoretical information or practical operations which provide the framework for an instructional experience.

The concepts presented in the surveying section angles, distance, elevation, office and field are being modified continually due to changes in technology and software. These concepts, as posed in responses from S. Estopinal (2008) (personal communication) and D. Patterson (2008) (personal communication) must be understood from a basic perspective for newer advanced information to be successfully incorporated into skill sets with minimal problems. Change will continue and a system must be developed which allows for a synchronized inclusion of relevant new information useful for the training of students. For this to occur efficiently, all stakeholders must recognize the meaningful change leading to the coordinated creation of contexts assisting in needed transitions. The construction management stakeholders include the construction industry, academia and equipment manufacturers need to strategically embrace a coordinated solution for a new pedagogy. The ability to recognize the more authentic engaging experiences along with the commitment to furnish the needed resources should generate the desired results (Innes, 2004).

Academic disciplines must pursue pedagogies that work in their own area of expertise. As Branford (1999) showed in his article “How We Learn,” Mathematics, Science and History must tailor specific models for effective learning to be realized. The same is true for the relatively new area of Construction Management. Drawing off both business and engineering curriculum, this unique applied science must develop its own academic curriculum paradigm for an effective student learning experience (Beliveau & Peter, 2002). As presented by Beliveau and Peter (2002), the constructivist model posed by Dewey has many features which can be molded

to fit most CM programs. Each program and class will have their own culture based on the diversity of the student body and faculty but generated patterns of learning will work for most (Gunderson, Moore, & Adams, 2006). The learning equation by Beliveau and Peter (2002) is an iterative spiral of experience which dovetails into one another each adding to the preceding experience. This building process as shown by Lee (1999) provides revision in curriculum and instruction as instructors reorganize some course materials to fit the constructivist philosophy. This creation involves a cultural component on the part of academics which must be changed for the effects of a redesigned course to take hold. By using the applied science aspects of construction, instructors can determine the minimal course theory needed for incorporating the practical application required for each concept presented. The synchronization of theory and practical will allow students to be on the front side of things knowing the answers and contemplating the more likely questions (Beliveau & Peter, 2002). This understanding of the probabilities of the anticipated situations will allow for a higher order of learning. This higher order of understanding has been noted by Dewey as an increase in adaptive capacity (Innes, 2004).

Generation of an authentic practical experience which students want to participate in has proven to be effective teaching tools (Felus, 2007; Suits, 2004). Knowledge constructed from these experiences must provide the transaction between the basic theories along with an engaging practical exercise. The construction surveying student must be presented a basic set of concepts from a theoretical point and then an engaging related practical application which generates an analysis for the synthesis of an individual's knowledge (Lee, 1999). The amount of synthesis a group of students generates is related to the experience (Bransford, et al., 1999). The experience can be presented to the class in different arrangements of the abstract and objective components. These different arrangements of practical and theoretical instruction may have

different impacts on students as to the generation or construction of new knowledge (Beliveau & Peter, 2002).

The basic concepts of surveying, angle, distance, elevation, office and field can be instructed from a theory and practical component. The practical component can be further divided into introductory and basic application components. This division of the practical offers a unique area of study as to the instruction of an applied science such as construction surveying (Suits, 2004). The ability to separate these abstract and objective components allows for the study of what impact might be generated in student's achievement based on different methods of instruction. Two methods which could be used for this type of experiment may be structured like the following alternatives. Method one would be a hybrid consisting of part theory and practical instruction components on the same day while method two would be a separated theory and practical instructional components presented on different days (Comparative method can be found in the appendix section). The same material would be covered in both methods over a two day period. The difference would be the pattern in which it was presented to the student. Following the instruction of all proposed material an achievement test would be given to determine the scores of students receiving the 2 different treatments. These scores would be compared using statistical procedures with SPSS for determination of each methods impact on the dependent variable student achievement.

The traditional style applied science lab has resulted from the normal arrangement of large lecture classes being instructed by established academics while labs are handled by graduate assistants. This culture of large classes with smaller labs has been used extensively with little modification (McDuffie & Graeber, 2003). T. Overlook (1994) and W. DiBiase (2002) have researched classes with realigned instructional composition of the lecture and lab components. Results in DiBiase's (2002) study of chemistry classes which compared the

traditional split lecture lab versus an integrated course determined that students in the integrated class with more querying activities scored better on tested material. T. Overlook's (1994) results determined that the scores achieved in both the traditional and integrated class were very similar with no measurable difference. Qualitative comments by Overlook (1994) noted that students in the integrated class had more insightful discussions but no further investigation was noted.

Future Learning Challenges and Opportunities

Constructivism and John Dewey's ideas on education have been used by many academics for the generation of many pragmatic models similar in composition as to constructing knowledge through active learning experiences (Goel, 2005). These models utilize the more prominent experiences within each discipline for the generation of a series of authentic exercises for generating cutting edge curricula. The outcome based criteria generated by ABET called EC2000 are grounded in an active group model fostering an increased awareness in the student relative to each arranged activity (Lambert, et al., 2006). The student centric format promoted by many current academic communities such as "Scholarship of Teaching and Learning" SOTL is a very different mode of teaching when compared to the age old lecture method used by most college instructors (Goel, 2005). Polled graduates by Goel (2005) and Volkwein (2006) both have rated the lecture mode as being archaic and not very useful in the learning cycle. Goel (2005) presents the comment of Hamilton Holt president of Rollins College when he stated his undergraduate experience was a waste of time pertaining to learning. Holt portrayed a lecture as being an activity of words being transferred onto a notebook with no analysis or synthesis occurring from this process of transcription (Goel, 2005).

Academia is clustered with many models similar to SOTL used by universities around the country as a focused attempt to increase learning in the classroom through a redesigned pedagogy (Goel, 2005). This pedagogy as presented in prior sections must incorporate pragmatic

authentic activities using the process of Bloom's Taxonomy (Lee, 1999) to raise an individual's present knowledge to a stage of evaluative understanding. This dialectical process can be correlated to Beliveau and Peter's (2004) "Experiential Spiral" needed for the construction management curricula. B. Matthews (2004) utilized the scheme of Problem Based Learning "PBL" for the presentation of his graphics course. This mode of instruction has many factors found in the constructivist school of thought through the usage of active learning exercises presented in a meaningful manner (Matthews, 2004). In Matthews (2004) he poses a pedagogical technique referred to as the "Osterman Feedback" which utilizes an interactive segmented lecture which causes students to reflect on presented problems (Matthews, 2004).

As noted by Goel (2005) many attempts at this pedagogical redesign have missed the point of generating alternative curriculums. Academics are very resistant to change and as presented by Goel (2005) academic institutions are very conservative in many ways to embracing new ideas. These ideas as Dewey posed are the tools which must be used to foster the increased adaptive capacity required for an evolution of the process of learning (Innes, 2004). Alternative means of education available to each discipline along with skepticism on academia's part make change hard. Each discipline has differing characteristics requiring varied curricula to generate the adaptive capacity sought by new pedagogies for educating the student. The applied science makeup of construction and surveying make these two areas a challenge for some alternatives such as asynchronous distance education. Distance education classes have incorporated lecture classes into the new formats while practical lectures have had mixed results (Clark, 2004).

Distance education is an area of teaching having a wide range of uses in the context of a virtual classroom (Clark, 2004; Schultz, 2007). This virtual classroom has been offered as a solution to the reduced number of instructors available to the surveying sections of colleges

(Schultz, 2007). This shortage is the result of only four universities in the United States offering PhD's in surveying. Shortages of instructors have resulted as both two year and four year schools are offering more surveying courses in the applied science curriculums (Crossfield, 2005). The distance education proposal is enticing but results from East Tennessee State University "ETSU" show that students using web enhanced classes in an applied area like surveying have lower scores than traditional classes. This has been attributed to a lack of understanding resulting from activities involving lecture or an in class activity which are presented differently in asynchronous classes. ETSU has instituted an evaluative project to assess the comparison of a web only and web enhanced classes. A study by Zheng (2005) compares three modes of study: conventional lectures, FEEDS (Florida Engineering Education Delivery System) a hybrid web type class and WebCT generating a myriad of results posing many of the inherent challenges of distance education. Web enhanced classes offered by WEB CT, the world's leading provider of e-learning solutions proved to be the most versatile mode of instruction. This web enhanced class is vital as a source for life long learning needed by most students and professionals in the construction industry due to the logistics of their employment (Zheng, 2005). Noting an increased activity in her study Zheng (2005) doesn't pose the makeup of the group or the makeup of class demographics. The class composition may be a group of dedicated students with more ability or desire to succeed and the noted increase in the class may be due to the makeup as opposed to the instructional medium. Distance education has become a widely used means to reach students. The virtual classroom has been effective when replacing classes in which lecture is the main mode of teaching. Collaborative courses such as applied sciences with a theoretical and practical composition must be monitored closely to determine whether the nontraditional distance course has emulated the traditional course. ABET has approved curricula based on dictated outcomes in their student's performances but methods used to reach these outcomes have not been scrutinized

(Crossfield, 2005). The outcome based learning is important but the individual courses have not been evaluated (Clark, 2004).

Recognition of the new modes of learning must be studied individually considering all context variables used in the transfer designs of these distance education models. The redevelopment of accredited engineering schools with their new pedagogical models must avoid the cloning of learning recognized by ABET in the early 1990's. Identified deficiencies by ABET led to the generation of EC2000 (Kenyon, 1993). So any rush to embrace new paradigms should be closely investigated prior to their incorporation into existing curricula. The resulting new accreditation for outcome based learning has oversight groups such as ABET and ACCE on guard against a complacent attitude to embrace all models worthy for consideration. The multidisciplinary recognition of the undergraduate education shortcomings by many academics, employers and graduates have set numerous queries in motion resulting in EC2000 (Lattuca, et al., 2006), How People Learn (Bransford, et al., 1999) and the Boyer commission report (Kenny, 1998) all indicating a major change must be devised for most college programs.

The National Science Foundation "NSF" has promoted research in areas for addressing many issues of learning confronting the nation. The study by Bransford (1998) "How We Learn" confirms many fears that the incorporation of change for creating a meaningful experience for students which successfully transfers newly generated knowledge for a deeper understanding is not easily done by many academics (Lee, 1999). NSF has requested many areas of research to meet the current needs such as Innovative Engineering Education and Curriculum Infrastructure "IEECI" (NSF, 2008). This program fosters the study of enhancing ways in teaching and learning in the area of engineering. Two recent awards reflect some of the current research being studied for enhancing the learning experience for students. Purdue University was awarded a grant to determine the effects of a "HPL" How People Learn" trained graduate teaching assistant

“GTA” compared to a “Non HPL” graduate assistant (Cox & Diefes-Dux, 2007). This study will confirm the effectiveness of the training a “GTA” in a certain way for its impact on undergraduate curriculum. Virginia Tech was awarded a grant for the investigation of an interdisciplinary study combining industry, academia and students to increase learning through a group experience (McNair, et al., 2007).

Academic disciplines must pursue pedagogies that work in their individual areas. As Branford posed In “How We Learn” (1998) mathematics, science and history must tailor specific models for effective learning to be realized. The same is true for the relatively new area of construction management “CM”. Drawing from both business and engineering disciplines this unique applied science must develop its own academic paradigm so effective student experiences can be designed for each course in this curriculum (Beliveau & Peter, 2002). As presented by Beliveau and Peter (2002), the constructivist model associated with Dewey has many features which can be molded to fit most “CM” programs. Each “CM” program and individual class will have their own culture based on the diversity of the student body and faculty. This diversity will impact learning pedagogies but patterns will develop which need to be investigated for the ability to use positive ideas while avoiding the obvious negative systems. The learning equation presented by Beliveau and Peter (2002) is an interactive spiral of experiences which dovetail into one another each adding to the preceding experience. This process is intuitively correlational to the taxonomy tools as presented by Lee (1999) in the usage of Bloom’s Taxonomy for creating an effective constructivist experience.

Learning will continue to evolve as changes in educational and societal systems are impacted by computers and technology. These technological advances offer the varied science (pure, applied and soft) different modes of educating a class (Walker, 2006; Zheng, 2005). The curricula developed will allow educators to fabricate their own classes from the available

models. Hybrid forms of all philosophies such as the constructivist philosophy by Dewey have been altered and fashioned in ways to challenge the student and increase his adaptive capacity (Innes, 2004). This process will continue as instructors focused on teaching, utilizing the ideas such as Bloom's taxonomy to produce courses which will challenge students in ways to motivate and educate (Bransford, et al., 1999). Incorporation of insightful ideas into redesigning the traditional lab offers a vast area for researchers such as DiBiase (2002), Overlook (1994) and Matthews (2004) to determine how learning can be increased by improvising the standard college lab.

Education has evolved through many different philosophies during mankind's history. From Plato's generation of ideas which were dialectically added to by his students (Ozmon & Craver, 2003) to Dewey and the current pragmatic view of realistic experiences, being created by a transactional exchange between the abstract and concrete components, new ideas will continue to emerge (Innes, 2004). This movement of change has been recognized by many and corollaries can be fashioned such as the model presented by Bransford et al. (1999). This pattern was also used by the Boyer commission in the generation of a model by Illinois State University's involvement in the Carnegie Academy for the Scholarship of Teaching and Learning "CASTL" (Gentry, 2009) and other scholars in the design of "SOTL". This report promotes change in the undergraduate instruction seeking new pedagogies in each academic discipline for the fostering of increased learning (Goel, 2005). This push noted in many "NSF" requests for proposals has a focused goal of generating best practice for instruction (Kemnitzer, 2008). Instructional methods being researched by NSF grantees may provide insightful ideas other academics might use to create meaningful experiences. This same push for a multidisciplinary view of things has been used successfully by the Eisenhower School of Leadership at Texas A&M for the generation of positive group experiences (Welch, 2000).

The collaborative components of a surveying class offer a good example to generate a system of change which continues to address the defined basic needs. The realm of surveying has nine defined major areas as posed by The National Council of Examiners for Engineering and Surveying “NCEES” (NCEES). These areas all build off a basic group of variables or elementary constructs for the generation of a spiraling educational experience similar to one presented by Beliveau and Peter (2002) in their view of education in the construction management area. Identification of these basic building blocks which are more resistant to change provides instructors the required basics for presentation of many courses. Interviews with D. Patterson (2008) (personal communication) and S. Estopinal (2008) (personal communication) confirmed the areas of angle, elevation, distance, office, and field as needed areas of instruction for an elementary construction surveying class. Textbooks by Kavanaugh (2007) and Crawford (2004) along with P. Holley’s digital text (2005) all present these areas in their introductory chapters.

The evolution of surveying equipment creates a major resource issue for many colleges (Clark, 2004). As Aramala (2000) presented in his paper construction schools must offer the latest technology because construction companies embrace change which offers cost savings with increased accuracy. This evolution will continue and a viable system needs to be developed which addresses the need for the new equipment along with an instructor’s ability to create classes which effectively challenge the students with authentic experiences for learning. The need for equipment can be addressed by industry helping with offering equipment in ways that academics can use to create authentic practical exercises without bearing the direct expense of expensive equipment with limited life cycles. The other consideration is to make sure that instructors have an effective handle on needed basic concepts and a way to learn the new methods for a current pragmatic knowledge base. Academics must recognize the required informational concepts needed for developing authentic experiences while maintaining a current

proactive focus on technology to effectively introduce new equipment and methods. Burch (2005) presented in his paper that technology is developing at such a rapid pace equipment becomes obsolete before an undergraduate graduates.

This equipment evolution entails new technology requiring new instructions. Measuring distances can be accomplished through the use of tapes, total stations and GPS which all do the same thing but each requires different evaluative and application phases. The evaluative phase necessitates the student determine what level of accuracy is needed while the application phase determines which tool gives the best results along with some basic instructions. New ideas must be pursued to incorporate applications entailing both an operational instruction of the practical operation and a theoretical understanding of the actual measuring being performed, as to the three dimensional concepts angle, distance and elevation. This meshing of the theory and practical is an example of the transactional relationship posed in the constructivist paradigm (Innes, 2004). The survey class provides a prototype of collaborative components which could encompass some of the proposed pedagogical changes into a scheme which could be noted as “Synchronized Change”. The synchronized change will allow the metamorphosis of a concepts theoretical information as the practical is under a continual degree of change as technologies build new equipment. This nontraditional usage of a scheduled change can be compared to the usage of a new media in the constructivist realm that being a video such as the digital textbook (Holley, 2005). Usage of video will allow for students to be presented theoretical, lecture material, in ways other than power point or text books. Traditional labs may have the correct balance of time and method of presentation for current material but instructors must be aware of change to keep the activities engaging (Naberezny & Ghilani, 2005). The area of Global Positioning Systems (GPS) in construction is an obvious area of continual change as new devices and technology evolve such as machine control. Machine control systems used in construction

have evolved from a laser based system to a GPS based system (Crawford, 2003; Kavanaugh, 2007). Each system, both in current use, does the same thing but because the operating system is different both should be presented in a construction surveying class evolving as the construction industry embraces the technology.

Generation of new ideas will promote the research and experimentation needed to stimulate a culture change of more intuitive investigations of construction education in addition to the teaching abilities of the “CM” faculty. This pursuit of a constructivist method involving experiential learning will allow the department an opportunity to embrace current leading edge ideas. The impact on curriculum and instruction has been mentioned in previous paragraphs from both a direct reorganization of some course materials but culture must be changed for the effects of change to take hold. By using the applied science aspects of construction, instructors can determine the minimal course theory needed for incorporating the practical application required for each concept presented. The spiraling of theory and practical will allow students to be on the front side of things knowing the answers and contemplating the more likely questions (Beliveau & Peter, 2002). This understanding of the probabilities of the anticipated situations will allow for a higher order of learning.

Curriculum needs to be developed which teaches current students while recruiting new ones. The workforce today is made up of 66% minority, gender and disabled populations (Jackson, 2003). Recruitment of diverse populations has been identified by the federal government as a high priority as the makeup of the national workforce becomes more diverse. Diversity is not limited in scope to ethnicity and gender but is also impacted by economic conditions. Students incapable of attending regular college schedules need offerings such as distant education through offsite locations or internet connections. Research and implementation of improvised traditional instruction utilizing new technologies such as streamed video can

change the way students learn (Holley & Dagg, 2005). The current view of life long learning involves more than a specified time in life for example between 18 and 22 years of age. This ability to fill a need at the specific time an individual needs the course will produce a higher quality product, the student (Smolka, 2002).

The new pedagogies have many components which might attract these sought after groups. Research and experimentation into elementary components of all disciplines may be a very advantageous way to both attract and give basic knowledge to these overlooked populations. Many programs have designated distance education as their outreach program to the nontraditional student (Walker, 2006; Zheng, 2005).

The development of this curriculum poses new opportunities to a type of student requiring continuing education or retraining. With this new curriculum, new ideas such as the usage of video taping in a class are being introduced. The use of the video component, real time or taped, offers a proactive instructor the template for new methods of imparting knowledge which is one half of the education equation. To foster the growth of this new media in classes, such as the surveying class may provide the opportunity to debug this new mode of instruction (Holley, 2005). The ability to research new methods of instruction will increase college department's capacity and competency for promoting new ideas. The collaborative nature of the survey class's practical and theoretical components provide a natural testing ground for the viability of this media being used by most applied science courses. Threading the theoretical and practical component of the surveying class is one area of research opportunity. The process of student reflection is altered by the reinforcing factors practical information offer when associated with the theoretical information of the identified basic concepts of surveying. Previous studies have shown variation in class results by altering the way lecture and lab components in a chemistry class are presented (DiBiase & Wagner, 2002). Changes in the area of surveying

instruction as well as distance education make this an obvious area of interest as to the integration for lecture and lab in the area of construction surveying.

CHAPTER 3

METHODOLOGY

Introduction

The purpose of this study is to determine which of two methods for presenting basic construction surveying concepts is more effective. Method one presents a theoretical component followed by an immediate practical exercise while method two provides the same material with separation of practical and theoretical components (separation will normally be one class period). This study used a quasi experimental design with intact groups for administration of the different treatments.

Population and Sample

Target population – The target population of this study are undergraduate students enrolled in Construction Management courses in a research extensive university in the southern region of the United States.

Accessible population – The accessible population of this study are undergraduate students enrolled in Construction Management courses in the fall of 2008 in a research extensive university in the southern region of the United States.

Sample – The sample population to be used in this research project consists of four intact classes taking Construction Surveying in the fall of 2008 in a research extensive university in the southern region of the United States.

IRB Procedures

Research projects which include students are reviewed by the Louisiana State University Institutional Review Board. This group reviews the purpose and procedures for the research proposal for assurance that participants are not subjected to any harm and that all means are

taken to protect the participants and their privacy. This study was approved under IRB # E4106 by the Louisiana State University Institutional Review Board.

Students scores were only included in the results of this study if the consent form was signed prior to the experiment. This consent form was approved by the Louisiana State University Institutional Review Board as to its conveyance to the student all needed information as to the scope of the study and measures to be used to protect them from any potential harm and related privacy issues. The student also retained the option to be dropped from the study if so desired,

Research Objectives

1. To describe the students enrolled in a junior level course in construction surveying at a research extensive university on the following personal and academic demographic characteristics:

- a. age
- b. academic classification
- c. overall college GPA
- d. GPA in all construction management courses completed
- e. grade achieved in prerequisite construction management courses
- f. grade achieved in the required college level calculus course

2. To describe the pre and post composite score and the score on each defined foundational surveying concept (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying (as measured by a teacher made achievement test) at a research extensive university.

3. To compare the composite score and the score on each defined foundational surveying concept (office, field, distance, angle, and elevation) in a junior level course in construction surveying (as measured by a teacher made achievement test) of students who are taught using an instructional

approach in which theoretical and practical components are merged with students who are taught using an instructional approach in which the theoretical and practical components are separated.

4. To compare the pre and post composite score and the score on each defined foundational surveying concept (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying (as measured by a teacher made achievement test) at a research extensive university.

5. To compare the composite score and the score on each defined foundational surveying concept (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying (as measured by a teacher made achievement test) by the time of the day the instruction was delivered.

6. To compare the composite score and the score on each defined foundational surveying concept (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying (as measured by a teacher made achievement test) by the class size (defined as number of students enrolled).

7. To determine if a relationship exists between the pretest achievement, composite score and the score on each defined foundational surveying concept (office, field, distance, angle, and elevation), and the pre-instructional self perceived ability in surveying (as measured by a researcher designed perceptual ability questionnaire) of students enrolled in a junior level course in construction surveying at a research extensive university.

8. To determine if a model exists explaining a significant portion of the variance in post-instructional composite score and the score on each defined foundational surveying concept (office, field, distance, angle, and elevation) from the following personal, academic, and perceptual characteristics:

a. Self-perceived surveying ability

- b. Age
- c. Class status (defined as freshman, sophomore, junior, or senior classification)
- d. Overall college GPA
- e. GPA on all Construction Management courses completed
- f. GPA on prerequisite Construction Management courses
- g. Grade achieved in required college calculus course
- h. Experimental treatment (integrated or separated)
- i. Class size (defined as the number of students enrolled in the course)
- j. Time of day that the instruction was delivered.

Data Collection

Data for this research project was gathered through the usage of three researcher generated instruments. During the first class all 4 intact groups completed the Perceptual Ability surveys on their individual pre instructional construction surveying ability. Prior to any treatment a pretest was given at the beginning of class two for determination of students abilities prior to either treatment (method of instruction). Upon completion of the initial section of instruction (first ten classes) a posttest was administered for gauging individual participating student's achievement. Demographic data was gathered from the university's database.

Measuring Instruments

Three instruments were used in this experiment for collection of data to accomplish the study objectives. The first instrument presented was a researcher developed Perceptual Ability Survey; the second instrument was a researcher developed Achievement Test and the third instrument was a demographic sheet for the retrieval of needed individual information for the completion of research objectives.

The perceptual ability survey contained eleven questions allowing students to rate their ability from "0" (no ability) to "4" (high ability). This instrument was composed of eleven questions consisting of the first ten dealing with ability assessments correlating to the five identified basic survey constructs office, field, distance, angle and elevation while question eleven requested participants to reveal where prior survey training may have been acquired.

These conceptual areas for instruction in basic construction surveying are the main areas found in the major texts utilized in the Construction Management Surveying college courses. Leading texts by W. Crawford and B. Kavanagh in Construction surveying confirm the foundational basis of these concepts. This instrument has been validated by an expert panel of notable surveyors as to its content. Steven Estopinal (2008) (personal communication), author of a college text, and David Patterson (2008) (personal communication) both past presidents of the Louisiana State Surveyors Association completed their assessments of the questionnaire during personal interviews identifying these five basic concepts as foundational to learning surveying. Mr. Estopinal has taught numerous continuing education classes in the region while Mr. Patterson has held numerous positions on state boards impacting the surveying industry.

The Achievement test, used for both pre and post experiment evaluations, was designed with the goal of measuring a student's ability in each of the five basic constructs. This test presented six questions per concept for determining any measurable differences between the two treatment programs administered during the experiment. The five concepts covered in this test are office, field, distance, angle and elevation which were confirmed by a panel of experts as being representative of elementary subject areas for surveying (Estopinal, 2008) (personal communication) (Patterson, 2008) (personal communication). The expert panel which validated this test consisted of notable surveying experts representing academia, association presidents and an author of a college text. This panel's individual assessments have shown no needed changes as to the overall makeup of the achievement test.

The demographic data sheet gathered individual information on age, classification, overall GPA, grade attained in pre requisite Construction management class and grade attained in college calculus class.

Experiment

This experiment was administered over five weeks. The treatment presented in the research design section was the administration of five separate researcher determined concepts validated by an expert panel and recognized survey industry experts. These constructs were presented in their practical and theoretical components in two varied combinations. The defined concepts, in their order of presentation, were office, field, distance, angle and elevation. The varied combinations of the theoretical and practical components of each concept were presented to the sample population in a separate and mixed format. The separate format involved the presentation of a concept's theoretical and practical components in two different successive classes while the mixed format was structured with both theoretical and related practical being presented during the same class period. The intact classes, two on a Monday-Wednesday and two on a Tuesday-Thursday schedule, were randomly assigned to one of the two formats. Each concept was presented in approximately a one week period with a pretest given to all participants prior to any instruction at the beginning of the experiment. Upon completion of all defined instruction an achievement test was given to all participants. Separate weeks are described in the following paragraphs with each format (separate and mixed) defined exactly in the format located in the appendix. The eight planned practical activities are composed of five recordable field exercises (copy of field instructions located in the appendix) and three hands on equipment exercises (operation of basic optical instruments).

Week One

The first week of the experiment involved introducing the class to surveying, informing them of the experiment along with presentation of the Institutional Review Board "IRB" consent form needed for the inclusion of their information and achievement test results in any publication. Completion of the Perceptual Ability survey was performed in the first class for

those choosing to participate. The pre-achievement test was administered before the introduction of any instructional material. This week entailed the introduction of chapters one, two and three with related lab activities in accordance with the design of the experiment. The concept “Office” or planning part of surveying was covered. The researcher-prepared Power Point “Fieldwork Observations” was used as the theoretical lecture material.

Week Two

This week was the first complete week of treatment which entailed coverage of chapters two, three and four. All students completed field lab one, “Location of the Points”, along with a non recordable lab activity involving the introduction of the basic components of an optical instrument using the Northwest NETH 203 electronic transit. This specific instrument has all the basic features found on an optical instrument. The basic features include horizontal and vertical lateral motions and optical focusing features for both cross hairs and imagery. This week covered the “Field” concept using the Power Points “Planning and Communication” and “Field Work Practices” as the theoretical lecture material.

Week Three

Instruction in week three was the mid point of the planned experiment. Chapters three, four and five were able to enhance one another in the defined presentation procedure. The concept “Distance” was the major focus of this week with some component parts of the concept “Angles” being started. The Power Point dealing with “Distance” was the instructional theoretical lecture material presented during this week. All students completed field lab two, “Measuring Direction with a Compass” along with a field lab three “Measuring Distance with a Steel Chain” which entailed measuring the distance between the practice sites points using the Sokkia Nylon coated steel tape # 825244. A basic instruction on turning angles with the Northwest NETH203 was also scheduled as a non recordable lab. The fourth recordable field lab

“Closing the Horizon” was scheduled for weeks three and four. This field exercise “Closing the Horizon” involved the turning of horizontal angles with the group of turned angles adding up to 360 degrees.

Week Four

This week brought both experimental treatments, mixed and separated, into the closing stages. Chapters Five “Angles” and Seven “Leveling”, the last two concepts in the elementary five forming the foundation of this study, were presented with all related activities being administered as per the format found in the appendix. The Power Points for “Angles” and “Leveling” were presented as scheduled. Field lab Five “Level Loop” along with the non recordable lab, Introduction of the Automatic level using the Northwest NCL22M was performed during week four. The concept “Elevations” was presented in the Power Point “Leveling” for instruction in the theoretical part of the treatment.

Week Five

The final week of the study was composed of one day presenting the last concept “Elevation” to complete the practical and theoretical instruction prescribed in the experiment. A brief review of all five sections was offered to answer any student’s questions for prospective material which was posed on the achievement test. This assessment was the first examination of the fall semester. This achievement test, presented on the tenth day of the semester coincided with the conclusion of this experiment. The experiment composition was fairly straight forward with enough flexibility to address the unplanned events. Events such as weather were addressed by utilizing a different context for the performance of the planned activity such as the presentation of a lab in a classroom rather than outdoors. This ability to move the venue from an open field to a courtyard offered the same desired goal from an instructional standpoint.

Research Design

<u>Treatment Cycle</u>				
Group1	NR	O ₁	X _s	O ₂

Group2	NR	O ₃	X _s	O ₄

Group3	NR	O ₅	X _m	O ₆

Group 4	NR	O ₇	X _m	O ₈

X_m Treatment using integrated format (Method 1)
X_s Treatment using separated format (Method 2)

This experiment was a quasi experiment research design. This design uses a pretest posttest for all groups incorporated in the experiment. This experiment is using 2 different means to present a collaborative offering of a theory and practical course. Two intact groups (same day) was given lecture material one day followed by an associated lab on a following day while two other intact groups (same day) was offered the same material but a mixed theory/practical offering.

As mentioned in Campbell and Stanley’s book this design is very effective under most circumstances which have certain inherent properties. This design will control most internal validity issues such as history, maturation, testing, instrumentation, selection and the selection maturation combined effect if the researcher incorporates good methodology when determining specific experimental treatments, evaluative assessments, and duration (length of experiment). Implementation of a well designed experiment will allow the researcher to utilize the advantages offered by Campbell and Stanley’s design. Statistical Regression as a threat to internal validity is a factor best controlled when tested groups are very similar when pretested prior to any treatments. Mortality is best handled by the pretest because dropped participants can be evaluated by looking at the similarities of those remaining in the study (Campbell & Stanley, 1963).

The procedure for the treatments was as follows. The treatments were randomly assigned based on a day with both intact classes for that day receiving the same treatment. The separate treatment was presented theoretical information on the defined concept followed by a practical lab experience at the following class meeting. The mixed format treatment offered concept theoretical information and a practical lab experience during the same class period.

CHAPTER 4

RESULTS

The results of this study are presented in this chapter with the findings organized by objective.

Objective One

Objective one was to describe the students enrolled in a junior level course in construction surveying at a research extensive university on the following personal and academic demographic characteristics: age, academic classifications, overall college GPA, GPA in construction management courses completed, grade achieved in prerequisite construction management course, and grade achieved in the required college level calculus class.

Age

The first variable on which information was collected on study participants was their date of birth. Age was computed from this measure as of the beginning of the course. The age of participants ranged from 20.17 to 29.53 years with a mean of 22.49 years ($SD = 1.775$). To further describe the study participants on age, they were divided into categories. The categories defined by the researcher were based on two year periods from 20 to 30 years old. The age category with the most students was 20.01 – 22.00 years ($n = 37, 47.44\%$). This information is presented in Table 2.

Table 2
Age^a of Students Enrolled in a Junior Level Construction Surveying Course at a Research Extensive University

Age Category	Frequency	Percentage
20.01 – 22	37	47.44
22.01 – 24	28	35.89
24.01 – 26	9	11.54
26.01 – 28	3	3.85

(Table Continued)

28.01 – 30	1	1.28
Total	78	100

Note. \underline{M} = 22.49, \underline{SD} = 1.775

^aAge as of the beginning of the experiment

Academic Classification

Another variable on which the study participants were described was academic classification. Categories used by the researcher were freshman (< 30 hrs completed), sophomore (30 – 59 hrs completed), junior (60 – 89 hrs completed) and senior (90 hrs + completed) year students. The category with the largest number of students was senior (n = 39; 50 %). This information is presented in Table 3.

Table 3

Academic Classification of Students Enrolled in a Junior Level Construction Surveying Course at a Research Extensive University

Class	Frequency	Percentage
Freshman	0	0.0
Sophomore	9	11.5
Junior	30	38.5
Senior	39	50.0
Total	78	100.0

Overall College GPA

Another variable on which the study participants were described was their overall college grade point average (GPA). This information was taken from university records to ensure its accuracy. These GPA measures ranged from 1.65 to 3.76 with a mean of 2.70 (\underline{SD} = 0.473). To further describe study participants' overall GPA's, the researcher presented the number of students in categories of GPA. The categories defined by the researcher were equivalent to one point on the 4-point GPA scale. The category with the most students was 2.01 – 3.0 (n = 53; 67.95%). Four of the students (5.13%) had overall GPA's below 2.0. This information is presented in Table 4.

Table 4
Overall College GPA^a of Students Enrolled in a Junior Level Construction Surveying Course at a Research Extensive University

Overall GPA Category	Frequency	Percentage
0.01 – 1.0	0	0.00
1.01 - 2.0	4	5.13
2.01 - 3.0	53	67.95
3.01 - 4.0	21	26.92
Total	78	100.00

Note. \bar{M} = 2.70, \underline{SD} = 0.473

^a GPA based on the following code values for grades A=4, B=3, C=2, D=1, F=0.

GPA in Construction Management Courses

Another variable on which the study participants were described was their grade point average (GPA) in all completed Construction Management (CM) courses. These GPA measures were taken from university records and ranged from 1.19 to 4.00 with a mean of 2.93 (\underline{SD} = 0.601). To further describe study participants' CM GPA's, the researcher presented the number of students in categories of GPA. The categories defined by the researcher were equivalent to one point on the 4-point GPA scale. The category with the largest number of students was 3.01 – 4.0 (n = 37; 47.44%). Five of the students (6.41%) had CM GPA's below 2.0. This information is presented in Table 5.

Table 5
Overall College GPA^a of Students Enrolled in a Junior Level Construction Surveying Course at a Research Extensive University

Overall CM GPA Category	Frequency	Percentage
0.01 – 1.0	0	0.00
1.01 – 2.0	5	6.41
2.01 – 3.0	36	46.15
3.01 – 4.0	37	47.44
Total	78	100.00

Note. \bar{M} = 2.93, \underline{SD} = 0.601

^a GPA based on the following code values for grade A=4, B=3, C=2, D=1, F=0.

Grade Achieved in Prerequisite Construction Management Course

Another variable on which the study participants were described was the grade achieved in the construction management course “Materials, Methods, and Equipment I” which is the prerequisite course to being enrolled in the construction surveying course. The range of the grades received by the study participants was from A to C, in this prerequisite course. The frequency of their course grades is presented in Table 6. The largest group was found in the grade category B (n = 34; 43.6%).

Table 6
Grade Achieved in Prerequisite Course by Students Enrolled in a Junior Level Construction Surveying Course at a Research Extensive University

Grade in Prerequisite Course ^a	Frequency	Percentage
A	17	21.8
B	34	43.6
C	27	34.6
D	0	0.0
F	0	0.0
Total	78	100.0

Note. $\bar{M} = 2.87$, $SD = 0.745$; Mean based on the following values for A=4, B=3, C=2, D=1, F=0.

^a Prerequisite course was “Materials, Methods, and Equipment I”

Grade Achieved in Required College Level Calculus Course

Another variable on which the study participants were described was the grade achieved in the required calculus course “Analytic Geometry and Calculus I.” The range of the grades received by the study participants was from A to D, in the calculus course. The frequency of their course grades is presented in Table 7. The largest group of study participants was found in the grade category C (n = 37; 47.4%).

Table 7
Grade Achieved in Required Calculus Course by Students Enrolled in a Junior Level Construction Surveying Course at a Research Extensive University

Grade in Required Course ^a	Frequency	Percentage
---------------------------------------	-----------	------------

(Table Continued)

A	7	9.9
B	23	32.5
C	37	52.1
D	4	5.6
F	0	0.0
Total	71 ^b	100.0

Note. \bar{M} = 2.46, \underline{SD} = 0.753; Mean based on the following values A=4, B=3, C=2, D=1, F=0.

^a Required course was “Analytic Geometry and Calculus I”

^b Seven study participants withdrew from the course prior to its completion and did not receive a grade

Objective Two

Objective two was to describe the pre and post achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying at a research extensive university. Each concept was measured on the researcher designed achievement test with six related questions. Expert evaluation of the achievement test prior to the experiment was used to establish the content validity of the instrument. The reliability of the achievement test was estimated using the Cronbach’s alpha procedure at $\alpha = 0.382$.

Pretest

The first part of objective two involved the description of the pretest achievement test scores (both the five sub-scale scores and the overall/composite achievement test scores) prior to any instruction. These scores measured the study participants’ existing knowledge of the five foundational concepts at the experiment’s inception. Each of the five sub-scales included six items, and subjects received one point for each correct response. Therefore, the possible range of scores for the sub-scales was from 0 to 6. The sub-scale on which participants recorded the highest score was “Office” with a mean of 3.67 (\underline{SD} = 1.269) and a range of scores from 1 to 6. The foundational concept “Elevation” had the lowest recorded pretest mean of 1.78 (\underline{SD} = 1.207). The overall/composite score for the pretest (which consisted of the sum of the five sub-

scale scores and had a possible range of 0 to 30 resulted in a mean of 12.62 ($SD = 3.098$). See Table 8 for the complete list of pretest achievement measures.

Table 8
Pretest Achievement Overall and on the Five Defined Foundational Surveying Concepts of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University

Variable	<u>M</u>	<u>SD</u>	Lowest	Highest	<u>n</u> ^a
Pretest Office	3.67	1.269	1	6	76
Pretest Distance	3.08	1.197	0	5	76
Pretest Angles	2.11	1.150	0	5	76
Pretest Field	1.99	1.026	0	4	76
Pretest Elevation	1.78	1.207	0	4	76
Pretest Total	12.62	3.098	4	21	76

Note. Possible range of scores for each sub scale was 0 to 6 and for the overall 0 to 30.

^a Two students were not present at time of pretest

Posttest

The second part of objective two involved the description of the posttest achievement test scores (both the five sub-scale scores and the overall/composite achievement test scores) at the conclusion of the experiment. These scores measured the study participants' existing knowledge of the five foundational concepts at the experiment's conclusion. Each of the five sub-scales included six items, and subjects received one point for each correct response. Therefore, the possible range of scores for the sub-scales was from 0 – 6. The sub scale on which participants recorded the highest score was “Office” having the highest recorded posttest mean of 5.41 ($SD = 0.751$). The foundational concept “Angles” had the lowest recorded posttest mean of 4.08 ($SD = 0.957$). The overall/composite score for the posttest (which consisted of the sum of the five sub-scale scores and had a possible range of 0 to 30 resulted with a mean of 23.59 ($SD = 2.305$). See Table 9 for the complete list of posttest achievement measures.

Table 9
 Posttest Achievement Overall and on the Five Defined Foundational Surveying Concepts of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University

Variable	<u>M</u>	<u>SD</u>	Lowest	Highest	<u>n</u> ^a
Posttest Office	5.41	0.751	3	6	76
Posttest Distance	5.24	0.781	3	6	76
Posttest Field	4.68	1.098	2	6	76
Posttest Elevation	4.18	1.116	1	6	76
Posttest Angles	4.08	0.957	2	6	76
Posttest Total	23.59	2.305	19	29	76

Note. Possible range of scores for each sub scale was 0 – 6 and the overall score 0 to 30.

^a Two students were not present at time of posttest

Objective Three

Objective 3 was to compare the achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying at a research extensive university through the use of two different instructional methods. Assessment of the study participant’s achievement overall and on the five defined foundational surveying concepts were measured by a teacher designed achievement test. Two different instructional approaches were used in the construction surveying course. These two methods (integrated and separated) were applied to the presentation of course material. The collaborative components, theoretical and practical, were placed together in the integrated format while the separated format offered the components on different days.

Pretest

The first part of objective three involved comparison of the pretest achievement scores (both the five sub – scale scores and the overall/composite achievement test scores) by the method of instruction received by the students in the study groups. Two of the groups received

instruction using the integrated method of instruction (the experimental method) and the other two groups received instruction using the separated method (the more traditional approach). The independent t-test procedure was used to make the six comparisons to accomplish this part of the objective. When these comparisons were made, only one of the six measures was found to have a statistically significant difference between the two groups. This measure was the “Distance” achievement sub – scale score. The “Integrated” group had a pretest score on this sub – scale of 2.78 (SD = 1.149) and the “Separated” group had a pretest score of 3.35 (SD = 1.189) ($t_{74} = 2.129, p = 0.037$). This indicates that the “Separated” instructional group had a significantly higher level of achievement at the administration of the pretest. See Table 10 for the complete list of comparisons made on the pretest measures.

Table 10
Comparison of Pretest Achievement Overall Score and Sub – Scores on the Five Defined Foundational Surveying Concepts by Method of Instruction Used in Teaching a Junior Level Course in Construction Surveying at a Research Extensive University

Concept	Instructional Method	<u>n</u>	<u>M</u> / <u>SD</u>	t^a	<u>p</u>
Distance	Integrated	36	2.78 / 1.149	2.129	0.037
	Separated	40	3.35 / 1.189		
Field	Integrated	36	1.83 / 0.971	1.242	0.218
	Separated	40	2.13 / 1.067		
Elevation	Integrated	36	1.86 / 1.150	0.579	0.565
	Separated	40	1.70 / 1.265		
Office	Integrated	36	3.58 / 1.251	0.569	0.571
	Separated	40	3.75 / 1.296		
Angles	Integrated	36	2.08 / 1.131	0.157	0.876
	Separated	40	2.13 / 1.181		

(Table Continued)

Total	Integrated	36	12.14 / 3.339	1.286	0.203
	Separated	40	13.05 / 2.837		

^a df = 74

Posttest

The second part of objective three involved comparison of the posttest achievement scores (both the five sub – scale scores and the overall/composite achievement test scores) by the method of instruction received by the students in the study groups. Two of the groups received instruction using the integrated method of instruction (the experimental method) and the other two groups received instruction using the separated method (the more traditional approach). The independent t-test procedure was used to make the six comparisons to accomplish this part of the objective. When these comparisons were made, none of the six measures was found to have a statistically significant difference between the two groups. See Table 11 for the complete list of comparisons made on the posttest measure.

Table 11
Comparison of Posttest Achievement Overall Score and Sub – Scores on the Five Defined Foundational Surveying Concepts by Method of Instruction Used in Teaching a Junior Level Course in Construction Surveying at a Research Extensive University

Concept	Instructional Method	n	M / SD	t ^a	p
Elevation	Integrated	35	4.37 / 1.114	1.359	0.178
	Separated	41	4.02 / 1.107		
Office	Integrated	35	5.34 / 0.765	0.695	0.489
	Separated	41	5.46 / 0.745		
Field	Integrated	35	4.77 / 1.087	0.637	0.526
	Separated	41	4.61 / 1.115		
Distance	Integrated	35	5.20 / 0.797	0.378	0.707
	Separated	41	5.27 / 0.775		

(Table Continued)

Angles	Integrated	35	4.11 / 0.867	0.312	0.756
	Separated	41	4.05 / 0.947		
Total	Integrated	35	23.80 / 2.207	0.724	0.471
	Separated	41	23.41 / 2.398		

^a df = 74

Objective Four

Objective four was to compare the Pre and Post achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying at a research extensive university through the usage of a researcher designed achievement test. Each foundational concept was measured on the researcher designed achievement test with six related questions. The overall/composite score was measured by the sum of the five sub-scale scores having a total of 30 questions.

Comparisons of the pretest and posttest achievement were performed using a paired “t” test. Using an a priori significance level of < 0.05 , each of the variables (pretest and posttest overall and the five sub-scales measuring the foundational concepts) means were compared to determine if study participants exhibited higher levels of achievement after instruction than they did before instruction. All six measures were found to be significantly higher at the posttest than they were at the pretest. The concept which had the most difference between the pretest and the posttest was “Field”. The pretest score for the “Field” sub-scale resulted in a mean of 1.99 (SD = 1.040) while the posttest had a mean of 4.66 (SD = 1.101) ($t_{73} = 15.537$, $p < 0.001$). The concept which had the least difference between the pretest and the posttest was “Angles” sub-scale. The pretest score for the “Angles” sub-scale resulted in a mean of 2.12 (SD = 1.158) while the

posttest had a mean of 4.09 ($SD = 0.909$) ($t_{73} = 11.325$, $p < 0.001$). See Table 12 for the complete list of comparisons made on these scores.

Table 12
Comparison of Pretest and Posttest Achievement Overall Score and Sub – Scores on the Five Defined Foundational Surveying Concepts of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University

Concept	Time of Test	n^a	M / SD	t^b	p
Field	Pretest	74	1.99 / 1.040	15.537	< 0.001
	Posttest	74	4.66 / 1.101		
Distance	Pretest	74	3.08 / 1.202	15.248	< 0.001
	Posttest	74	5.27 / 0.764		
Elevation	Pretest	74	1.78 / 1.219	12.903	< 0.001
	Posttest	74	4.18 / 1.127		
Office	Pretest	74	3.64 / 1.267	12.082	< 0.001
	Posttest	74	5.45 / 0.705		
Angles	Pretest	74	2.12 / 1.158	11.325	< 0.001
	Posttest	74	4.09 / 0.909		
Total	Pretest	74	12.61 / 3.140	25.910	< 0.001
	Posttest	74	23.65 / 2.272		

^a Four students were not present for both pretest and posttest

^b $df = 73$

Objective Five

Objective 5 was to compare the achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying (as measured by a teacher made achievement test) by the time of day that the instruction was delivered. Assessment of the study participant's achievement overall and on the five defined foundational surveying concepts were measured by a teacher

made achievement test. Two of the groups received instruction during the morning while the other two groups received instruction in an afternoon time period. The two morning and two afternoon sections of each treatment were merged together to determine if the class's time schedule might have an impact on achievement.

Pretest

The first part of objective five involved comparison of the pretest achievement scores (both the five sub – scale scores and the overall/composite achievement test scores) by the time of day instruction was received by the students in the study groups. Two of the groups received instruction during the morning while the other two groups received instruction in an afternoon time period. The independent t-test procedure was used to make the six comparisons to accomplish this part of the objective. When these comparisons were made, two of the six measures were found to have a statistically significant difference between the two groups. These measures were the “Elevation” achievement sub – scale score and the “Total” (overall achievement scores). The groups that received instruction in the morning had a mean pretest score on the “Elevation” subscale of 2.11 (SD = 1.203) and the groups receiving instruction in the afternoon had a mean pretest score of 1.45 (SD = 1.132) ($t_{74} = 2.455, p = 0.016$). The results for the “Total” score (overall achievement) that received instruction in the morning had a pretest score of 13.37 (SD = 3.008) and the groups receiving instruction in the afternoon had a pretest score of 11.87 (SD = 3.042) ($t_{74} = 2.161, p = 0.034$). See Table 13 for the complete list of comparisons made on the pretest measures.

Table 13
Comparison of Pretest Overall Achievement and Sub - Scores on the Five Defined Foundational Surveying Concepts by Time of Day Used in Teaching a Junior Level Course in Construction Surveying at a Research Extensive University

Concept	Time of Day	<u>n</u>	<u>M</u> / <u>SD</u>	<u>t</u> ^a	<u>p</u>
---------	-------------	----------	----------------------	-----------------------	----------

(Table Continued)

Elevation	Morning	38	2.11 / 1.203	2.455	0.016
	Afternoon	38	1.45 / 1.132		
Office	Morning	38	3.87 / 1.212	1.364	0.177
	Afternoon	38	3.47 / 1.310		
Field	Morning	38	2.08 / 1.100	0.780	0.438
	Afternoon	38	1.89 / 0.953		
Distance	Morning	38	3.18 / 1.136	0.764	0.447
	Afternoon	38	2.97 / 1.262		
Angles	Morning	38	2.13 / 1.234	0.198	0.843
	Afternoon	38	2.08 / 1.101		
Total	Morning	38	13.37 / 3.008	2.161	0.034
	Afternoon	38	11.87 / 3.042		

^a df = 74

Posttest

The second part of objective five involved comparison of the posttest achievement scores (both the five sub – scale scores and the overall/composite achievement test scores) by the time of day instruction was received by the students in the study groups. Two of the groups received instruction during the morning while the other two groups received instruction in an afternoon time period. The independent t-test procedure was used to make the six comparisons to accomplish this part of the objective. The Levene’s test for the equality of variance, performed on the data prior to the independent t-test determined for the sub-scales “Distance” and “Field” the variances were not homogeneous. Therefore the researcher used the t-test with equal variance not assumed for these comparisons. Examination of the results of the t-test revealed that one of the six measures (overall and sub-scales) was found to have a statistically significant difference

between the two groups (morning and afternoon). This measure was the “Field” achievement sub – scale score. The groups that received instruction in the morning had a mean posttest score on the “Field” sub-scale of 4.41 (SD = 1.235) and the groups receiving instruction in the afternoon had a significantly higher mean posttest score of 4.95 (SD = 0.887) ($t_{65.09} = 2.193, p = 0.032$).

See Table 14 for the complete list of comparisons made on the posttest measures.

Table 14
Comparison of Posttest Overall Achievement and Sub - Scores on the Five Defined Foundational Surveying Concepts by Time of Day Used in Teaching a Junior Level Course in Construction Surveying at a Research Extensive University

Concept	Time of Day	<u>n</u>	<u>M / SD</u>	<u>t</u>	<u>p</u>
Field ^a	Morning	37	4.41 / 1.235	2.193	0.032
	Afternoon	39	4.95 / 0.887		
Angles ^b	Morning	37	3.92 / 0.894	1.513	0.135
	Afternoon	39	4.23 / 0.902		
Distance ^c	Morning	37	5.32 / 0.626	0.960	0.345
	Afternoon	39	5.15 / 0.904		
Office ^b	Morning	37	5.49 / 0.731	0.887	0.378
	Afternoon	39	5.33 / 0.772		
Elevation ^b	Morning	37	4.27 / 1.045	0.652	0.516
	Afternoon	39	4.10 / 1.188		
Total ^b	Morning	37	23.41 / 2.362	0.685	0.495
	Afternoon	39	23.77 / 2.265		

^{a, c} Levene’s test for the equality of variance was determined to be significant

^a Field df = 65.09

^c Distance df = 67.82

^b df = 74

Objective Six

Objective 6 was to compare the achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course at a research extensive university in construction surveying (as measured by a teacher made achievement test) by the class size (defined as number of students enrolled). Assessment of the study participant's achievement overall and on the five defined foundational surveying concepts were measured by a teacher made achievement test. Each treatment group had a large class (maximum enrollment 24 students) and small class (less than full enrollment). The two large classes and two small classes for each treatment (integrated and separated) were merged together to determine if the class's size had an impact on achievement.

Pretest

The first part of objective six involved the comparison of the pretest achievement scores (both the five sub – scale scores and the overall/composite achievement test scores) by the class size in which instruction was received by the students in the study groups. Two of the groups received instruction using the small class size while the other two groups received instruction using the large class size. The independent t-test procedure was used to make the six comparisons to accomplish this part of the objective. The Levene's test for the equality of variance, performed on the data prior to the independent t-test determined for the sub-scale "Field" the variance was not homogeneous. Therefore the researcher used the t-test with equal variance not assumed for these comparisons. Examination of the t-tests revealed that none of the six measures was found to have a statistically significant difference between the two groups (large and small). See Table 15 for the complete list of comparisons made on the posttest measure.

Table 15

Comparison of Pretest Overall Achievement and Sub - Scores on the Five Defined Foundational Surveying Concepts by Class Size Used in Teaching a Junior Level Course in Construction Surveying at a Research Extensive University

Concept	Class Size	<u>n</u>	<u>M / SD</u>	<u>t</u>	<u>p</u>
Office ^a	Small	30	3.37 / 1.159	1.710	0.091
	Large	46	3.87 / 1.310		
Field ^b	Small	30	2.20 / 0.805	1.581	0.118
	Large	46	1.85 / 1.135		
Angles ^a	Small	30	2.33 / 1.061	1.405	0.377
	Large	46	1.96 / 1.192		
Elevation ^a	Small	30	1.67 / 1.093	0.637	0.526
	Large	46	1.85 / 1.282		
Distance ^a	Small	30	3.17 / 1.289	0.513	0.609
	Large	46	3.02 / 1.145		
Total ^a	Small	30	12.73 / 2.876	0.259	0.796
	Large	46	12.54 / 3.264		

^a df = 74

^b Levene's test for the equality of variance was determined to be significant

^b Field df = 73.41

Posttest

The second part of objective six involved comparison of the posttest achievement scores (both the five sub – scale scores and the overall/composite achievement test scores) by the class size in which instruction was received by the students in the study groups. Two of the groups received instruction using the small class size while the other two groups received instruction using the large class size. The independent t-test procedure was used to make the six comparisons to accomplish this part of the objective. When these comparisons were made, none

of the six measures was found to have a statistically significant difference between the two groups. See Table 16 for the complete list of comparisons made on the posttest measure.

Table 16
Comparison of Posttest Overall Achievement and Sub - Scores on the Five Defined Foundational Surveying Concepts by Class Size Used in Teaching a Junior Level Course in Construction Surveying at a Research Extensive University

Concept	Class Size	<u>n</u>	<u>M / SD</u>	<u>t</u> ^a	<u>p</u>
Distance	Small	30	5.10 / 0.845	1.238	0.220
	Large	46	5.33 / 0.732		
Office	Small	30	5.30 / 0.750	1.011	0.315
	Large	46	5.48 / 0.752		
Angles	Small	30	3.97 / 0.928	0.871	0.386
	Large	46	4.15 / 0.894		
Field	Small	30	4.80 / 1.031	0.740	0.462
	Large	46	4.61 / 1.145		
Elevation	Small	30	4.10 / 1.155	0.529	0.599
	Large	46	4.24 / 1.099		
Total	Small	30	23.27 / 2.243	0.994	0.323
	Large	46	23.80 / 2.344		

^a df = 74

Objective Seven

Objective seven was to determine if a relationship existed between the pretest achievement, overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation), and the pre-instructional self perceived ability in surveying (as measured by a researcher designed perceptual ability questionnaire) of students enrolled in a junior level course in construction surveying at a research extensive university. The Pearson

Product Moment correlation coefficient was used to see if a relationship existed between the pretest achievement and the pretest self perceived ability questionnaire. Summarized results using Pearson Correlation Coefficient show no significant relationships between the student questionnaire and achievement pretest scores. The Perceptual Ability Survey Instrument was estimated to have a high degree of reliability as indicated by a Cronbach's Alpha of 0.833. In addition, the content validity of this instrument was established through a review of experts. This information is presented in Table 17.

Table 17
Relationship between Pretest Self Perceived Ability in Surveying and Pretest Achievement Overall and on the Five Defined Foundational Surveying Concepts of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University

Achievement Pretest Scale/Sub-Scale	<u>r</u>	<u>n</u>	<u>p</u>
Elevation	0.205	76	0.075
Total	0.150	76	0.195
Field	0.088	76	0.450
Angles	0.066	76	0.572
Distance	0.037	76	0.753
Office	0.007	76	0.955

Objective Eight

Objective eight was to determine if a model existed explaining a significant portion of the variance in post-instructional achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) from the following personal, academic, and perceptual characteristics: self perceived surveying ability, age, class status, college GPA, construction management GPA, grade achieved in prerequisite construction management course, grade achieved in required college calculus course, experimental treatment, class size and time of

the day instruction was presented to students enrolled in a junior level course in construction surveying at a research extensive university.

Each of the criterion variables were regressed on the potential predictor variables for the determination of any significant models. The criterion variables consisted of the six dependent variables, Post Instructional “Overall” achievement and the five foundational concepts. The independent variables were entered in a stepwise regression due to the exploratory nature of the study.

In conducting the multiple regression analysis, one of the predictor variables class status used in the analysis was categorical in nature had to be converted to a dichotomous variable. This categorical variable, class status was converted to a dichotomous variable by classifying the junior students (junior and non-junior) and senior students (senior and non senior). This grouping of class status did not include a similar setup of sophomore participants because they were too few in number to be included in the independent variable.

Each of the criteria variables was regressed on the independent variables to determine if a significant model could be identified. Upon the determination of the model step two was the determination of the multiple correlation coefficients “R” and the coefficient of determination “R²”. The determined “R²” indicated the amount of variance found in the criterion variable which was attributed to the predictor variables. Step three was the determination of the significance of the multiple “R” calculated in step one. The last step in this process was the determination of the significance of the individual predictor variables identified in step one as possible predictors. One of the assumptions underlying the use of multiple regression is the absence of high levels of multicollinearity among the independent variables. Prior to conducting the regression analyses for the six outcome measures, the researcher examined the tolerance and variance inflation factor levels to determine if excessively high levels of multicollinearity were

present. When this was done, no excess multicollinearity was found. Therefore, the researcher proceeded with the planned regression analyses.

Posttest Total

For descriptive purposes, two-way correlations between the predictor (independent) variables in the regression and the post-instructional achievement “Overall” score (dependent) variable determined that the independent variables Construction Management GPA and College GPA were significant. Construction Management GPA had the highest measured correlation. Additional findings are presented in Table 18.

Table 18
Relationship between Selected Predictor Measures and Post - Instructional Overall Achievement of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University

Variable	<u>R</u>	<u>p</u>
Construction Management GPA	0.402	< 0.001
College GPA	0.271	0.013
Grade in Prerequisite CM Course	0.187	0.063
Class Size	0.146	0.118
Senior	0.120	0.164
Junior	- 0.120	0.164
Age	0.091	0.230
Grade in Required Calculus Course	0.079	0.261
Experimental Treatment	- 0.065	0.299
Time of Day	0.043	0.363
Perceived Survey Ability	0.026	0.415

Multiple regression analysis of the criterion variable posttest total resulted in one predictor variable being identified for a model. The predictor variable identified for this criterion

variable was construction management GPA. This variable explained 16.2 % of the variance in the posttest total. The remaining 10 independent variables were excluded from the regression model due to no significant impact on the model. Additional findings are presented in Table 19.

Table 19
Multiple Regression Analysis of Post - Instructional Achievement Overall Score and Selected Predictor Variables of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University

ANOVA				
Sources of Variation	df	MS	F - Ratio	p
Regression	1	61.978	12.757	0.001
Residual	66	4.858		
Total	67			
Model Summary				
Model	R ²	F Change	Sig F Change	Standardized Coefficients Beta
Construction Management GPA	0.162	12.757	0.001	0.402
Variables not in the Equation				
Variable	t	p		
Age	1.635	0.107		
Senior	1.600	0.115		
Junior	1.600	0.115		
Time of Day	1.015	0.314		
College GPA	0.790	0.432		
Experimental Treatment	0.711	0.479		

(Table Continued)

Grade in Prerequisite CM Course	0.533	0.596
Grade in Required Calculus Course	0.452	0.653
Class Size	0.337	0.737
Perceived Survey Ability	0.171	0.864

Posttest Distance

For descriptive purposes, two-way correlations between the predictor (independent) variables in the regression and the post-instructional achievement sub-score on the foundational concept “Distance” (dependent) variable determined that the independent variables Construction Management GPA, Age and Class Size were significant. Construction Management GPA had the highest measured correlation. Additional findings are presented in Table 20.

Table 20
Relationship between Selected Predictor Measures and Post - Instructional Achievement Sub-score on the Foundational Concept “Distance” of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University

Variable	<u>R</u>	<u>p</u>
Construction Management GPA	0.326	0.003
Age	0.240	0.025
Class Size	0.201	0.050
College GPA	0.165	0.089
Senior	0.137	0.133
Junior	- 0.137	0.133
Time of Day	- 0.133	0.139
Grade in Prerequisite CM Course	0.124	0.156
Experimental Treatment	0.035	0.387
Perceived Survey Ability	- 0.032	0.398

(Table Continued)

Grade in Required Calculus Course	0.022	0.429
-----------------------------------	-------	-------

Multiple regression analysis of the criterion variable posttest distance resulted in two predictor variables being identified for a model. The predictor variables identified for this criterion variable were construction management GPA and Age in years. These variables explained 20.7 % of the variance in the posttest Distance sub-score. The other nine predictor variables were excluded due to having no significant impact on the model. Additional findings are presented in Table 21.

Table 21
Multiple Regression Analysis of Post - Instructional Achievement Sub-score on the Foundational Concept “Distance” and Selected Predictor Variables of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University

ANOVA					
Sources of Variation	df	MS	F - Ratio	p	
Regression	2	4.192	8.480	0.001	
Residual	65	0.494			
Total	67				
Model Summary					
Model	R ² Cumulative	R ² Change	F Change	Standardized Sig F Change	Coefficients Beta
Construction Management GPA	0.106	0.106	7.860	0.007	0.396
Age	0.207	0.101	8.238	0.006	0.325
Variables not in the Equation					
Variable	t	p			
Class Size	1.363	0.178			
Grade in Prerequisite CM Course	0.773	0.443			

(Table Continued)

Experimental Treatment	0.764	0.447
Senior	0.493	0.623
Junior	0.493	0.623
Perceived Survey Ability	0.439	0.662
Grade in Required Calculus Course	0.389	0.699
College GPA	0.341	0.734
Time of Day	0.194	0.847

Posttest Elevation

For descriptive purposes, two-way correlations between the predictor (independent) variables in the regression and the post-instructional achievement sub-score on the foundational concept “Elevation” (dependent) variable determined that the independent variable Construction Management GPA was significant. Additional findings are resented in Table 22.

Table 22
Relationship between Selected Predictor Measures and Post - Instructional Achievement Sub-score on the Foundational Concept “Elevation” of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University

Variable	<u>R</u>	<u>p</u>
Construction Management GPA	0.267	0.014
Grade in Required Calculus Course	0.183	0.068
Experimental Treatment	0.179	0.072
College GPA	0.135	0.136
Perceived Survey Ability	0.084	0.248
Time of Day	0.079	0.261
Age	0.065	0.300
Class Size	0.058	0.320

(Table Continued)

Senior	0.058	0.319
Junior	0.058	0.319
Grade in Prerequisite CM Course	0.024	0.424

Multiple regression analysis of the criterion variable posttest elevation resulted in one predictor variable being identified for a model. The predictor variable identified for this criterion variable was construction management GPA. This variable explained 7.1 % of the variance in the posttest Elevation sub-score. The other ten predictor variables were excluded due to having no significant impact on the model. Additional findings are presented in Table 23.

Table 23
Multiple Regression Analysis of Post - Instructional Achievement Sub-score on the Foundational Concept “Elevation” and Selected Predictor Variables of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University

ANOVA				
Sources of Variation	df	MS	F - Ratio	p
Regression	1	6.055	5.047	0.028
Residual	66	1.200		
Total	67			
Model Summary				
Model	R ²	F Change	Sig F Change	Standardized Coefficients Beta
Construction Management GPA	0.071	5.047	0.028	0.267
Variables not in the Equation				
Variable	t	p		
Grade in Prerequisite CM Course	1.911	0.060		

(Table Continued)

Experimental Treatment	1.617	0.111
College GPA	1.136	0.260
Age	1.054	0.296
Grade in Required Calculus Course	0.871	0.387
Senior	0.807	0.423
Junior	0.807	0.423
Perceived Survey Ability	0.744	0.460
Time of Day	0.280	0.780
Class Size	0.125	0.901

Posttest Office

For descriptive purposes, two-way correlations between the predictor (independent) variables in the regression and the post-instructional achievement sub-score on the foundational concept “Office” (dependent) variable determined that the independent variables College GPA, Construction Management GPA and Grade in Prerequisite CM Course were significant. College GPA had the highest measured correlation. Additional findings are presented in Table 24.

Table 24
Relationship between Selected Predictor Measures and Post - Instructional Achievement Sub-score on the Foundational Concept “Office” of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University

Variable	<u>R</u>	<u>p</u>
College GPA	0.325	0.003
Construction Management GPA	0.315	0.004
Grade in Prerequisite CM Course	0.260	0.016
Class Size	0.149	0.113
Time of Day	- 0.098	0.213

(Table Continued)

Age	- 0.096	0.219
Experimental Treatment	0.091	0.231
Perceived Survey Ability	0.058	0.320
Grade in Required Calculus Course	0.008	0.475
Senior	0.005	0.482
Junior	- 0.005	0.482

Multiple regression analysis of the criterion variable posttest office resulted in one predictor variable being identified for a model. The predictor variable identified for this criterion variable was College GPA. This variable explained 10.6 % of the variance in the posttest Office sub-score. The other ten predictor variables were excluded due to having no significant impact on the model. Additional findings are found in Table 25.

Table 25
Multiple Regression Analysis of Post - Instructional Achievement Sub-score on the Foundational Concept “Office” and Selected Predictor Variables of Students Enrolled in a Junior Level Course in Construction Surveying at a Research Extensive University

ANOVA				
Sources of Variation	df	MS	F - Ratio	p
Regression	1	4.052	7.813	0.007
Residual	66	0.519		
Total	67			
Model Summary				
Model	R ²	F Change	Sig F Change	Standardized Coefficients Beta
College GPA	0.106	7.813	0.007	0.325

(Table Continued)

Variables not in the Equation

Variable	t	p
Grade in Prerequisite CM Course	1.008	0.317
Grade in Required Calculus Course	0.926	0.358
Construction Management GPA	0.770	0.444
Experimental Treatment	0.744	0.459
Perceived Survey Ability	0.673	0.504
Senior	0.569	0.571
Junior	0.569	0.571
Class Size	0.412	0.682
Age	0.353	0.725
Time of Day	0.256	0.799

Posttest Angles

Multiple regression analysis of the criterion variable posttest angles resulted in no predictor variables being identified for a model.

Posttest Field

Multiple regression analysis of the criterion variable posttest field resulted in no predictor variables being identified for a model.

CHAPTER 5

SUMMARY AND CONCLUSIONS

Purpose

The purpose of this study is to determine which of two methods for presenting basic construction surveying concepts is more effective. Method one presents a theoretical component followed by an immediate practical exercise while method two provides the same material with separation of practical and theoretical components (separation will normally be one class period). The objectives of the study were the following:

Objectives of the Study

1. To describe the students enrolled in a junior level course in construction surveying at a research extensive university on the following personal and academic demographic characteristics:
 - a. age
 - b. academic classification
 - c. overall college GPA
 - d. GPA in all construction management courses completed
 - e. grade achieved in prerequisite construction management courses
 - f. grade achieved in the required college level calculus course
2. To describe the Pre and Post achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying at a research extensive university.
3. To compare the achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) in a junior level course in construction surveying (as measured by a teacher made achievement test) of students who are taught using an instructional approach in which theoretical and practical components are merged with students who are taught using an instructional approach in which the theoretical and practical components are separated.

4. To compare the Pre and Post achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying at a research extensive university.
5. To compare the achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying (as measured by a teacher made achievement test) by the time of day that the instruction was delivered.
6. To compare the achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying (as measured by a teacher made achievement test) by the class size (defined as number of students enrolled).
7. To determine if a relationship exists between the pretest achievement, overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation), and the pre-instructional self perceived ability in surveying (as measured by a researcher designed perceptual ability questionnaire) of students enrolled in a junior level course in construction surveying at a research extensive university.
8. To determine if a model exists explaining a significant portion of the variance in post-instructional achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) from the following personal, academic, and perceptual characteristics:
 - a. Self-perceived surveying ability,
 - b. Age,
 - c. Class status (defined as freshman, sophomore, junior, or senior classification),
 - d. Overall college GPA,
 - e. GPA on all Construction Management courses completed,
 - f. GPA on prerequisite Construction Management courses,
 - g. Grade achieved in required college calculus course,

- h. Experimental treatment (integrated or separated)
- i. Class size (defined as the number of students enrolled in the course), and
- j. Time of day that the instruction was delivered.

Procedures

The target population of this study was defined as undergraduate students enrolled in Construction Management courses in a research extensive university in the southern region of the United States. The accessible population of this study was undergraduate students enrolled in Construction Management courses in the fall of 2008 in a research extensive university in the southern region of the United States. The sample used in this study consisted of four intact classes taking Construction Surveying in the fall of 2008 in a research extensive university in the southern region of the United States. The four intact classes were randomly assigned to the two different instructional treatments used in this experiment. Two classes on the same day (day two) were instructed in method one which presented both theoretical and practical material on the same day while the other two classes on the same day (day one) were instructed in method two which involved lecture and related practical material being presented on separate days. The two classes treated with the mixed method (method one) consisted of 37 students (14 in the early class, 23 in the late class) while the students treated with the separate method (method two) consisted of 41 students (24 in the early class, 17 in the late class),

Data was collected through the usage of three generated researcher instruments. The instruction was based on the first 10 days of each class. During class one all study participants completed a perceptual ability questionnaire which requested answers to their perceived ability on basic surveying concepts. All 78 study participants were pretested during class two prior to any instruction for a gauge of their knowledge overall and on the five basic surveying concepts (angle, distance elevation, field and office). During the experimental period lecture and practical exercises were covered as per each individual treatment. Power points were used for instruction

of the theoretical side of each concept while the eight labs consisted of three introductory labs and five field labs for presentation of the practical component. The treatments were introduced between classes two and nine in preparation for the posttest assessment. During class ten a posttest was given to measure each student's knowledge upon completion of the experiment.

Findings

Objective One

The goal of objective one was the description of students enrolled in a junior level course in construction surveying at a research extensive university on six characteristics. The findings for participants were a group with a mean age of 22.49 (SD= 1.775) with 83.33% (n = 55) being in the range of 20 – 24 years. Regarding the student's academic classification the largest group were seniors (n = 39, 50%).

The academic achievements for experimental participants were gathered for two cumulative areas of interest along with two individual courses. The first area considered was the overall college GPA for each student at the beginning of the experiment. Findings for overall GPA resulted in a mean of 2.70 (SD = 0.473) with the largest group 67.95% (n = 53) within the range of 2.01 – 3.00. The second area of cumulative grades was the GPA achieved in all construction management (CMGPA) courses completed at the time of the experiments inception. Findings for the CMGPA resulted in a mean of 2.93 (SD = 0.601) with the largest group 47.44% within the range of 3.01 – 4.00. Individual grades were considered for two courses, "Materials, Methods, and Equipment I" and "Analytic Geometry and Calculus I". "Materials, Methods, and Equipment I" is the immediate prerequisite course required for taking Construction Surveying. Findings for students grades attained in "Materials, Methods, and Equipment I" were found to have a mean of 2.87 (SD = 0.745) with the largest group 43.6% (n = 34) receiving a "B".

Findings for students grades attained in “Analytic Geometry and Calculus I” were determined to have a mean of 2.46 (SD = 0.753) with the largest group 52.1% (n = 37) receiving a “C”.

Objective Two

The goal of objective two was the description of pre and post achievement overall and on five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying at a research extensive university.

Pretest achievement results were determined and the conceptual area “Office” was found to have the highest mean of 3.67 (SD = 1.269) while the concept “Elevation” was found to have the lowest mean of 1.78 (SD = 1.207). The pretest “Total” was determined to have a mean of 12.62 (SD = 3.098).

Posttest achievement results were determined and the conceptual area “Office” was found to have the highest mean of 5.41 (SD = 0.751) while the concept “Angle” was found to have the lowest mean of 4.08 (SD = 0.957). The posttest “Total” was determined to have a mean of 23.59 (SD = 3.098).

Other areas needing mentioning were the concept of “Field” had the largest net gain of 2.69 from a pretest score of 1.99 to a posttest score of 4.68 while the concept of “Office” had the smallest net gain of 1.84 going from a pretest score of 3.67 to a posttest score of 5.41

Objective Three

The goal of objective three was the comparison of achievement overall and five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying at a research extensive university based on two different instructional approaches. Method one (experimental) used an integrated

format, theoretical and practical components, while method two (traditional) used a separated format.

Pretest achievement results were determined and the conceptual area “Office” (separated) was found to have the highest mean of 3.75 (SD = 1.296) while the concept “Elevation” (separated) was found to have the lowest mean of 1.70 (SD = 1.265). The pretest “Total” (separated), highest for two pretest total groupings, was determined to have a mean of 13.05 (SD = 2.837). Test for significant differences between the pretest groups were performed by an independent “t” test. Findings in this area determined the concept of pretest “Distance” results were significant. “Distance” (integrated) had a mean of 2.78 (SD = 1.149) while “Distance” (separated) had a mean of 3.35 (SD = 1.189) and ($t_{74} = 2.129$, $p = 0.037$).

Posttest achievement results were determined and the conceptual area “Office” (separated) was found to have the highest mean of 5.46 (SD = 0.745) while the concept “Elevation” (separated) was found to have the lowest mean of 4.02 (SD = 1.107). The posttest “Total” (integrated), highest for two posttest total groupings, was determined to have a mean of 23.80 (SD = 2.207). Test for significant differences between the posttest groups using the independent “t” test resulted in no significant differences in these pairings.

Objective Four

The goal of objective four was the comparison of the pre and post achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying at a research extensive university.

Pretest achievement results were determined and the conceptual area “Office” was found to have the highest mean of 3.64 (SD = 1.267) while the concept “Elevation” was found to have

the lowest mean of 1.78 ($SD = 1.219$). The pretest “Total” was determined to have a mean of 12.61 ($SD = 3.140$).

Posttest achievement results were determined and the conceptual area “Office” was found to have the highest mean of 5.45 ($SD = 0.705$) while the concept “Angle” was found to have the lowest mean of 4.09 ($SD = 0.909$). The posttest “Total” was determined to have a mean of 23.65 ($SD = 2.272$).

Tests of significance were determined through the usage of a paired “t” test. All comparison of pretest and posttest achievements was determined to be significant. The most significant concept was “Field” having a ($t_{74} = 15.537, p < 0.001$) while the least significant was “Angles” having a ($t_{74} = 11.325, p < 0.001$). Significance for the “Total” overall score was found to have a ($t_{74} = 25.910, p < 0.001$).

Objective Five

The goal of objective five was the comparison of achievement overall and five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying at a research extensive university based on the time of the day instruction was delivered.

Pretest achievement results were determined and the conceptual area “Office” (morning) was found to have the highest mean of 3.87 ($SD = 1.212$) while the concept “Elevation” (afternoon) was found to have the lowest mean of 1.45 ($SD = 1.132$). The pretest “Total” (morning), highest for two pretest total groupings, was determined to have a mean of 13.37 ($SD = 3.008$). Test for significant differences between the pretest groups were performed by an independent “t” test. Findings in this area determined the concept of pretest “Elevation” and “Total” results were significant. “Elevation” (morning) had a mean of 2.11 ($SD = 1.203$) while “Elevation” (afternoon) had a mean of 1.45 ($SD = 1.132$) and ($t_{74} = 2.455, p = 0.016$). “Total”

(morning) had a mean of 13.37 (SD = 3.008) while “Total” (afternoon) had a mean of 11.87 (SD = 3.042) and ($t_{74} = 2.161, p = 0.034$).

Posttest achievement results were determined and the conceptual area “Office” (morning) was found to have the highest mean of 5.49 (SD = 0.731) while the concept “Angle” (morning) was found to have the lowest mean of 3.92 (SD = 0.894). The posttest “Total” (afternoon), highest for two posttest total groupings, was determined to have a mean of 23.770 (SD = 2.265). The Levene’s test for the equality of variance, performed on the data prior to the independent t-test determined for the sub-scales “Distance” and “Field” the variances were not homogeneous. Therefore the researcher used the t-test with equal variance not assumed for these comparisons. Test for significant differences between the posttest groups using the independent “t” test resulted in the concept of “Field” having significant differences in compared pairings. “Field” (morning) had a mean of 4.41 (SD = 1.235) while “Field” (afternoon) had a mean of 4.95 (SD = 0.887) and ($t_{65.09} = 2.193, p = 0.032$).

Objective Six

The goal of objective six was the comparison of achievement overall and five defined foundational surveying concepts (office, field, distance, angle, and elevation) of students enrolled in a junior level course in construction surveying at a research extensive university based on the class size in which the instruction was delivered.

Pretest achievement results were determined and the conceptual area “Office” (large) was found to have the highest mean of 3.87 (SD = 1.310) while the concept “Elevation” (small) was found to have the lowest mean of 1.67 (SD = 1.093). The pretest “Total” (small), highest for two pretest total groupings, was determined to have a mean of 12.73 (SD = 2.876). The Levene’s test for the equality of variance, performed on the data prior to the independent t-test determined for the sub-scale “Field” the variances was not homogeneous. Therefore the researcher used the t-

test with equal variance not assumed for this comparison. Test for significant differences between the pretest groups were performed by an independent “t” test. Findings in this area determined no significant results.

Posttest achievement results were determined and the conceptual area “Office” (large) was found to have the highest mean of 5.48 (SD = 0.752) while the concept “Elevation” (small) was found to have the lowest mean of 4.10 (SD = 1.155). The posttest “Total” (large), highest for two posttest total groupings, was determined to have a mean of 23.80 (SD = 2.344). Test for significant differences between the posttest groups using the independent “t” test resulted in no significant differences in these pairings being determined.

Objective Seven

The goal of objective seven was the determination if a relationship existed between achievement overall and five defined foundational surveying concepts (office, field, distance, angle, and elevation) and the pre instructional self perceived ability in surveying of students enrolled in a junior level course in construction surveying at a research extensive university.

There were no significant relationships determined in the correlational analysis. The Perceptual Ability Survey Instrument was estimated to have a high degree of reliability as indicated by a Cronbach’s Alpha of 0.833.

Objective Eight

The goal of objective eight was to determine if a model exists explaining a significant portion of the variance in the criterion variables, post-instructional achievement overall and on the five defined foundational surveying concepts (office, field, distance, angle, and elevation) from the predictor variables including a group of ten personal, academic, and perceptual characteristics.

Multiple regression analysis of the criterion variable posttest “Total” resulted in one predictor variable being identified for a model. The predictor variable identified for this criterion variable was construction management GPA. This variable explained 16.2 % of the variance in the posttest total.

Multiple regression analysis of the criterion variable posttest “Distance” resulted in two predictor variables being identified for a model. The predictor variables identified for this criterion variable were construction management GPA and Age in years. These variables explained 20.7 % of the variance in the posttest Distance sub-score.

Multiple regression analysis of the criterion variable posttest “Elevation” resulted in one predictor variable being identified for a model. The predictor variable identified for this criterion variable was construction management GPA. This variable explained 7.1 % of the variance in the posttest Elevation sub-score.

Multiple regression analysis of the criterion variable posttest “Office” resulted in one predictor variable being identified for a model. The predictor variable identified for this criterion variable was College GPA. This variable explained 10.6 % of the variance in the posttest Office sub-score.

Multiple regression analysis of the criterion variables posttest “Angles” and “Field” resulted in no predictor variables being identified for a model.

Conclusions

Instructional Content

The researcher’s first conclusion is that the instruction delivered in basic construction surveying in this experiment was effective. The conveyed information allowed the study participants to attain significant improvement in scores on the posttest used as a measure of achievement as compared to the pretest assessment. This researcher further concludes the

combination of instruction delivered and student's beginning knowledge were integrated effectively for the generation of authentic basic construction surveying experiences required for the understanding of the five basic concepts (office, field, distance, angle, and elevation),

The first two objectives encompassed describing two of the basic components of this study, the participants and their associated results from both a pre-instruction and post-instruction perspective. It is this researcher's opinion the study participants were a mature group of undergraduate students, close to completion of their college studies. This group was composed of participants with above average academic ability and a minimal amount of knowledge about construction surveying. The instructional treatment presented to all students, regardless of method was determined to be successful based on the large gains recorded on the achievement scores. The following part of this section gives additional more in-depth reasons with implications and recommendations of the researcher.

The instruction provided during this experiment was presented to a group of students comprising four intact classes. These groupings were determined by the study participants for various personal reasons such as personal schedules or degree requirements. Study participants were found to consist of a majority of "Senior" students (greater than 90 hours of completed courses) with most being between the ages of 20 -24 years old. The academic achievement of this group was determined to be in the upper "C" range (2.50 - 2.99) for both overall "College" GPA and Construction Management GPA. Additionally, pivotal classes such as the prerequisite Construction Management class "Materials, Methods, and Equipment I" and the required calculus course "Analytic Geometry and Calculus I" were also found to be in the upper "C" range (2.50 – 2.99). These findings describe a student with above average abilities nearing the end of his college career. The academic background and abilities possessed by the study participants describe a student with the required basic skill set for understanding basic

construction concepts. Courses such as Construction Surveying should be able to build on this basic knowledge, presenting new applications for the analysis and synthesis of new information as presented in Blooms Taxonomy (Lee, 1999).

Achievement test scores, pretest and posttest, provided a plethora of information with significant conclusions. Pretest results provided a benchmark for this experiment where the study participant's skill sets existed in reference to construction surveying at the experiment's inception. The overall pretest composite score describes a group with a minimal amount of understanding of construction surveying as determined in the achievement test scores for the five foundational concepts questions (six questions per concept). The overall group (all participants) was found to be able to successfully answer approximately 40 % of the questions correctly. Pretest assessments of pre-existing basic conceptual knowledge resulted in a higher score in the concept of "Office" which the researcher attributes to the student's understanding of general concepts which entails a large amount of cumulative knowledge. The lower scores in the concepts of "Angles" and "Elevations" are attributed to the minimal knowledge about surveying. The concepts of "Angles" and "Elevation" are more specific to surveying which encompasses significant amounts of integrated information often found exclusively in math and science courses (Genovese, 2007).

Posttest results presented a sizable increase in the "Overall" score with approximately 80% of the questions answered correctly. The concept "Office" was the highest while the concepts of "Angle" and "Elevation" were the weakest. The determination that "Angles" and "Elevation" are also weak in the posttest would present the rationale of some inherent variable causing the low scores on both achievement tests. This weakness could be due to the placement of instruction for these concepts during the experiment (near the end) or to an existing weak skill set such as math (Ellingson, 2006; Williamson, 2008). The concept of "Field" was found to have

the largest increase in raw score from the pretest to the posttest. This increase is attributed to the concept of “Field” being utilized in all practical exercises. The basic components of field are found in all planning applications of any field exercise. The generalization of the field concept in all lab exercises give the study participants an increased amount of time to develop a better understanding of this concept.

The researcher recommends a strategy be implemented which addresses the lowest concept scores found in the posttest assessment. These conclusions for the limited understanding of the Angles and Elevations concepts after receiving the conceptual instruction might be strengthened by lengthening the study by an additional class or placing these two concepts earlier in the curriculum. The extra time would allow the incorporation of an additional exercise for strengthening the noted concepts. For example, the addition of an elevation exercise such as the “peg test” would reinforce the elevation concept along with the related math due to related calculations. Additionally, more time might be spent covering these concepts by overlapping exercises in a way similar to the way the “Field” concept is reinforced over all the exercises at least from a methods standpoint. The cross-over effect for the field concept could be the result of more exposure which allows for more reflection and evaluation of the experience. This enhanced analysis is the basis for a greater understanding of an experience. Also the usage of more querying practical exercises should add to the learning process. This usage of querying exercises enhances the critical thinking of students versus the usage of exercises based in a verifying scheme (Suits, 2004). The revamping of the angle exercise “closing the horizon” should include a more querying format which requires the student to reflect on the exercise in ways that increase the ability to do angle calculations such as angle summation. These types of activities would enhance both the angles concept understanding and the individual’s math skills. These

improvised exercises require more critical thinking of the participant through the integration of math and science components in the practical exercise (Pang & Good, 2000).

Instructional Context

The researcher's conclusion is that the two instructional formats, integrated and separated, used in this experiment are equivalent. This equivalency is based on the finding that the achievement results between the two methods were not significantly different. The researcher further concludes that the time of day and size of class were not significant factors in the instruction of basic construction surveying concepts. Objectives three to six were related to the contextual basis of the experiment. The researcher's conclusions are that both instructional formats were significant as to the ability of increasing the study participant's overall knowledge of surveying. This researcher must further state that all in class work groups used in the four intact classes had three or four members. This grouping is an optimum number given the need for more than two people to perform the lab exercises. Additionally, all class sizes were less than 24 students which the researcher believes is a maximum number for one instructor to effectively manage in the lab portion of the instruction. The following section expands on these conclusions with related implications and researcher recommendations.

The findings of this study offer a number of alternatives to Construction Surveying and other applied sciences. The theoretical and practical instructional treatments achieved significant results in all six areas of comparison, overall and the five concepts on the posttest. Study participants were able to glean the needed information during the experiment for major gains in posttest achievement in all six areas compared. This collaborative grouping of the theoretical and practical instruction was able to create a meaningful experience for an increased adaptive capacity (Innes, 2004). This increased knowledge generated enhanced skill sets for the study participants. The alternative grouping of the collaborative components (theoretical and practical)

into an integrated (experimental) and separated (traditional) format creates opportunities for academia's delivery of instruction in the area of applied science. The determination that both formats of instruction are equivalent in ability to convey the needed information gives instructors more options for class design with variable resources. Universities must seek innovative methods of instruction to meet the changes in available resources and student needs. The ability to schedule a course's instructional delivery through the usage of alternative media such as the internet present unique solutions for addressing these challenges (Clark, 2004; Ghilani & Seybert, 2000; Zheng, 2005).

The traditional applied science class often entails the collaborative combination of theoretical and practical components offered at different time periods for efficient usage of resources. The ability to use the internet and other new media for the delivery of course information poses an opportunity which an instructor could consider using in the development of a distant education type course. This new system of delivery creates a new way for students to reflect on presented material. Theoretical material traditionally presented in lecture is much easier to prepare for internet delivery than practical material due to the required face to face interaction needed in most lab settings. Courses such as the Construction Surveying must place the student with the equipment for the successful creation of a learning experience which entails a different set of logistics for curricula development. These alternative methods of instructional delivery require academia to rethink the collaborative grouping of the lecture/lab components for the maintenance of the authentic experience used by students to increase their knowledge. This study's findings present instructors with results that the separation of the collaborative components should have minimal impact on student's achievement when the same material is presented within a relevant period of time such as a day which was used in this experiment. Findings like these offer distance education an opportunity to investigate usage of non-traditional

methods for presentation of an applied science course such as construction surveying which has a lecture lab format. Lecture material could be offered via the internet with the lab component being offered in a traditional classroom setting.

The integrated format, a hybrid mix of the traditional format, should be the same in pedagogical value based on the results of this study. The integrated format (experimental) has been used by some applied science and science instructors for instruction of courses. This method of bringing both the theory and related practical information during the same class period offers students the opportunity immediate reflection of class material (DiBiase & Wagner, 2002; Overlook, 1994) (Slattery, 2009) (electronic communication). Also the merging of relevant material allows the instructor a more meaningful role as a mentor (Overlook, 1994). This role as a facilitator is one currently being promoted by the NSF (Kemnitzer, 2008) for investigation as to new innovative findings.

The contextual aspects of class size and time of day were also determined to be not significant in achievement for the “Overall” and five foundational concepts. Recognition that class size (24 or less) and time of day have no noticeable impact give instructors some flexibility for planning a construction surveying curricula. The size of work groups should be maintained in the range of four students for the generation of similar results. The group effects have been recognized as having a significant positive impact on the learning process (Gunderson, Moore, & Adams, 2006; Lambert, Terenzini, & Lattuca, 2006; Welch, 2000). Additionally as class sizes increase (greater than 24: six groups) the integrated method becomes impractical for one instructor to logistically manage the lab instruction. This area of instructional research involving the applied sciences offers academics some meaningful insight from a planning aspect. Findings present the instructor of a distance education course the insight that usage of a separate format

when instructing the lecture will have no measurable effect provided the lab portion is offered in an interactive mode with groups limited to four participants and labs sizes of 24 students.

This researcher recommends that applied science courses with class sizes of 24 should use the integrated format given the opportunity the instructor can become more of a mentor. This mentor relationship has been found to be more potent in the teaching process (Beliveau & Peter, 2002; Overlook, 1994). Usage of the integrated format allows for a more “holistic” presentation of an experience. This holistic approach by instructors has been found to be more advantageous to the pedagogical process (Dees, et al., 2007). This holistic approach allows the instructor to look at the creation of an experience in a multidimensional aspect. Instructors must be able to ascertain student’s abilities for designing interactive engaging exercises for a proactive learning experience (Beliveau & Peter, 2002; Pang & Good, 2000). The separated format should be used for larger classes in which the lecture and lab are instructed separately. The traditional lecture/lab is capable of creating equivalent authentic experiences for students when the same material is presented. This ability to create equivalent experiences is supported by the results of this study.

Instructional Research

This researcher concludes that the predictive capabilities for the perceptual ability survey and proposed models were limited in their ability to assess the study participants pre-existing survey knowledge. The goal of objectives seven and eight was to predict the outcome of future experiments based on the assumptions that the instruments used as well as the identified predictors were significant. It is this researcher’s opinion that the information gathered was beneficial but minimally to the stated objectives. The researcher’s conclusion is confirmed by the low pretest scores which reflect a group with a minimal amount of basic construction surveying conceptual knowledge. The ability of a student to self assess his pre-existing knowledge was not successful. Pretest scores determined students had a limited understanding of construction

surveying while their opinions were more robust as to existing knowledge. The researcher's conclusion is the same for the generation of models based on the independent variables (predictors) used. The researcher further concludes that the identified model is not effective in its prediction ability due to only considering academic variables. Inclusion of non academic variables such as cultural ones for example, participation in the construction students association, may show an increase in the amount of explained variance in the model. The results for the model are supportive of some previous conclusions that study participants are intelligent but lack specific survey knowledge. This researcher also believes there are many other aspects of a student's development which impact his current knowledge at the inception of this experiment. The following section expands on these conclusions with related implications and researcher recommendations.

The ability to predict the outcome of a student's success is an area to which many researchers have sought answers. The construction surveying class is an interesting course impacted by many disciplines requiring a diverse skill set (Patterson, 2008) (personal communication). The pre-instructional perceptual ability survey of the study's participants "Survey" knowledge was gathered from a subjective assessment tool which allowed students to gauge their abilities by answering ten questions related to their background in construction surveying. These results are due to the lack of understanding entering students have in their skill set pertaining to this new area of instruction. The assessment of a student's beginning knowledge gives credence to the need for a strong foundation of basic concepts. The development of a relevant skill set will provide participants the critical thinking skills needed for more in-depth analysis of more complex technical applications dependent on the foundational concepts (Ellingson, 2006).

The development of a successful curriculum in this area of surveying has most often been presented from the practical side which transforms the teaching process to a technical training session (Burch, 2005). Technical training required for the new technologies often times doesn't address basic information from a conceptual standpoint. Academics must provide the student with a balanced education of both theoretical and practical information creating a more holistic experience (Beliveau & Peter, 2002). The creation of this experience provides the student the information required for the creation of new knowledge. This process allows the student to comprehend provided information, then analyzing and synthesizing from continual reflection generated from the experience (Innes, 2004; Lee, 1999).

The ability to assess an entering student's skill set at the beginning of a class offers academia a number of prospective opportunities. The capacity to gauge a student's tangible knowledge base gives an instructor some insight as to the planning of a course curricula. By knowing the existing knowledge prior to a course, an instructor can plan instructional delivery to match the potential ability of the class. For the successful completion of any course such as construction surveying, it is imperative that the student have the basic concepts understood. This basic skill set provides the information base for the enhancement of a student's knowledge base (Innes, 2004). Researchers must be able to identify the needed domain knowledge such as the five basic concepts which provide the foundation for instruction on all subsequent specialized applications. Additionally researchers need to identify the predictor variables which provide a student the ability to learn the material to be presented in a course. These identified variables can be gathered together and used in a multiple regression calculation to test the variables worthiness of being included in the desired outcome. The desired outcome is a model which explains the majority of the variance found in a participant's score which is attributed to the impacting variables identified to be included in the model.

Identification of these variables presents researchers a beginning point for the prediction of a participant's score before the outset of an experiment (Orth, 2004). This prediction is based on the projected impact of the identified predictors based on the information entered for each participant. The information gathered for this experiment led this researcher to conclude the identified predictors were weak in the ability to predict the outcome of the student's construction surveying achievement. This assessment is based on the results determined through the multiple regressions of the six dependent variables, overall and five foundational concepts, with the 11 predictor variables. Cumulative knowledge (college GPA) and construction management GPA (CMGPA) were found to be a significant predictor for four of the dependent variables. The identification of these two predictors, "Cumulative GPA" (all classes) and "Construction Management GPA" (CM classes) are obvious indicators of existing knowledge giving an instructor some idea as to potential achievement of the study participant. The low percentage variance realized in all four of the models lead this researcher to believe there are areas outside of the obvious academic dimensions impacting the overall potential ability of the construction management student. This idea of external variables such as culture and non academic issues impacting a student's achievement was identified in a Penn State study (Strauss & Terenzini, 2005). Even though the obvious association of a high GPA presents a student capable of being successful it is not the sole reason. Earlier studies by Darryl Orth (2004) determined that high school GPA and math scores gave the best ability for predicting the success of an entering construction management student. Determination of a group of successful predictors will give researchers in this area the ability to identify the major components of a skill set. Previous studies such as Strauss (2005) point to the positive impact groups have on an individual's learning. This ability to reflect on experiences as a group has proven to be very powerful teaching tools. Studies at the Eisenhower School of Leadership at Texas A&M have achieved

excellent results on real world projects involving hybrid groups of students from the different disciplines which made up the class (Welch, 2000). Identification of effective predictors allows the creation of a model which would serve as a template for evaluating statistically a group of students or an individual's achievement. These defined predictors will allow researchers to project expected outcomes.

This researcher recommends future investigations should include a mixed method study continuing usage of quantitative methods with the incorporation of qualitative methods such as student interviews for the identification of additional potential predictors. This ability to pre-assess a group of students will give instructors insight into the transferability of successful treatments. Identification of successful models will permit researchers the ability to make a logical deduction as to the likelihood of successfully transferring an instructional format such as the two methods used in this research, integrated and separated, to a different demographic group. This ability to evaluate success or failure of a new innovative instructional format will allow researchers the prospect of evaluating the ability to transfer experiments results beyond the experimental group by using the same predictors to generate a result based on the new groups demographics on the identified variables.

The instructional formats used in this experiment should be further investigated for determining a set of basic concepts for instruction of advanced construction surveying layout. Additionally applied science courses which are similarly impacted by technology should identify basics for foundational instruction of students. Academia's synchronization of technological change with maintenance of basic knowledge will provide education a high road as compared to technical training. In closing Beliveau & Peter (2002) stated construction management students today needed to the ability to anticipate problems before they occurred. This proactive ability in

this researchers opinion is a major difference education offers as opposed to the reactive ability technical training provides.

REFERENCES

- Ali, T. A., Nave, J. W., & Clark, M. M. (2005). A new bachelor degree curriculum at east tennessee state university. *Surveying and Land Information Science*, 65(3), 195-200.
- American Council for Construction Education (2006). Standards and criteria for accreditation of postsecondary construction education degree programs, *Document 103*, (pp. 1-29), from <http://www.acce-hq.org/accreditationprocedures.htm>.
- American Institute of Constructors Constructor Certification Commission (2005). *Level 1 - Construction fundamentals*: American Institute of Constructors, 489-494.
- American Society for Engineering Education (1994). Grinter report reprint. *Journal of Engineering Education*, January, 74-94. Retrieved from <http://www.asee.org/resources/grinter/cfm>
- Aramala, J. O. (2000). The impact of new surveying instruments on the construction surveying course of study *Journal of Construction Education*, 5(3), 16.
- Beliveau, Y. J., & Peter, D. (2002). *Educating the builder of tomorrow - A constructivist educational model*. Paper presented at the ASC Proceedings of the 38th Annual Conference, (pp.1-12).
- Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (1999). *How people learn: Brain, mind, experience and school*. Washington, DC: National Academy Press.
- Brock, J. F. (2006, April 24, 2006). *Four surveyors of the gods: In the XVIII dynasty of egypt - new kingdom c. 1400 B. C.* Paper presented at the ACSM Conference, Orlando, Florida, (pp. 1-16).
- Bureau of Economic Analysis (2008). Gross domestic product by industry accounts. *Industry Economic Accounts* Retrieved March 1, 2009, from <http://www.bea.gov/industry/fedguide.htm#gpo>
- Burkholder, E. F. (2005). Geomatics curriculum design issues. *Surveying and Land Information Science*, 65(3), 151-157.
- Burtch, R. (2005). Surveying education and technology: Who's zooming who. *Surveying and Land Information Science*, 65(3), 135-143.
- Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental designs for research*. Boston: Houghton Mifflin Company.
- Chapin, L. T., Rondebush, W. H., & Krone, S. J. (2003). Cooperative education in the associated schools of construction. *Journal Of Construction Education*, 8(1), 56-68.

- Clark, M. M. (2004). *Teaching surveying online: Some experiences* Paper presented at the ACSM 2004 Conference Papers, (pp. 1-11).
- Cox, M., & Diefes-Dux, H. (2007). Expansion of "how people learn" metrics in engineering classrooms. Purdue University: National Science Foundation, from www.nsf.gov/awardsearch/showAward.do?AwardNumber=0648380.
- Crawford, W. G. (2003). *Construction surveying and layout* (3rd ed.). West Lafayette, IN: Creative Construction Publishing, Inc.
- Crossfield, J. K. (2005). *How geomatics professional employment characteristics impact four year educational programs*. Paper presented at the ACSM 2005 Conference Sessions Papers,(pp. 1-5).
- Dancy, M. H., & Beichner, R. J. (2002). But are they learning? Getting started in a classroom evaluation. *Cell Biology Education*, 1(Fall), 87-94.
- Dees, D. M., Ingram, A., Kovalik, C., Allen-Huffman, M., McClelland, A., & Justice, L. (2007). A transactional model of college teaching. *International Journal of Teaching and Learning*, 19(2), 130-139.
- DiBiase, W. J., & Wagner, E. P. (2002). Aligning general chemistry laboratory with lecture at a large university *School Science and Mathematics*, 102(4), 158+. Retrieved from <http://www.questia.com/PM.qst?a=o&d=5002466385>
- Ellingson, L. A. (2006). *Measurement in construction*. Paper presented at the ASC Proceedings of the 42nd Annual Conference, (pp. 1-8).
- Felus, Y. A. (2007). Essential gis concepts in surveying education. *Surveying and Land Information Science*, 67(3), 175-182.
- Genovese, I. (2007). Surveying up close. *ACSM Bulletin*(227), 12-16.
- Gentry, D. (2009). Conceptualizing the scholarship of teaching and learning. 4. Retrieved from <http://www.sotl.ilstu.edu/resLinks/sotlMats/SoTL.shtml>
- Ghilani, C. D. (2000). The surveying profession and its educational challenge. *Survey and Land Information Systems*, 60(4), 225-230.
- Ghilani, C. D., & Seybert, T. A. (2000). Experience in the delivery of an internet course *Survey and Land Information Systems*, 61(2), 197-203.
- Gibson, D. W. (2007). Peer review for quality. Point of Beginning, April 1. 2007, (pp. 1-6). Retrieved from http://www.pobonline.com/copyright/BNP_GUID_9-5-2006

- Goel, S. (2005). Do engineering faculty know what's broken. *The National Teaching and Learning Forum*, 15(2), 1-10.
- Greenfeld, J., & Potts, L. (2008). Surveying body of knowledge - Preparing professional surveyors for the 21st century. [survey education]. *Survey and Land Information Science*, 68(3), 133-143
- Gunderson, D. E., Moore, J. D., & Adams, M. S. (2006). *Group learning pedagogy and value analysis*. Paper presented at the ASC proceedings of the 42nd Annual Conference, (pp. 1-8).
- Hatipkarasulu, Y., Liggett, B., & Padilla, D. (2008). *Using technology to teach a new generation of constructors: A student perspective*. Paper presented at the 44th General Meeting of ASC at Auburn, (pp.1-9).
- Holley, P. W. (2005). *Alternative reference materials: A case study in publishing a digital textbook for construction surveying*. Paper presented at the ASC Proceedings of the 41st Annual Conference, (pp. 1-10).
- Holley, P. W., & Dagg, C. (2005). *Multidisciplinary collaborative experiences: A case study in sustainable construction and design*. Paper presented at the ASC Proceedings of the 41st Annual Conference, University of Cincinnati, (pp. 1-6).
- Howard, W. (2005). Leadership: Four styles. *Education*, 126(2), 384+.
- Innes, R. B. (2004). *Reconstructing undergraduate education: Using learning science to design effective courses*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Jackson, S. A. (2003, October 11, 2003). *Engineering education in the 21st century*. Paper presented at the Society of Women Engineers, Birmingham, Alabama, (pp. 1-7).
- Kavanaugh, B. F. (2007). *Surveying with construction application* (6th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.
- Kay, D. H. (2003). *Adding a land surveying option to a construction management program*. Paper presented at the ASC Proceedings of the 39th Annual Conference, Clemson University, (pp. 1-8).
- Kemnitzer, S. (2008). Innovations in engineering education, curriculum, and infrastructure. Arlington: National Science Foundation, (pp.1 - 14), from <http://www.nsf.gov/pubs/2008/nsf08610/nsf08610.pdf>.
- Kenny, R. W. (1998). Reinventing undergraduate education: A blueprint for america's research universities, (pp. 1-46). Retrieved from <http://naples.cc.sunysb.edu/Pres/boyer.nsf/>
- Kenyon, R. A. (1993). The coming revolution in engineering and engineering technology education: A new paradigm for the 21st century. *Education*, 113(3), 361+.

- King, C. J. (2006). Engineers should have a college education. *Research and Occasional Paper Series : CHSE.8.06*, (pp. 1-7). Retrieved from <http://cshe.berkeley.edu/>
- Kreber, C. (2003). The scholarship of teaching; A comparison of conception held by experts and regular academic staff. *Higher Education*, 46(1), 93-121.
- Lambert, A. D., Terenzini, P. T., & Lattuca, L. R. (2006). *More than meets the eye: Curricular and programmatic effects on student learning*, (pp.1-37). Paper presented at the Association for Institutional Research. Retrieved March 24, 2007
- Lattuca, L. R., Terenzini, P. T., & Volkwein, J. F. (2006). Engineering change: A study of the impact of ec2000. Baltimore, MD: ABET, from [http:// Engineering%2520Change222.pdf](http://Engineering%2520Change222.pdf)
- Lee, V. S. (1999). Creating a blueprint for the constructivist classroom. *The National Teaching and Learning Forum*, 8(4), 1 - 6.
- Lowe, P., Ashworth, A., & Williams, A. (2008). *How effectively do current learning methodologies prepare graduates in the UK workplace?*, (pp. 1-12). Paper presented at the 44th General Meeting of ASC at Auburn, Auburn University.
- Matthews, B. (2004). *The effects of direct and problem-based learning instruction in an undergraduate introductory engineering graphics course*. (Doctoral Dissertation, North Carolina State University, Raleigh). Networked Digital Library of Theses and Dissertations, URN etd-09022004-130834.
- McCall, M. W., Jr., Lombardo, M. M., & Morrison, A. M. (1988). *The Lessons of Experience: How Successful Executives Develop on the Job*. New York: The Free Press.
- McCauley, C. D., & Velsor, E. V. (2004). *The Center for Creative Leadership: Handbook of Leadership Development* (2nd ed.). San Francisco: Jossey-Bass.
- McCuen, T. L. (2007). *Industry experience: An important requirement for construction faculty*, (pp.1-8). Paper presented at the 43rd General Meeting of ASC.
- McDuffie, A. R., & Graeber, A. O. (2003). Institutional norms and policies that influence college mathematics professors in the process of changing to reform-based practices. *School Science and Mathematics*, 103(7), 331+. Retrieved from <http://www.questia.com/PM.qst?a=o&d=5002572074>
- McNair, L., Terpenney, J., Goff, R., Paretto, M., & Borrego, M. (2007). Preparing engineering students for the challenges of interdisciplinary design teams, Virginia Polytechnic Institute and State University: National Science Foundation, from www.nsf.gov/awardsearch/showAward.do?AwardNumber=0648439.
- Merriam-Webster (2009). *Merriam-Webster Online Dictionary*. Retrieved from <http://www.merriam-webster.com/dictionary>

- Millett, C. A., Payne, D. G., Dwyer, C. A., Stickler, L. M., & Alexiou, J. J. (2008). *A Culture of Evidence: An Evidence-Centered approach to Accountability for Student Learning Outcomes*. Princeton, NJ: ETS.
- Naberezny, B. J., & Ghilani, C. (2005). Revving up an introductory surveying lab. *Surveying and Land Information Science*, 65(3), 163-168.
- National Science Board (2007). *Moving forward to improve engineering education*. Arlington, VA: National Science Foundation.
- NCEES. Procedure to become a licensed surveyor Retrieved information retrieved from website on November 15, 2006., from http://www.ncees.org/licensure/licensure_for_land_surveyors/#how
- Noble, D. (1999). Pursuing scholarship in teaching. *The Whistle*, (pp1-3). Retrieved from <http://www.whistle.gatech.edu/archives/99/july/5/teaching.html>
- Overlook, T. H. (1994). *Comparison of effectiveness of collaborative learning methods and traditional methods in physic classes at northern maine technical college*. Nova Southeastern University, (pp. 1-29). Retrieved from ERIC Ed 367394.
- Orth, D. L. (2004). *Identifying predictor variables of students success in a construction management program*, (pp. 1-9). Paper presented at the ASC Proceedings of the 40th Annual conference, Brigham Young University.
- Ozmon, H. A., & Craver, S. L. (2003). *Philosophical Foundations of Education* (7th ed.). Upper Saddle River, New Jersey: Merrill Prentice Hall.
- Pang, J., & Good, R. (2000). A review of the integration of science and mathematics: Implications for further research. *School Science and Mathematics*, 100(2), 73. Retrieved from <http://www.questia.com/PM.qst?a=o&d=5002329488>
- Reeves, K., Hernandez-Gantes, V., & Blank, W. (2007). Using constructivist teaching strategies in engineering education: Gauging the impact on student learning and retention. University of South Florida: National Science Foundation, from www.nsf.gov/awardsearch/showAward.do?AwardNumber=0648190.
- Ryan, R. C., & Callahan, M. P. (2007). *Developing and teaching a collaborative design and construction administration course*. Paper presented at the 43rd General Meeting of ASC, (pp. 1-11).
- Sanders, M. (2006). Technology education leadership: Observations and reflections. *The Technology Teacher*, 66(3), 31+. Retrieved from <http://www.questia.com> March 13, 2008.
- Schultz, R. (2007). Geomatics education: Two major problems. *Professional Surveyor Magazine*, 27, (pp. 62-64).

- Senior, B. A. (2001, April 4-7). *Engineering evaluation criteria 2000: A critical review centered on construction education*. Paper presented at the ASC proceedings of the 37th Annual Conference, University of Denver, (pp. 117-124).
- Smolka, C. M. (2002). Adult learning, social sciences, and technology: A combination for the future. *International Journal of Public Administration* 1113+. Retrieved from <http://questia.com>.
- Strauss, L. C., & Terenzini, P. T. (2005). *Engineering learning: Multiple influences on the development of analytical and group skills*. (pp. 1-20). Paper presented at the Association for Institutional Research.
- Suits, J. P. (2004). Assessing investigative skill development in inquiry-based and traditional college science laboratory courses. *School Science and Mathematics*, 104(6), 248+. Retrieved from <http://www.questia.com/PM/qst?a=o&d=5007637083>
- Turner, H., & Neto, F. A. (2000). Integration of technology into a surveying engineering curriculum. *Surveying and Land Information Systems*, 60(1), 37-46.
- Utschig, T. T., & Schaefer, D. (2008). *Opportunities and challenges in professional education-related faculty development in the us*, (pp. 1-6). Paper presented at the 38th ASEE/IEEE Frontiers in Education Conference. Retrieved November 17, 2008, from http://www.srl.gatech.edu/Members/dschaefer/Publications/paper_1731_final.pdf
- Van de Walle, J. A. (1999). *Reform mathematics vs. the basics: Understand the conflict and dealing with it*, (pp. 1-14). Paper presented at the 77th Annual Meeting of NTCM.
- Volkwein, J. F., Lattuca, L. R., Harper, B. J., & Domingo, R. J. (2006). *Getting in sync: The impact of accreditation on student experiences and learning outcomes*, (pp. 1-35). Paper presented at the Association for Institutional Research.
- Walker, S. E. (2006). Journal writing as a teaching technique to promote reflection. *Journal of Athletic Training*, 41(2), 216-221.
- Welch, R. L. (2000). Training a New Generation of Leaders. *Journal of Leadership Studies*, 7(1), 70+.
- Williams, S., & Liu, J. (2003, April 8 - 12). *Implementing advanced construction layout technologies utilizing university/industry collaboration - A case study*, (pp.1-11). Paper presented at the ASC Proceedings of the 39th Annual Conference, Clemson University.
- Williamson, K. C. (2008). *College mathematics problem solving ability*, (pp.1-14). Paper presented at the 44th General Meeting of ASC at Auburn, Auburn University.

- Wilson, J. W., Fernandez, M. L., & Hadaway, N. (1993). Mathematical problem solving. In P. S. Wilson (Ed.), *Research ideas for the classroom: High school mathematics*, (pp. 1-25). New York: MacMillan.
- Wurm, K. B. (2005). Andragogy in survey education. *Surveying and Land Information Science*, 65(3), 159-162.
- Zheng, D. X. M. (2005, April 6-9, 2005). *Construction Engineering Education Models in Florida*. Paper presented at the ASC Proceedings of the 41st Annual Conference, University of Cincinnati, (pp. 1-5).

APPENDIX A

CONSENT FORM

1. Study Title: Determination of the most Efficient Collaborative Method of Instruction for Basic Construction Surveying
2. Performance Site: Louisiana State University and Agricultural and Mechanical College
3. Investigator: The following investigator will be available for questions about this study, M-Th, 11:30 a.m. – 4:30 p.m.
Gabriel N. Trahan Jr. 578-7129
4. Purpose of the Study: The purpose of this research project is to determine whether disassociating the presentation of the collaborative components, practical and theoretical, of a Basic Construction Surveying application will have a measurable effect.
5. Subject Inclusion: Individuals enrolled In Construction Management 3100, “Construction Surveying and Layout”, Fall 2008
6. Number of Subjects: 96
7. Study Procedures: The study will consist of the first 6 weeks of Construction Management 3100. Prior to the first of 3 units of instruction, students may be presented a pretest. As a potential participant, the student has the right to withdraw from the study at any time during the testing period. At the conclusion of the first unit of instruction, all students will complete a post test. The test scores for all students not participating in the study scores will be removed prior to data analysis.
8. Benefits: Study will yield valuable information as to the more efficient method to present the conceptual material of basic construction surveying.
9. Risks: The only risk would be the inadvertent release of test scores. However, every effort will be made to maintain the confidentiality of test scores. Files will be kept in secure cabinets to which only the investigator has access. No individual identifiers will be included in the data coded for analysis on the computer.

10. Right to Refuse: Subjects may choose not to participate or to withdraw from the study anytime without penalty or loss of benefits to which they might otherwise be entitled.
11. Privacy: Results of the study may be published, but no names or identifying information will be included in the publication. Subject identity will remain confidential unless disclosure is required by law.
12. Signatures: The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigator. If I have questions or other concerns, I can contact Robert C. Mathews, Institutional Review Board, (225) 578-8692. I agree to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

Signature of Subject

Date

APPENDIX B

PERCEPTUAL ABILITY SURVEY

Name _____ **Survey/Layout Skill Inventory**
 Email _____ Student ID number _____

Rate your Ability using the following scale from (1-4)
 Circle the best answer that describes your Ability in each area.

(1) No ability (2) Low ability (3) Medium ability (4) High ability

Statements	Answers			
1) Describe your survey field ability	1	2	3	4
2) Describe your construction layout ability	1	2	3	4
3) Describe your ability to operate an optical level	1	2	3	4
4) Describe your ability to operate a laser level	1	2	3	4
5) Describe your ability to operate a Total Station	1	2	3	4
6) Describe your ability to operate a Transit (Either digital or conventional)	1	2	3	4
7) Describe your ability to operate a Survey grade GPS receiver	1	2	3	4
8) Describe your ability to work with electronic construction drawings	1	2	3	4
9) Describe your ability with mathematics in general	1	2	3	4
10) Describe your ability with trigonometry	1	2	3	4

11) If you have prior surveying or construction surveying experience, please circle the category which best describes the setting in which this skill was learned.	1 Weekend Warrior 2 Assisted on a survey crew 3 Construction survey crew 4 Professional survey crew member
---	---

APPENDIX C
ACHIEVEMENT TEST

Legend for description of each questions construct area (At the end of each Question)

A (Angle)
D (Distance)
E (Elevation)
F (Field)
O (Office)

Name
CM3100

Fall 2008
Exam 1

- 1) Field Angle used for the establishment of an accurate grid system, by measuring the direction and distance between a series of points is called?
 - A) Direct Angles
 - B) Traverse Angles
 - C) Reverse Angles
 - D) Accumulated Angles

A

- 2) How many degrees are found in an 11 sided polygon?
 - A) 720
 - B) 1800
 - C) 1080
 - D) 1620

O

- 3) 2 Vectors defining an angle have the following directions at a nodal point. The incoming vector has a azimuth of 168 degrees with an outgoing vector azimuth of 118 degrees. What angle from the following group is created by this intersection?
 - A) 140 degrees
 - B) 130 degrees
 - C) 328 degrees
 - D) 150 degrees

A

- 4) What is the sum of the following angles 20d 12' 14", 13d 18' 22" & 19d 45' 56"?
 - A) 53d 26" 35"
 - B) 54d
 - C) 53d 15' 42"
 - D) 53d 16' 32"

O

- 5) Which of the following is not a basic rule for measuring a distance with a steel tape?
- A) Never cut a distance
 - B) Measure in 1 direction only
 - C) Pull tight to eliminate sag
 - D) Use chaining pins on multiple chain lengths **D**
- 6) When laying out a distance of 100 ft. with a chain having an actual length of 100.01 ft, how is the measured distance corrected when measuring between the 2 points. (How is the correction applied)?
- A) Subtracted
 - B) Added
 - C) Multiplied
 - D) Divided **D**
- 7) Distances measured in areas of different elevations require an improvised methodology, which of the following techniques describes this field application?
- A) Incremental measuring
 - B) Breaking chain
 - C) Random occupation
 - D) Holding the tape high **D**
- 8) From the following list which one is used to measure distances?
- A) Electronic Transit
 - B) Laser levels
 - C) Total Stations
 - D) Automatic Levels **D**
- 9) Given a rectangular structure that is 40 ft on one side with a diagonal distance of 50 ft. What is the length of the other side?
- A) 65 ft
 - B) 50 ft
 - C) 30 ft
 - D) 74 ft **O**

- 10) When reading a rod for determining elevations, a rod man should do which of the following?
- A) Rock the rod left to right slightly
 - B) Rock the rod back and forth slightly
 - C) Hold the rod solid and stiff
 - D) Place the rod close to the point of interest
- F**
- 11) When using an optical level, field engineer's can focus both the cross hairs and image. Which of the following describes the situation of unfocused crosshairs?
- A) Parabolax
 - B) Parallax
 - C) Parallelism
 - D) Haziness
- F**
- 12) Benchmark is best described as
- A) Point used in the differential leveling process with a known elevation
 - B) Point marked by a 60d slotted nail
 - C) Permanent solid point whose elevation must be determined
 - D) Point which is used as a temporary point in the leveling process
- E**
- 13) Record keeping is an important part of surveying. Which of the following is considered to be a legal document?
- A) Sub contractors log book
 - B) Engineers field book
 - C) Superintendent's site drawings
 - D) Daily production reports
- O**
- 14) Calculate the benchmark elevation from the following information? (Turning point elevation 30.6 ft., Back sight rod reading 2.8 ft., and a closing level loop rod reading of 6.3 ft.)
- A) 29.9 ft.
 - B) 36.9 ft.
 - C) 39.7 ft.
 - D) 27.1 ft.
- E**

- 15) Mechanical part of an automatic level which creates a horizontal line of sight is?
- A) focusing pinion
 - B) horizontal cross hair
 - C) compensator
 - D) objective lens retainer
- E**
- 16) Field engineers and layout personnel are not qualified to perform which task from the following list?
- A) Set building corners
 - B) Radial layout of design points
 - C) Set jobsite control
 - D) Establish property lines and boundaries
- F**
- 17) Field engineers must be aware of many important concepts in the performance of field applications. When performing a series of measurements (angles elevations or distances) if all the shots were very close this series of shots could be considered to have a high degree of?
- A) Tolerance
 - B) Precision
 - C) Accuracy
 - D) Maintenance
- F**
- 18) Bucking the line in a leveling exercise is best described by which selection?
- A) Setting an HI at the beginning of a job which can be converted to a daily elevation
 - B) Random location of instrument each day
 - C) Location of instrument next to primary control monument
 - D) Using the same HI every day
- E**
- 19) Three measurable values which determine the position of one point to another?
- A) Plumb, level, straight
 - B) Height of Instrument, horizontal angle, zenith angle
 - C) Direction, distance, elevation
 - D) Diagonal, grade, plumb
- O**
- 20) Closing the level loop is a procedure requiring which of the following selections?
- A) Ending a traverse line at a primary control point
 - B) Ending a level line at a turning point
 - C) Ending a level line at a benchmark
 - D) Ending a level line at the end of the open traverse
- E**

21) Office duties performed by field engineers include all of the following except

- A) Project documentation
- B) Information requests by owners
- C) Building design
- D) Procurement of materials

O

22) Which of the following normally provides most of the survey control information on a jobsite?

- A) Wooden stakes
- B) Site drawings
- C) Superintendents meetings
- D) Planimetric features

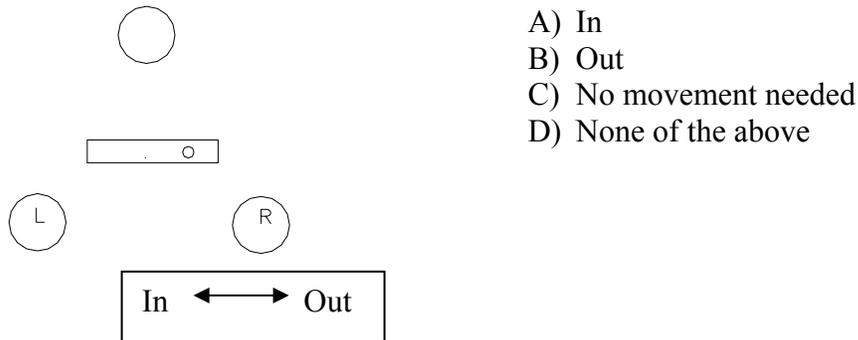
F

23) A steel chain with a nominal length longer than the actual length would be considered what type of error?

- A) Instrumental
- B) Natural
- C) Environmental
- D) Operator

D

24) Which direction does the right screw “R” needs to move to center the bubble?



F

25) When measuring a distance with a steel tape, which of the following 4 selections has a minimal or no effect?

- A) Extreme Temperatures
- B) Flat ground
- C) Alignment
- D) Sag in the tape

D

26) The following term $229^{\circ} 22' 23''$ is best described by which of the following?

- A) Bearing
- B) Azimuth
- C) Line of Sight
- D) Parabolic direction

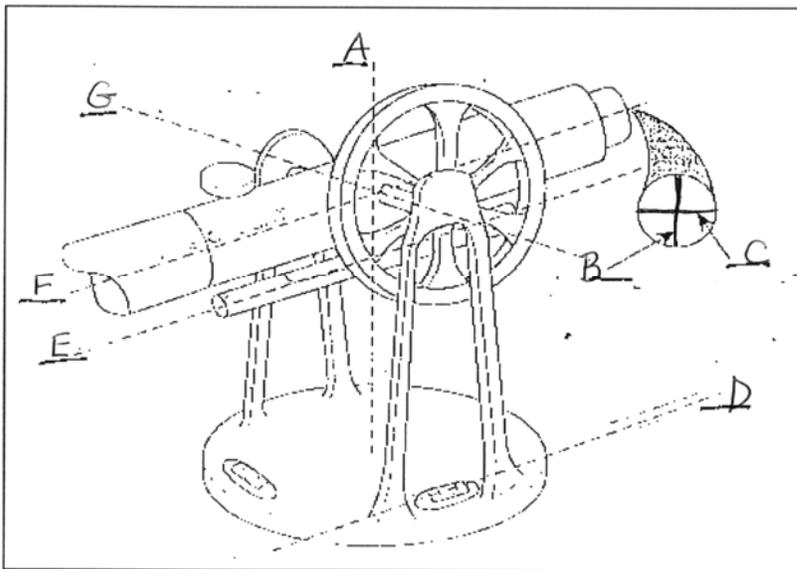
A

27) Which of the following angle closes the horizon for the following 4 angles ($30^{\circ} 20'$, $50^{\circ} 20'$, 210° , $20^{\circ} 20'$)?

- A) $49^{\circ} 20' 20''$
- B) $59^{\circ} 30' 20''$
- C) 59°
- D) 49°

A

28) From the following diagram which selection denotes the vertical axis of this standard transit?



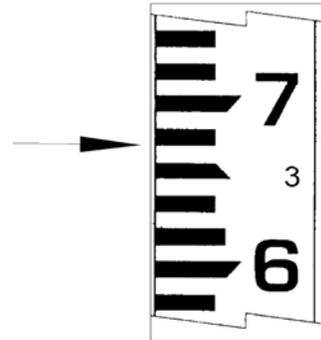
- A) F
- B) G
- C) A
- D) B

A

29) What is the rod reading denoted by the diagram where the arrow point denotes on the rod section?

- A) 3.72
- B) 3.65
- C) 3.67
- D) 3.74

E



30) Construction surveying requiring the turning of angles involves methods which deliver high accuracies. Which of the following should always be performed when turning angles?

- A) Long Backsight
- B) Short Backsight
- C) Long Foresight
- D) Short Foresight

A

<p>Day 3</p> <p>Lecture Chapter 2 (completed) Chapter 3 (partial) Power Point 2 “Planning and Communication”(completed)</p> <p>Lab Basic lab 1 Introduction to Digital Transit (Northwest NETH203)</p>	<p>Day 3</p> <p>Lab Field lab 1 “Location of points” Basic lab 1 Introduction to Digital Transit (Northwest NETH203)</p>
<p>Day 4</p> <p>Lecture Chapter 3 (completed) Power Point 3 “Fieldwork Practices”</p> <p>Lab Field lab 2 “Measure Direction with a Compass”</p> <p>Layout of Field book presented</p>	<p>Day 4</p> <p>Lecture Chapter 3 Chapter 4 Power Point 3 “Fieldwork Practices” Power Point 4 “Chaining a Distance”</p> <p>Layout of Field book presented</p>
<p>Week 3</p>	
<p>Day 5</p> <p>Lecture Chapter 4 Power Point 4 “Chaining a Distance”</p> <p>Lab Field lab 3 “Measuring a Distance with a Steel Chain Tape”</p>	<p>Day 5</p> <p>Lab Field lab 2 “Measure Direction with a Compass” Field lab 3 “Measuring a Distance with a Steel Chain Tape”</p>
<p>Day 6</p> <p>Lecture Chapter 5 (partial) ½ Power Point 5 “Angles”</p> <p>Basic lab 2 “Introduction to Angle Operation of Northwest NETH203 Digital Transit”</p>	<p>Day 6</p> <p>Lecture Chapter 5 Power Point 5 “Angles”</p>

Week 4	Week 4
<p>Day 7</p> <p>Lecture Chapter 5 (completion) Power Point 5 “Angles’ (completed)</p> <p>Lab Field lab 4 “Closing the Horizon”</p>	<p>Day 7</p> <p>Lab Basic lab 2 “Introduction to Angle Operation of Northwest NETH203 Digital Transit” Field lab 4 “Closing the Horizon”</p>
<p>Day 8</p> <p>Lecture Chapter 7 (partial) ½ Power Point 6 “Leveling”</p> <p>Lab Basic lab 3 “Introduction to the Operation of Northwest NCL22 Auto Level”</p>	<p>Day 8</p> <p>Lecture Chapter 7 Power Point 6 “Leveling”</p>
Week 5	Week 5
<p>Day 9</p> <p>Lecture Chapter 7 (completion) Power Point 6 “Leveling” (completed)</p> <p>Lab Field lab 5 “Level Loop with Elevation Determination”</p>	<p>Day 9</p> <p>Lab Basic lab 3 “Introduction to the Operation of Northwest NCL22 Auto Level” Basic lab 3 “Introduction to the Operation of Northwest NCL22 Auto Level”</p>
<p>Day 10</p> <p>Exam 1 Posttest given 1 hour time limit</p>	<p>Day 10</p> <p>Exam 1 Posttest given 1 hour time limit</p>

“Construction Surveying and Layout” 3rd Edition by Wesley G. Crawford
(Note Power Point Presentations were prepared from material generated and diagrams scanned from the aforementioned textbook by Wesley Crawford.)

APPENDIX E
FIELD EXERCISES

Lab Exercise 1

Location

Objective: This Lab Exercise will involve the location of our 13 control points. Additionally distances will be measured between the 12 working points by pacing. Record data for the lines listed below along with a diagram of points in a sketch for a Field Book entry (Example below).

Basic steps:

- 1) Class will perform this exercise individually
- 2) Evaluate site noting location and description of points
- 3) Layout 100 ft fiberglass tape and determine your number of steps /100ft
- 4) Pace off distance between points noting each lines specific number. Calculate distance by multiplying paces x length of your pace recording calculated distance in the table.

Title of Lab: Location and Estimated Distances

Line	Paces	Distance
1-2		
2-3		
3-4		
4-5		
5-6		
6-7		
7-8		
8-9		
9-10		
10-11		
11-12		
12-1		

Lab Activity 2

Measuring Direction with a “Compass”

Objective: This Lab Exercise will involve the measurement of directions between 12 control points. Direction will be recorded for for each line using the supplied compasses. Record data for the lines listed below in the Field Book (Example below). Sketch a rough drawing showing each direction.

Basic steps

5) Directions will be recorded (estimate to nearest 5 degrees)

Title “Measuring Direction with a Compass”

Line		Direction	Line		Direction
1-2			2-1		
2-3			3-2		
3-4			4-3		
4-5			5-4		
5-6			6-5		
6-7			7-6		
7-8			8-7		
8-9			9-8		
9-10			10-9		
10-11			11-10		
11-12			12-11		
12-1			1-12		

Lab Activity 3

Measuring Distances with a Steel Tape

Objective: This Lab Exercise will involve the measurement of longer control lines in a forward and reverse direction. Distance will be recorded using guidelines introduced in class for measuring distances longer than one chain length. Data will be recorded in the Field Book (Example below).

Basic steps

- 6) Class will divide into Groups
- 7) Distance will be measured on a group of set points in a forward and reverse direction
- 8) Record distances using a steel tape
- 9) On right hand side average the distances and compare results.

Title “Measuring Longer Distances with a Steel Tape”

Line	Steel Distance (F)	Steel Distance (R)	Average	(F-R)	Discrepancy Ratio
1 - 2					
2 - 3					
3 - 4					
4 - 5					
5 - 6					
6 - 7					
7 - 8					
8 - 9					
9 - 10					
10 - 11					
11 - 12					
12 - 1					

Lab Activity 4

Closing The Horizon

Objective: This lab will introduce the Angle Measuring aspect of a Surveying Instrument (Horizontal Angles). Multiple Targets will be placed at various points and direct horizontal angles will be determined and recorded.

Basic Steps:

- 1) Set the Transit over a set Point
- 2) Turn the instrument on, Tilt Scope (Initialize)
- 3) Sight to backsight (point on Left) with the Vertical cross hair splitting the target
- 4) Zero Set Horizontal Circle on Backsight (Make sure clamp for horizontal is clamped)
- 5) Release motion and turn to Foresight(point on Right)
- 6) Record Horizontal Angle
- 7) Repeat (Log both Horizontal Angles) and average
- 8) Proceed to next Point Sequence

Title: Closing the Horizon

Backsight Point	Foresight Point	Angle 1	Angle 2	Average
1	2			
2	3			
3	4			
4	5			
5	6			
6	7			
7	8			
8	1			
			Total	

Lab Activity 5

Differential Leveling “Level Loop”

Objective : This exercise will introduce the automatic level and the concept of Differential leveling.

Basic Steps

- 1) Each group will start the level loop by Backsighting to a Benchmark Hub Pt.100A (assumed elevation of 100.00 ft).
- 2) Proceeding from the benchmark to the TBM Pt 12 (2 setups with turning points will be utilized.) (note procedure from lecture)
- 3) Returning from the TBM back to the Benchmark will provide the the Closing of the Level Loop
- 4) Side shots will be taken to pts 7 and 8 before closing loop
- 5) Perform Arithmetic Check of BS and FS to confirm Calculations
- 6) Note example of Field Book layout Below

Title Level Loop

Point	BS	HI	FS	SS	Elevation
BM to TBM					
BM 100					
Inst1					
TP 1					
Inst2					
TBM pt 12					
TBM to BM					
TBM pt 12					
Inst 3					
TP 3					
Inst 4					
Point 7					
Point 8					
BM 100					

VITA

Gabriel Norman Trahan is a native of Southeast Louisiana. He graduated from East Jefferson High School. Gabriel attended the University of New Orleans, graduating in December 1977, with a Bachelor of Arts degree in biological sciences. He has worked in the surveying and engineering field since 1983 as a systems specialist offering measurement solutions to the engineering and construction industry. Gabriel completed a Master of Business Administration at the University of New Orleans in August 1987.

Gabriel joined the LSU Construction Management Department as an adjunct instructor in 2002 developing the current construction surveying course. He was promoted to a full time instructor in the fall of 2006. His life long dream of a doctorate became possible through the many integral contacts from being affiliated with Louisiana State University. This pursuit for Gabriel began in September of 2005 and will be completed in December of 2009 when the degree of Doctor of Philosophy is conferred at the Fall Commencement ceremony.