Experiential Learning from Internships in Construction Engineering

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Abstract

The fundamental, educational value of internship experience in undergraduate construction engineering education is explored. Analysis of learning outcomes from the structured, construction internships required for the B.S. degree in Construction Engineering and Management at Purdue University are compared with experiential learning theories of Kolb and others, providing a basis for explaining how internship learning "works." The nature and benefits of construction internships which comprise authentic involvement are presented. Students' reported learning experiences are compared to the four modes of experiential learning, concrete experience, reflective observation, abstract conceptualization, and active experimentation. Prevalent learning modes during construction internships are found to be active experimentation and reflective observation, and it is inferred that the dominant learning style in a construction environment is the accommodative learning style postulated by Kolb. Conclusions are drawn based on data from 170 student reports from internship work sites across the country over two years. Important observations include the realization that quality internships enable students to "learn how to learn" in ways that are highly applicable in their future work environments, and that are not otherwise attainable in classroom learning. It is shown that undergraduates are more adequately developed for many demands of their future practice when educators make high-value experiential learning a part of the curriculum.

A. Introduction

Purposes of the study

The analysis reported in this paper is part of a broader effort to substantiate three hypotheses which are believed to characterize experiential learning from effective, undergraduate student internships in the practice of construction engineering and management. These hypotheses are:

1. The knowledge gained by students through experiential learning from internships in construction constitutes significant and uniquely valuable preparation for the requirements of their future professional practice in that field;

2. Much of the learning which is gained during these internships cannot be attained in any other way, especially not in the classroom, and

3. A valuable outcome of construction internships is "learning how to learn," a situation which deserves

appreciation by engineering educators.

A necessary, initial approach for exploring these hypotheses was to examine the nature of the learning which takes place during construction internships, and to describe it in terms of established learning theory. Clear understandings of the nature of this learning, once described, can provide a basis for educators to accept and act upon the hypotheses above.

The specific focus of the present study is to show that the learning which happens during effective construction internships is aptly described and interpreted by an established model for experiential learning, that of David A. Kolb[28].

<u>Conditions for the study</u>

The study is based on a review of the existing literature on experiential learning, and on analysis of the outcomes of student learning from the program of structured construction internships which are required for the ABET-accredited, Bachelor of Science degree in Construction Engineering and Management at Purdue University.

The term "internship" has a wide range of connotations in engineering education. In this study, and to extrapolate its conclusions, certain characteristics of an internship program and of the students' status and experience apply. An "effective internship" as used in this study is characterized by:

a. Completing the internship assignment(s) is an integral component of the engineering degree program and constitutes a significant educational objective of the program;
b. The university takes an active role in the quality and the administration of the intern's experience;
c. The student intern's employer ("sponsor firm") is actively engaged in management and execution of major construction projects and conscientiously mentors the student intern;
d. The student, the university, and the sponsor firm all share a common goal: highly effective student learning through authentic involvement, and
e. The student appreciates the importance of learning from, and the benefits of succeeding in, the internship experience.

Internship work periods typically are scheduled so that the student can complete the university course of study in the normal (say, eight semesters in residence) time. In the internships on which this study is based, students can be assigned to work locations anywhere in the U.S., but usually away from home and never on campus.

The Purdue University internship program for the Bachelor of Science in Construction Engineering and Management (BSCEM) reported on in this study is described later. The background for this program was previously described by Tener[50].

<u>Reader's Guide</u>: Content of the six sections of the paper:

A. Background and B. Kolb's Model of Experiential Learning cover relevant theories and models which explain education as the process of learning through the transformation of experience;

C. Internships as Learning Activities covers the particular characteristics of learning on internships, and the benefits of these educational programs to students, universities and employers;

D. Experiential Learning and the Construction Environment covers the unique characteristics of the construction environment and discusses some skills and attributes needed by construction engineers and managers;

E. Understanding How Construction Interns Learn Using Kolb's Model covers a study which analyzes and explains the learning modes experienced by 170 undergraduate construction interns during two summers of field work, and

F. Conclusions contains a concise tally of what was learned from this study.

Readers who are knowledgeable about experiential learning theory and models could skip sections A and B; readers knowledgeable about current engineering co-op and internship learning programs could skip section C, and readers familiar with construction engineering and management practice could skip section D.

B. Background

> *"For education the lesson is clear; its prime objective must be to increase the individual's cope-ability, the speed and economy with which he can adapt to continual change…Experiential programming methods will supplant the familiar, frequently brain-draining lecture ... Students must learn how to learn…Tomorrow's illiterate will not be the one who can't read; it will be the one who has not learned how to learn."*[23]

Educators and constructors almost universally believe that work experience in construction during undergraduate years provides students with significant learning that could not be gained otherwise. Nonetheless, only about 10% of construction education schools have field internship programs[53]. Significant opportunities exist for universities to expand the number and value of construction internship programs.

To provide university educators and administrators with incentives for increasing the use and the quality of internship programs, new understanding about the nature and benefits of experiential learning in the construction environment is needed. The effort needed must go beyond simply advocacy and opinions. The concept that field experience for undergraduate construction engineers in fact comprises real learning must be validated.

Literature Review

Here some accepted definitions and theories of experiential learning in higher education are briefly summarized. A more complete review of the literature on experiential learning for engineering undergraduates was reported[54].

Certain issues prevalent in the literature on this topic are relevant to engineering educators today, such as the observation that, to meet the demands of society, learning must be dynamic, lifelong, and relevant to learner needs[8]. Learning by doing is fundamental to the educational process. Co-op programs, apprenticeships, internships, and practica have always been components of skill-oriented study programs. The laboratory has always been regarded as a necessary component of engineering education. Even so, the fundamental values of and benefits from experiential learning for engineering undergraduates have yet to be fully exploited.

A number of taxonomies (classifications of educational objectives) exist which document the learning sequence followed by students in the learning process. Probably the most well known is Bloom's taxonomy for the cognitive domain[5], which includes knowledge, intellectual abilities and intellectual skills. The affective domain includes interest, attitudes, and values[30]. The psychomotor domain includes motor skills and speech behaviors[47]. Lastly, the experiential domain includes the participative acquisition of knowledge[49]. Each of these taxonomies describes the levels of increasing sophistication that learners display as they proceed from the beginning of their awareness to the limit of behavioral change.

To develop sophisticated skills requires learning activities that include individualized interaction with situations that are realistic, open-ended, complex, unstructured and perhaps even undefined[23]. The desired attributes attained in learning activities in the upper levels of the taxonomy are essentially derived by involving the student in complex, problem-solving, decision-making activities. It then follows that experiential learning activities should be an intended component of a learning program.

The Pioneer – John Dewey

It is primarily in this century with the work of John Dewey that learning through experiences has become valued as an important foundation in formal educational settings. Dewey anchored his thinking in the assumption of an "organic connection between education and personal experience." It is the work of Dewey, probably the most influential educational theorist of the twentieth century, which best articulates the guiding principles for programs of experiential learning in higher education[28].

In the last 50 years, many of Dewey's ideas have found their way into traditional educational programs. A myriad of programs have emerged including internships, cooperative education, apprenticeships, work-study programs, engineering clinics, service learning, and laboratory studies. In each of these approaches, experiential learning can be more-or-less characterized by:

> *"Students who use information they are trying to learn, who challenge and grapple with their new knowledge, or who use it to solve problems,*

tend to learn more effectively than students who passively read, memorize, or merely absorb that to which they have been exposed." [23]

Piaget's Theories of Childhood Development

Stated simply, Piaget's theory describes how intelligence is shaped by experience. Intelligence is not an innate characteristic of the individual but arises as a product of the interaction between the person and his or her environment[28]. Simplified and edited versions of Piaget's work focusing on those aspects of his theory which affect engineering education are presented in *Teaching Engineering*[51].

Piaget's work identifies and describes four major stages of cognitive growth that emerge from birth to about the age of 14-16. In the final stage, during onset of adolescence, the child moves from symbolic processes based on concrete operations to the symbolic processes of representational logic, the stage of formal operations. The child develops the possible implications of his or her theories and proceeds to experimentally test which of these are true. Therefore, the child's basic learning style is convergent, in contrast to the divergent orientation in the earlier, representational stage.

Piaget's cognitive development theory identifies those fundamental developmental processes that shape the basic learning process of adults[18].

Perry's Theory of Development of College Students

William Perry's work illustrates how college students respond to their college education. Briefly stated, Perry's model is concerned first with how students move from a *dualistic* view of the universe to a more *relativistic* view, and second, how students develop commitments within this relativistic world.

Perry describes dualism as: "Division of meaning into two realms – Good versus Bad, Right versus Wrong, We versus They, All that is not Success is Failure, and the like. Right answers exist somewhere for every problem and authorities know them. Right answers are to be memorized by hard work. Knowledge is quantitative". In contrast, Perry terms the highest stages of development "Commitments in relativism," defining commitment as "an affirmation, choice, or decision…made in the awareness of relativism". Perry's relativism is "Diversity of opinion, values, and judgment derived from coherent sources, evidence, logic, systems, and patterns allowing for analysis and comparison. Some opinions may be found worthless, while there will remain matters about which reasonable people will reasonably disagree. Knowledge is qualitative, dependent on contexts"[41].

Perry found that as students move through college, most display distinct movement away from Dualism toward Commitment. He found in students an increasing capacity to recognize ambiguities, conflicts, and paradoxes, an increasing capacity to tolerate these conditions, and an increasing capacity to make commitments[26].

Experiential learning presents particularly rich demands for reasoned, thoughtful commitment and action in the face of ambiguity, conflict, and paradox[26]. It constitutes situations in which, as Perry notes, "knowledge is qualitative, dependent on contexts." The tension between the demand for action and the barrier to action calls for the student to engage in a controversial give and take that can be extremely challenging, even painful, for the student. This realistic challenge, however, is a significant driver of the student's growth.

The Work of David A. Kolb

The widely respected model of experiential learning today is that of David A. Kolb. Kolb has theorized and defined experiential learning as a multi-dimensional process. In his model, the process of experiential learning is described as a four-stage cycle involving four adaptive learning modes -- concrete experience, reflective observation, abstract conceptualization, and generalizations, and active experimentation. The next section covers Kolb's model in more detail, as it is the dominant experiential learning theory applicable to construction internships.

C. Kolb's Model of Experiential Learning

It is Kolb's model that the authors find most valuable for interpreting and describing "how learning works" during construction internships. No other published theory is as complete for our purposes nor as descriptive of the range and depth of the opportunities, experiences, and outcomes which are typical for construction interns. The ways that student interns learn in a construction environment, as described in their reports and observations, are clearly decipherable by applying the terms and concepts in Kolb's model.

In formulating his model of experiential learning, Kolb primarily built on the work of Dewey[13], who recognized the importance of experience in the process of learning; Lewin[31], who emphasized active participatory learning; and Piaget[42], who conceived of intelligence as largely a result of the interaction of the individual with the environment.

At the heart of Kolb's model "is a simple description of how experience is translated into concepts that can be used to guide the choice of new experiences"[2]. He describes learning as a four-step cycle based on the orthogonal relationship of two continua of cognitive growth and learning: the concrete-abstract continuum and the reflective-active continuum (Figure 1). The concrete-abstract continuum, which represents how individuals gather (grasp) information from their environment, ranges from a preference for involvement with particular and palpable events to a preference for detached analysis. The reflective-active continuum, which represents how individuals process (transform) the information they gather, extends from learners who take a more observational role in learning to those who prefer active participation. Individuals must continually choose, along the respective continua, how they will gather and process information to resolve the problems and conflicts presented by any learning situation[2].

According to Kolb, experiential learning proceeds through these four modes, which require four different types of abilities. The *concrete experience* (CE) mode requires individuals to immerse themselves in the immediacy of the moment, relying on their intuitive and affective responses to the situation. Conversely, *abstract conceptualization* (AC) calls for logical thinking and rational evaluation to create ideas that integrate their observations into logically sound theories. *Reflective observation* (RO) demands a tentative, impartial perspective toward a learning situation – a willingness to patiently consider many alternatives. *Active experimentation* (AE) stresses action, participation, and risk taking in learning, with an emphasis on pragmatically testing previously generated concepts.

In Kolb's model flexibility is the key to effective learning and, hence, to optimal performance in any endeavor. "A learner moves through the cycle by first having an immediate experience (CE), which becomes the basis for observations and reflections (RO). These observations and reflections are assimilated and distilled into a concept or theory (AC), from which new implications for action can be generated. The newly developed ideas can then be tested actively (AE) and can serve as guides for creating new experiences. The cycle begins anew, but at a higher level of complexity"[2].

As will be shown, the four modes in Kolb's cycle are clearly illustrated time and again when construction interns report the ways in which they gained valuable learning from their experiences.

Relevance of learning types and cycles

"Nothing is ever real until it is experienced." *John Keats*

Significant research and investigation has been performed describing the various dichotomies in learning styles. Wankat & Oreovitz summarized these works in their excellent book, *Teaching Engineering* [51]. They first describe *reflection versus impulsivity*[11] which measures the tendency either to reflect over possible answers or to impulsively select a solution. Secondly, information processing can be either *deep or shallow*[11]. Deep processors learn the meaning and connections of ideas, whereas shallow processors tend to learn in terms of symbols and by memorization. Another dichotomy involves *deductive and inductive* learners[17]. Deductive reasoning starts with general principles and then deduces consequences from these general principles. Inductive reasoning begins with specifics and then proceeds to induce generalities. Other dichotomies are also interpreted (*field-independent versus field-sensitive, sequential versus holistic, etc.*).

A particularly relevant dichotomy reported by Wankat & Oreovicz involves active and reflective processing of information. Active experimenters want to do something with the information in the external world. They want to try the activity and learn by doing, thus, experiential learning. Reflective individuals want to process the information internally. They want to contemplate it. This dichotomy is part of the Kolb learning cycle, discussed earlier. Building on this model, Kolb developed an inventory of learning styles. The four types developed are Divergers, Assimilators, Convergers, and Accommodators, described and characterized in Table 1. A modified interpretation of Kolb's learning cycle encompassing the learning styles is shown in Figure 2.

TABLE 1. Kolb's Learning Styles Taxonomy[4]

KOLB'S LEARNING STYLES TAXONOMY				
Characteristics	DIVERGERS (DIV)	ASSIMILATORS (ASM)	CONVERGERS (CON)	ACCOMMODATORS (ACC)
Grasp Experience Through	Concrete Experience	Abstract Conceptualization	Abstract Conceptualization	Concrete Experience
Transform Experience	Reflective observation	Reflective observation	Active experimentation	Active experimentation
Their Major Strength	Imaginative ability	Create theoretical models	Converge quickly to one answer. (opposite to DIV)	Do well in situations where they must adapt. Use trial & error. (opposite to ASM)
They like to	View situations from different perspectives and weave many relationships into a meaningful whole.	Assimilate diverse data into an integrated whole. Focus on ideas and theories.	Deal with things rather than people.	Focus on doing things and having new experiences.
They are	People oriented Emotional	Less interested in people Concerned about abstract concepts	Unemotional	Risk takers Intuitive Impatient Pushy
Preferred Learning Activities	Brainstorming Role playing Discussion Questioning Visualization Journals	Lectures Reading Objective testing Seminars Example problems Analyzing	Laboratory Simulations Problem solving Experiments Reports Demonstrations Tinker	Do it themselves Design Open-ended problems Work experience Teach someone else Think tank

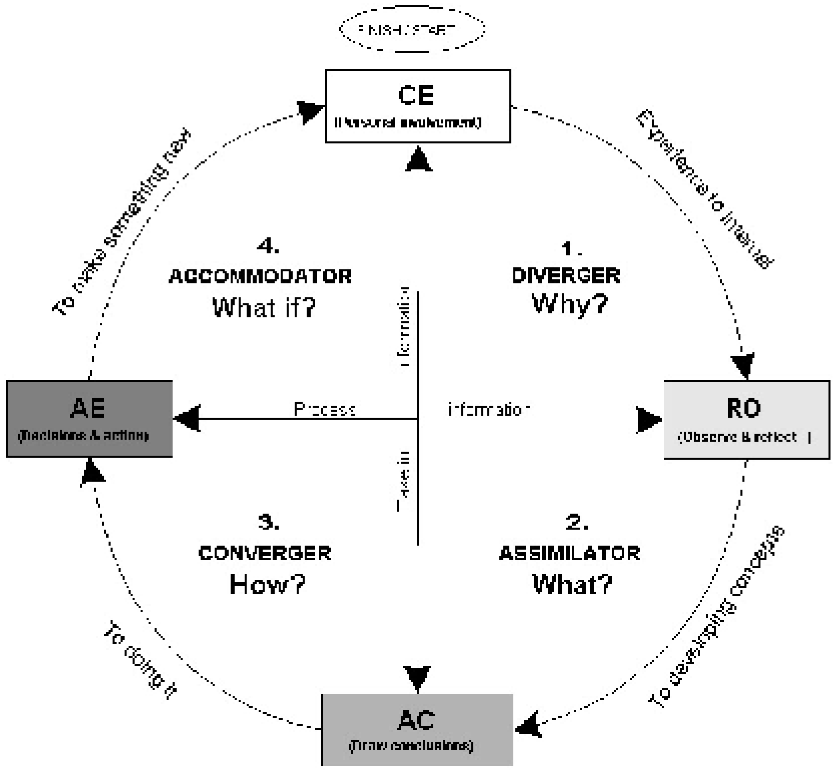

Figure 2. Modified Kolb's Learning Cycle [28,51]

How does one discover which students are characterized by the various learning styles? The Learning-Style Inventory (LSI) can be highly effective in identifying learning styles in students. It is relatively inexpensive and easy to administer, and students themselves can score it[26]. It can be especially useful to have prospective interns take Kolb's LSI prior to beginning their internship. Discussing their own preferred learning style, the special strengths of their learning style, and the ways their learning style may either conflict with or complement alternative styles can aid students to a more fruitful internship experience[26]. The Myers-Briggs Type Indicator (MBTI) is also a proven tool in engineering education for recognizing and accommodating interpersonal differences[51].

It is important to note that while these are *preferred styles*, every student has the potential for using, and the need for developing, all four styles. By working through Kolb's entire cycle systematically, a student would be compelled to use all styles. Individuals whose preference for a givenstyle is particularly strong can determine the niches within which they will be more likely to succeed. According to Wankat and Oreovicz[51], accommodators tend to move toward management, sales and marketing; divergers move toward personnel and creative positions. Convergers tend toward hard-core engineering jobs such as plant operations, design, and construction. Assimilators gravitate toward research, development, and planning.

Lastly, the critical relevance of Kolb's learning styles and learning cycle to experiential learning becomes even more evident when considering the normal routines to which engineering students are exposed during their college education. McCarthy[34] describes this routine as a "pendulum style" of teaching. That is, it oscillates between quadrants 2 (what?) and 3 (how?), favoring assimilators and convergers. This routine, commonly found throughout engineering education, fails to complete the entire learning cycle. Students seldom have the opportunity to, and may not have learned the motivations to, "try it themselves," unless they have directed co-ops or internships. This pendulum style constrains the retention of knowledge and fails to excite the preferred learning style of many students[51].

Summary

A range of credible theories exist which can serve as bases for understanding the nature of experiential learning. For learning situations provided by construction internships, the Kolb model is the most valuable and relevant and will be employed throughout the analysis which follows. An extension of Kolb's and other theories is presented in Appendix A: "Some Characteristics & Objectives of Experiential Learning," which educators may find of value in further interpreting and describing student learning from internships, co-ops, and related programs.

D. Internships as Learning Activities

"Experience is not what happens to you, it's what you do with what happens to you."

Aldous Huxley

Context

The various models of experiential learning activities fall into two classes according to Harrisberger et al.[23]: simulations and "authentic involvement." Simulations consist of fabricated situations that are carefully designed to meet selected learning objectives and are under close faculty control. "Authentic involvement" exposes the student to real situations with open-ended outcomes, although the faculty may influence the selection of the situations and set performance criteria to assure that established learning objectives are attained.

The focus of this study is on learning activities from "authentic involvement." Authentic involvement activities occur within real, live, on-going situations. They involve a "client" who has a real need to obtain a solution that generally has not yet been determined. The client may be an industrial firm, an institution or a government agency, depending on the field of study. In the case of construction engineering and management interns, the clients (here termed sponsor firms) are usually general contractors, construction managers, specialty trade contractors, engineering firms, or construction owners.

The common and widely adopted form of authentic involvement learning for engineering students is the alternating work and study program, known as the cooperative education or "co-op" program. Through cooperative education student learning is extended into the workplace. For nearly a century in U.S. engineering education, co-op students have enjoyed the significant benefits of irreplaceable experiential learning, preparating them for their engineering careers. In "Co-op's 90-Year Odyssey," Sam Sovilla has chronicled the history of and the key issues in co-op programs in engineering education[48].

The authors believe that the analysis and conclusions presented in this study can be found applicable and relevant to co-op learning in the civil and construction engineering fields, and probably to other engineering fields as well. The scope of the study, however, is hereafter focused on programs defined as effective construction internship programs.

Nature of Internships

A wide variety of formats for undergraduate learning through authentic involvement are termed internships. Internships are defined for purposes of this study as follows:

> *Internships – A structured and supervised professional experience, within an approved agency, for which a student earns academic credit. It usually involves a specified period of time with employment status while on leave from the academic program. It usually has little or no academic content or faculty involvement, except for placement assistance[26].*

An internship engages the student in a unique relationship between the work place and the academic institution – a three-way partnership where, intern, site supervisor, and academic advisor are key players in the learning opportunity described in previous sections[26]. This interdependent partnership is represented in Figure 3.

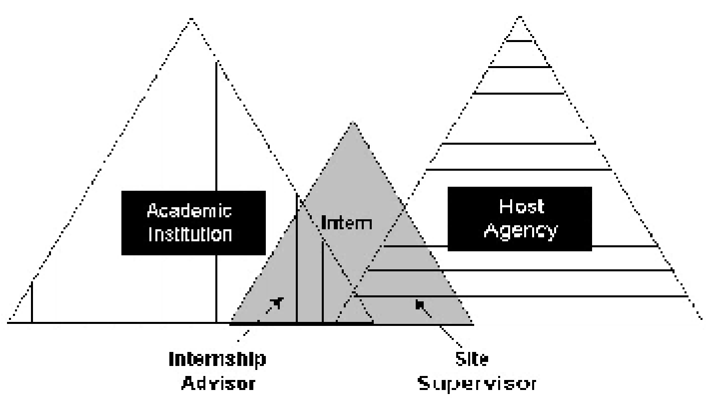

Figure 3. The Internship as Transformative Partnership [26]

The key players operate as a partnership with a shared goal: the intern's learning, growth, and development. To be effective, the internship needs the sustained commitment, cooperation, and involvement of all three members in achieving its objectives. Note that, according to Inkster & Ross, overlapping of the site supervisor and internship faculty advisor is a key feature of the partnership. In the 24-year experience of the Purdue University BSCEM program, this close working relationship of university and sponsor firm is essential.

Benefits of Effective Internships

Benefits to Students

The influence of cooperative education work experience on aspects of development and growth of the student participants has been reported. Students participating in internship programs can test their early choice of career fields and make decisions based upon on-the-job experience. Studies also indicate increased academic performance such as higher grade point averages, fewer failed courses, and higher graduate record examination scores[44].

It is the authors' observation that student interest and enthusiasm in the classroom is enhanced as a result of their internship experiences. The academic course of study takes on new meaning and coursework becomes more relevant, even if indirectly, when the student believes the subject relates to activities they have seen in authentic work situations.

After-graduation job prospects are improved because of the internship work experience. These students enter the work force with, generally, more maturity, self-reliance, social skills, and confidence in their abilities to set goals and to achieve them. They generally have a well-developed sense of purpose, both as to their career choice and their place in that career. Upon graduation they appreciate the advantages that their internship experience and learning has provided as they face their impending job demands. Their self-confidence and demonstrable knowledge of the "real world" are significant benefits during job interviews, with those students who have interned usually gaining the preferred job offers.

A particularly significant benefit from internship experience is the development of the student's sense of self-efficacy. Self-efficacy is defined as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances"[3]. Superficially, self-efficacy may seem similar to self-confidence or self-esteem, which are simply people's opinions of themselves. Self-efficacy however influences human behavior in work environments more deeply than does self-esteem. Self-efficacy "plays a powerful role in determining the choices people make, the effort that they will expend, how long they will persevere in the face of challenge, and the degree of anxiety or confidence they will bring to the task at hand"[16]. The concept of self-efficacy provides an explanation as to why personal behavior can vary widely between persons of similar skill level attempting similar tasks. Construction internships almost universally enable students to develop their self-efficacy beliefs, as can be shown.

Employers of engineering graduates today look for a set of skills, the so-called "soft skills," that are usually well-developed during construction internship assignments. These include oral communication, written communication, critical thinking skills, leadership, and an overall sense of the "big picture." Appropriate behavior traits such as accepting responsibility, taking initiative, respecting flexibility, and acting with a sense of urgency are developed. Student interns will manage and resolve job stress, learn conflict resolution skills, and develop self-control behaviors. Interns experience such tasks as facilitating meetings and managing within constraints, gaining organizational skills that are hardly ever attained in the academic setting.

Money earned while interning provides financial assistance to pay college expenses and is available to each student regardless of family income levels or other financial arrangements. Thus, students who intern are less burdened by financial needs. This can be a factor in a student's initial interest in and commitment to pursue an internship.

Benefits to the University

The university which accepts as its mission the preparation of graduates for engineering practice cannot fail to recognize the imperative role which experiential learning must play in the undergraduate's education. When the university proactively supports an effective internship program, it can enjoy positive effects on curriculum development, on the quality of student life, and even on the finances and resources of the university. Institutional benefits of internship programs, compiled from numerous sources, include:

- Expands the range of educational opportunities for students by integrating learning at the workplace into the academic program.
- Assists in the recruitment and retention of students.
- Improves student and faculty access to state-of-the-art equipment and technology by using the workplace as a laboratory extension of the classroom.
- Keep college curricula up-to-date with changes in industry through constant input from the employment sector.
- Provides the ability to offer a direct learning experience to students, which should provide them with positive motivation.
- Builds a positive relationship between the institution and the business community[27,38,44].

It is the authors' experience that an effective internship program, administered in close concert with intern sponsor firms who hire the graduates, gains the university respect and resources which would not otherwise be generated.

Benefits to Employers

Employers invest in interns for a variety of reasons, but either first or second on everyone's list is early identification of potential long-term hires. Most employers desire to make the best possible selection of new hires, increase the cost-effectiveness of recruiting expenditures, reduce the new-hire turnover, and build bench strength[38]. However, not every intern will receive an offer of post-graduate employment and not every full-time offer will be accepted. The following list of employer benefits was compiled from several sources:

- Provides an excellent pool of well-prepared employees.
- Improves personnel selection process by using actual on-the-job performance as a basis for permanent hiring decisions.
- Increases cost-effectiveness of recruitment and training.
- Increases retention rates among permanent employees recruited and hired through an experiential learning program. Both students and employers have the time to try out the position and ensure that the fit is the most productive and effective for both.
- Enhances human resource flexibility with effective short-term employees.
- Strengthens company relations with colleges and students sources[27,38,44].

Of the three parties involved in the internship process, it is generally the employers who realize how beneficial an effective internship program can be. Often it is the university that needs convincing, not the industry nor the students. Pressure from industry to supply interns can influence the university to adopt and maintain a quality internship program, to the ultimate benefit of all parties.

D. Experiential Learning and the Construction Environment

As preface to the study of specific internship experiences in construction, a brief overview of the nature of construction engineering and management practice and the characteristics commonly expected among construction managers is useful.

<u>Scope of Construction Engineering and Management Practice</u>

MIT Construction Management Professor Fred Moavenzadeh described well the scope of the construction engineering and management endeavor:

> *"Construction engineering and management is concerned with assembling and transforming manpower, materials, equipment and economic resources into the buildings, industrial plants, and infrastructure facilities required to serve a variety of societal needs. It involves accomplishing planning, design, construction, operations, and maintenance activities through a complex network and set of interrelationships among a diversity of private companies and governmental organizations. In addition to the construction contractors and subcontractors who perform the actual construction work, other participants in the process include – the client or owner who defines the need for a facility; the investor or lender who provides the capital; the engineers and architects who design the facility; the labor organizations which supply manpower resources and skill, the manufacturer and suppliers who provide construction materials products and equipment; regulatory agencies which prescribe and enforce codes, standards, and regulations; and other*

organizations and individuals involved in research development, education and informantion exchange."[36]

Construction engineering and management in the U.S. is no longer an unsophisticated, unprofessional endeavor. Integral components of this thriving profession now include strategic planning and management; development and application of newly engineered systems of material and equipment; specialized financial management; development and applications of information technology; niche strategies and market segmentation; leadership and human resource management in a demanding, "people" business, and productivity and competitiveness issues to cite a few.

The general nature of management embraces all the activities found in the construction environment:

- Planning (setting goals and standards, scheduling, budgeting, programming)
- Controlling (evaluation of performance, in view of the plan, resources, quality)
- Organizing (dividing tasks, departmentalizing, establishing communication procedures)
- Directing (guiding, instructing, motivating, training)
- Coordinating (with designers, suppliers, authorities, subcontractors)[52]

These universal managerial activities are carried out throughout the construction processes. However, managerial tasks in construction are executed in an environment which is very different from that encountered in other industries. Unique aspects of the construction environment include:

- Every project has distinctive characteristics regarding its purpose, design, setting, stakeholders, and the resources needed for its execution.
- Each project is executed in a different location with a different labor force.
- There is seldom unified authority for all phases of design and production.
- Every project has a permanent influence on its neighborhood, and uniquely impacts the safety and well being of its users.
- Successful execution of each project is highly dependent on the performance of teams of people brought together for that particular project.

Together, these features profoundly influence the managerial, economic, legal and sociological aspects of the construction process. Few managerial tools and techniques, whether involving scheduling, accounting, information systems or robotics, can be applied "as is" to the construction practice. Actually, some current trends (expanding use of the design-build method of project delivery, and a tendency for engineering design practice to become a more rote process, based on codes, manuals and computer programs) are yielding a contention that the managing of construction ventures may be the most challenging professional field within civil engineering practice[35].

The construction industry, as always, is undergoing constant change. Increasingly, the industry is looking to university construction programs to meet the need for entry-level, trained engineers and managers to keep up with this rapid change. Construction educators have to date met their calling to prepare constructors for the workplace. However, from numerous respected sources, there is evidence that construction programs must change in the future to respond the demands of this dynamic marketplace. [22, 43, 46, 52]

Skills and Attributes of Construction Managers

The professional practice of construction engineering and management requires university graduates with the needed education, experience and personal attributes. The challenge of how to prepare students in these areas is therefore of importance to the industry and to conscientious educators[52]. Publications on the subject describe the prevailing construction management programs and include detailed reports of the construction industry's stated needs for program content[7,10,14,22,35,39].

From these studies it is evident that communication, management and control, problem-solving, and leadership are the among the pivotal knowledge, skills, and abilities required of future construction managers. Tomorrow's marketplace will reward individuals who can manage people and information, set and meet objectives, and lead their projects to success. This concept is articulated in the words of a construction expert who noted, "I don't sell construction. I sell people and communication"[35].

Construction engineering, scheduling and planning, estimating, and project management will continue to be important competencies for constructors. These core subjects reflect the focus of most undergraduate construction curriculums today. Yet, competency in these traditional subjects alone is not sufficient to succeed in today's construction environment. The growing need is for competencies in communicating effectively with people of diverse backgrounds, mentalities, attitudes, and experience. The success of each construction venture depends on the abilities of managers and engineers to communicate orders, instructions, requests, reports and myriad other types of information, to all the participating parties[52].

This brief comment on the construction work environment provides a context for examining closely the way in which experiential learning from construction internships works.

E. Understanding How Construction Interns Learn Using Kolb's Model

This study comprised an analysis designed to discern the nature of student intern learning modes, using 170 student intern reports from their summer work experience and based on Kolb's model. First we introduce briefly the particular internship program to explain the settings for the student experiences. The analysis and conclusions follow.

The Purdue Construction Engineering and Management (CEM) Internship Program

The student's internship obligation for the Purdue BSCEM degree requires students to complete three twelve-week internships, employed by a sponsor firm, usually a construction contractor or corporation.

Placement of interns with sponsor firms is arranged and closely controlled by Purdue faculty through the Director of Internships. Each CEM student intern completes the three work periods with the same sponsor firm, with occasional exceptions. Student work locations and job assignments are determined by the sponsor firm, who submits an evaluation of the intern's performance to the university for each work period. At the conclusion of each work term, students are required to submit a written report to the CEM Director of Internships covering the experience during the work period.

Research Methodology

In a concluding section of the summer internship report, all students were required, during 1999 and 2000, to respond to these questions: "(1) What was the most valuable thing I learned during this internship period? and (2) "How did I learn that?" This simple device was designed to elicit an open-ended, personal observation by the student which might reveal either or both (a) the substance (topics) from the construction environment which the student considered important and were learned, and (b) the learning modes employed by interns in their construction work. While a more comprehensive questionnaire might be crafted, the results of using this simple device proved quite revealing and were deemed valuable for a first-order analysis.

A total of 198 reports from student interns in their first, second, and third summer work periods, were read and analyzed. The 170 usable student reports exhibited learning abilities in terms explainable by Kolb's model of experiential learning. Due to a variety of reasons, 14% of all 198 internship reports submitted were unusable. Some students did not respond to the questions usefully while some simply omitted the "most valuable learning" section.

The students' "most valuable learning" responses were analyzed and categorized according to the four modes of Kolb's model of experiential learning: concrete experience, reflective observation, abstract conceptualization, or active experimentation. While many reports displayed that the student employed more than one of the four modes, each response was categorized based upon the learning ability that was most dominantly utilized.

An example will illustrate: In one internship report, a student stated that the most valuable skill that she learned over the summer was the details of how a concrete placement operation works. Further, she stated that she learned this information while hypothesizing a new method for concrete delivery. The background information on her experience is as follows. During fieldwork, the intern was assigned to a concrete placement operation. While placing the concrete, she continuously watched and absorbed the details of the operation (concrete experience). After the initial stint of placing concrete, the intern reflected on the processes that were involved in the placement operation. In this case, she observed a flaw in the concrete delivery (reflective observation). Once this flaw was identified, the intern thought of a better way to move the concrete from the truck to the placement site (abstract conceptualization). The next day on the job, the intern tried out the new system, and observed its effectiveness (active experimentation). In learning about concrete placement, this intern moved through all four stages of Kolb's model. Based however upon the intern's written description of how she learned this skill, the majority of the learning appeared to occur while the student was contemplating a new method of concrete delivery. This experience was then classified as abstract conceptualization. In cases such as this one, the author classified the dominant learning mode used according to his judgment in interpreting the student's written report.

In some cases learning experiences appeared to represent two of the modes in equal measure. For instance, a student stated that the most valuable item learned during the summer, communication around the jobsite, was learned by watching others and then by applying these methods. In such cases the experience was categorized as both active experimentation and concrete experience, with ½ point allocated to each of these categories.

To further illustrate ways that students' reported learning modes were interpreted, excerpts from selected reports below are compared to Kolb's description of the relevant learning mode. Appendix B contains 30 additional excerpts from student reports which the authors found especially revealing and interesting.

Concrete experience:

> "The most valuable thing that I learned this past summer was how the general contractor fits into the whole project…I learned this by going to the weekly jobsite meetings with the owner and design professionals and also seeing some of the interaction between the superintendent and the subcontractors." (M. M., 2000)

Kolb describes concrete experience as the ability to "involve oneself fully, openly, and without bias in new experiences"[27]. When recounting their most valuable learning experiences, construction student interns repeatedly use phrases such as 'I learned this by observing…' 'I learned this by watching others…' and 'I learned this by being completely immersed in…' Interns describe numerous situations where they absorbed the details of the experiences, akin to Kolb's description of concrete experience.

Reflective observation:

> "The most valuable thing that I learned was not realized when on the job but while looking back and evaluating my experience. I found the most important thing is that I need to take charge of my own learning…I came to this realization when looking back and seeing what I was disappointed that I did not learn or do." (J. H., 2000)

The excerpt clearly portrays Kolb's definition of reflective observation, explicitly stating that she came to a new realization by looking back and critically evaluating her experience. Kolb's definition of reflective observation, "They must be able to reflect on and observe their experiences from many different perspectives," matches many student reports.

Abstract conceptualization:

> "Throughout this internship, I learned one extremely valuable thing: The plans may be printed in black and white, but when it comes time to build them, there are many shades of gray that come into the picture. This was brought to my attention many times throughout the internship, but one time exemplifies this learning experience.
> In the $17 million middle school, there is a lot of stained and scored concrete. It sounds simple on the plans. You pour the slab, score it, and then stain it. Where is the problem?
> The problem is since this is exposed concrete, and heavy equipment, such as lifts, will be running across it, it would be next to impossible to prevent any chipping, cracking, or gouging from occurring. You could put plywood over the concrete after you stain and score it to protect the concrete. Problem solved. Not exactly, what happens when rocks work their way under the plywood and then chip the concrete?
> You could hold down the concrete a couple of inches, come back and top it off, then stain and score it. If that is the case how do you set the structural steel to the correct elevation on the imbeds? What exactly do you do?
> These are just a few of the possible solutions to the particular problem. As you can see there are indeed problems introduced into the picture that plans do not account for." (R. K., 2000)

The learning described here details the process of abstract conceptualization. The student identified a problem with the current situation and projected possible solutions to the problem. Kolb's definition of abstract conceptualization is, "They must be able to create concepts that integrate their observations into logically sound theories," as this student did.

Active experimentation:

> "The most valuable thing I learned this past summer was how to communicate on the phone. I did a lot of it and I finally became good at it." (B. G., 1999)

> "The most valuable thing I learned this internship period would definitely have to be how to manage/run a project and deal with people. I was able to learn all of these things by actually being 'thrown' on the job without much prepping or knowledge of the project. I was able to learn by a hands-on approach as opposed to a theoretical approach." (J. C., 2000)

In each of these situations, the intern actively participated in the construction process, thereby elevating his own personal knowledge through this participation. These interns adapted through active experimentation. Thrust into a situation, after initial experiences, they performed according to Kolb's definition of active experimentation: "using theories (created during abstract conceptualization) to make decisions and solve problems."[28]

Data Analysis: Learning Modes

Using the methodology described above, 170 student reports from a two-year period were categorized according to the learning modes displayed. The results are compiled in Table 2.

Learning Mode	1999	2000	Total	Percentage
Active Experimentation	29	42	71	42%
Reflective Observation	17	39	56	33%
Concrete Experience	16	17	33	19%
Abstract Conceptualization	5	5	10	6%
Total	67	103	170	100

Table 2: Learning Modes from Construction Student Intern Reports

As the data shows, active experimentation was the most frequently encountered mode of learning (42% of cases), according to students reporting their most valuable learning experience in construction internships. Typically, students who adapted through this mode learned either a technical skill or something about themselves. For students whose most valuable learning experience was adapted through reflective observation (33% of cases), either communication skills or something about their own identity were most typically learned. Concrete experience was a less common mode of adaptation (19% of cases). When concrete experience was reported, students typically learned a communication skill, with some instances of technical skills. Abstract conceptualization accounted for only 6% of the total number of experiences, all involving the learning of a technical skill.

<u>Data Analysis -- Learning Styles</u>

Some tentative inferences may be made as to learning styles which appear to be favored in a construction internship environment. While the "simple device" questions to which students responded in this study were not intended to generate information about their learning styles, invoking Kolb's model again can provide some potentially useful indications.

As seen in Figure 2, each quadrant of the Kolb's model represents a learning style. Each quadrant is bounded by two learning modes. In the case of the accommodative style, concrete experience and active experimentation comprise the boundaries. Likewise, each of the other three styles (quadrants) have a closer relationship to two particular learning modes. By grouping the learning mode data drawn from student reports (Table 3) pair-wise, some preference for the respective quadrants of the model may be suggested.

Table 3 displays for each learning style the relative prevalence of the respective modes for the 170 student experiences. The sum of concrete experience plus active experimentation -- bounding the accommodative learning style -- has the highest "score." One might presume from this that the accommodative learning style may be the most prominent learning style encountered in typical construction internship experiences. To the authors this makes sense. Taking a broad, subjective view of construction environments, accomodators (see Table 1) would appear to be have the style most compatible with the kinds of tasks and learning situations encountered across a wide set of internship work settings. Likewise (Table 1), the assimilative learning style may have the least relevance of the four styles for experiential learning in typical construction settings.

	Learning Mode				
Learning Style	**Concrete Experience**	**Reflective Observation**	**Abstract Conceptualization**	**Active Experimentation**	**Total "Score"**
Accommodative	19			42	61
Divergent	19	33			52
Convergent			6	42	48
Assimilative		33	6		39

Table 3: Learning Styles Inferred from Learning Modes, Construction Internships

These tentative observations about learning styles certainly lack desirable rigor, which could probably be attained through a directed research effort, for verifying learning style preferences for learners of construction engineering and management.

A Comment About Self-Efficacy Development from Internships

Developing self-efficacy beliefs was cited earlier as a benefit to students from effective internship experiences. While the student reports in this study were not analyzed scientifically to assess self-efficacy development outcomes, it is subjectively evident from scanning the student reports (above, Appendix B, and original reports) that almost every construction student intern gained significantly in this aspect. It is the authors' conviction that developing self-efficacy beliefs is a particularly valuable outcome of effective construction internships, that engineering educators have yet to recognize this outcome as a bona fide educational process, and that future research in this area would be beneficial.

F. Conclusions

Regarding Study Purposes

The general purpose of this study was to examine the nature of the learning which takes place during construction internships, and to describe it in terms of established learning theory. Its specific focus was to show that student learning from effective construction internships is aptly described and interpreted by Kolb's model for experiential learning.

Conclusions reached in regard to these purposes were:

1. It is possible, through the simple device of written student responses to two concise questions, to determine with confidence the learning modes, as defined by Kolb's model, demonstrated by students in effective construction internships.

2. For the conditions of this study, 75% of students reported prominent learning by the active experimentation (42%) or the reflective observation (33%) modes. Concrete experience (19%) and abstract conceptualization (6%) were less frequently encountered.

3. It can be inferred that the accommodative learning style may be the most prominent learning style encountered in typical construction internship experiences, a tentative observation deserving more study.

4. A significant majority of construction student interns gained significantly in developing self-efficacy beliefs as a result of their internship experiences.

5. Taken together, these conclusion lend support to the hypothesis that knowledge gained by students through experiential learning from internships in construction is in fact a real educational process, deserving of integration into university program objectives.

Regarding Three Hypotheses

This study was intended to underly further, broad efforts toward validating three hypotheses:

1. The knowledge gained by students through experiential learning from internships in construction constitutes significant and uniquely valuable preparation for the requirements of their future professional practice in that field.

2. Much of the learning which is gained during these internships cannot be attained in any other way, especially not in the classroom, and

3. A valuable outcome of construction internships is "learning how to learn," a situation which deserves appreciation by engineering educators.

Conclusive, future proofs for these assertions can find some beginning bases in the analysis reported in this paper.

Limitations of the study

1. Applicability of the conclusions reached here are limited to effective construction internships as

described by five characteristics in the section, "Conditions for the Study." Nonetheless, the authors believe that the conclusions and the implications of this study have significant potential value for advancing the understanding, and describing the educational value, of other experiential learning programs. Co-ops, internships, and other effective authentic involvement in many engineering fields, especially civil engineering, provide distinct learning outcomes similar to the nature and value reported here.

2. Some important features of Kolb's model have not been invoked in this study. Particularly, no analysis was done to relate the grasping and transforming aspects of Kolb's learning theory to the observed student intern learning. For that reason, no substantive arguments were developed as to learning styles.

G. Recommendations for Further Work

The authors envision an exciting array of opportunities for further study, suggested by the work begun with this paper. Some questions which arise, answers to which will be valuable to many engineering educators, are:

1. To what extent do the learning modes and styles experienced by undergraduate interns match those needed for success in the early careers into which they graduate? Knowing this could sustain the argument that "learning how to learn" in internships is real knowledge, gained through an educational process deserving to be integrated into undergraduate engineering program objectives.

2. How do the grasping and transforming aspects of Kolb's learning theory describe experiential learning observed in student internships?

3. How do a student's learning modes progress as the student advances through second and third internship work periods? Are there ways of designing a sequence of internship assignments and tasks so as to maximize learning in preferred modes?

4. What preferred learning styles are most evident in successful construction engineers and managers? Could knowing this help to guide entering freshman to select their career field wisely?

5. In what ways can internships be made most effective in developing "soft skills" in undergraduate engineers?

6. To what extent, and how, can university experience with successful construction internship programs be used to advance other experiential learning programs?

7. What simple, effective ways are there for assessing and understanding the nature and value of experiential learning in a wide range of engineering internship and co-op programs?

The authors are certain that continued exploration of the nature of learning from effective engineering co-ops and internships will reveal deeper and more convincing appreciation of their irreplaceable educational value. It may ultimately be proved that -- since experiential learning from effective construction internships is truly an educational process which has significant value and cannot be attained in other ways -- this kind of experience should be made an essential part of every undergraduate program which prepares graduates for professional careers in construction.

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APPENDIX A -- Some Characteristics and Objectives of Experiential Learning

There is considerable similarity among the models of the learning process discussed in this paper.Taken together, they form a valuable perspective on learning and development, a perspective that can be characterized by the following propositions summarized by Kolb(1984):

- Learning is best conceived as a process, not in terms of outcomes.
- Learning is a continuous process grounded in experience
- The process of learning requires the resolution of conflicts between dialectically opposed modes of adaptation to the world
- Learning is an holistic process of adaptation to the world
- Learning involves transactions between the person and the environment
- Learning is the process of creating knowledge

A learning program that accommodates the above propositions has the potential of accommodating and enhancing a large inventory of skills and attributes that are valued in a professional education.

Each of the following is a skill and/or attribute that can be reinforced by a well-designed experiential learning program[23]:

Problem-solving Skills
Interpersonal Awareness
Creative Expression
Communication Skills
Technical Skills
Self-confidence Building
Computation Skills
Leadership Skills
Planning Skills
Professional Ethics
Engineering Judgement

Any combination, or all of these skills, can be adopted as program objectives when designing an experiential learning activity. Together they comprise a rather definitive attribute inventory for many of the desired competencies of a graduate engineer.

In addition to the inventory of attributes, there are several classes of operational skills that are enhanced by an experiential learning activity. The following summary was formed from numerous sources[23,33,38]:

ABILITY TO REASON
How to do it – without knowing how.
How to go ahead anyway.
How to capitalize on resources.
How to make a decision and develop it.

PRACTICALITY
How to be clever and shrewd.
How to make it simple and practical.
How to do it low cost & on time.
How to make it safe & reliable.

TEAMWORK
How to divide up work.
How to deal with people.
How to work with diversity.
How to convince the skeptic.

ENTREPRENEURIAL SKILLS
How to capitalize on an opportunity.
How to negotiate and compromise.
How to be a developer.
How to fail and win anyway.

All of these skills are valued for succeeding as a professional. All must be learned by involvement and experience. Together, they comprise the interactive, interpersonal, communicative skills that an engineer must attain to be successful.

Typically, these skills are acquired by many engineering students "on-the-job" after schooling. The degrees of proficiencies attained are randomly scattered and essentially accidental. These functional attributes are usually not consciously set as learning objectives within engineering degree programs. Yet, all are as essential to success as the technical skills of the engineering disciplines. An experiential learning activity can be designed to provide students the opportunities to develop these attributes. Advantages of involvement during undergraduate schooling years include the opportunities to critique and diagnose the outcomes, integrate learning gained in disparate environements, close the loop, and reinforce successes, among others.

APPENDIX B -- Excerpts From Student Internship Reports.

These excerpts reveal particularly clear or interesting student comments concerning the substance of their learning, and the learning mode, for particular experiences during 1999 or 2000.

Revealing Concrete Experience Experiences:

"The most valuable thing that I learned in my internship would be how to work with people and respond to them in a professional manor [sic]…I watched how they (others in the office) dealt with a problem and worked with others to find a mutually beneficial solution." (A. M., 1999)

"Having never worked in a professional environment before, the most valuable thing I learned this summer was how to deal with people in different situations that arose…I learned this from simply being able to watch and listen to other people in my office when they were on the telephone or dealing with subcontractors." (M. H., 1999)

"My most valuable thing I learned is what it takes to make a project come together. I had never really knew how a bid process worked until I saw it firsthand…I learned this by working with the others around me as well as trying to observe what everyone else did to make things run more smoothly." (B. J., 1999)

"The basics of electrical construction and project management are the most valuable things I have learned…(I learned this) through attending the submittal party for Oakbrook Pointe…For two days I sat and observed the interaction between the architects and engineers…" (R. S., 1999)

"The most valuable thing that I learned this past summer was how the general contractor fits into the whole project…I learned this by going to the weekly jobsite meetings with the owner and design professionals and also seeing some of the interaction between the superintendent and the subcontractors." (M. M., 2000)

"The most valuable thing I have learned during this internship period was communication skills…I learned this by just watching others interact. You can't really be taught this, other than just observing others." (C. L., 2000)

"People skills without question were the most valuable thing I learned this summer…I learned this skill through observation." (R. J., 2000)

"The most valuable thing I learned during this internship period was what it really took to completely manage a project…I learned this by being completely immersed in the day to day operations of the job…" (M. R., 2000).

"The most valuable thing I learned during this internship period is to pay attention to detail and to be observant…I learned this valuable lesson by observing (persons associated with the project) perform their jobs." (J. P., 2000)

Revealing Reflective Observation Experiences:

"The most valuable thing I learned during this internship is that I need to be very thorough when I am reading things and communicating with other people…I learned these habits from one of my project managers who is very thorough and communicated ideas clearly." (C. D., 1999)

"The most valuable thing I learned this summer was the importance of communication on the jobsite. (This summer we had a) ISO 14001 audit…Not only did the office personnel have to know about B____ Environmental Aspect, but so did nearly 500 field workers…Due to superb communication on our site, B___ Construction Company has become the first General Contractor in the United States to become ISO 14001 certified." (J. B., 1999)

“The two most important things I learned this summer were (to) expect the unexpected and when it comes to estimating you can never be too thorough, or anal. You have to be flexible and since I am a perfectionist, I wanted everything to be exactly as I planned. Well, I learned the hard way…It was a very stressful lesson…but I know that I will be able to reflect on this summer…” (M. V., 2000)

“The most valuable thing I learned this internship period was the importance of keeping subcontractors on schedule…It wasn’t until I was in the field that I saw the true effects of someone falling behind schedule…I understand that there are some delays that can’t be avoided, but something like a manpower issue could have and should have been avoided.” (N. H., 2000)

“One important lesson I learned is it is essential to be a well rounded person to be successful. Knowing all the information covered in my engineering classes is not sufficient to be successful in my career. As I worked with various people this summer it became apparent the more you know, the greater potential you have for success.” (T. K., 2000)

“I feel the most valuable lesson that I learned this summer was that no matter what your experiences have been in the past, you must accept all of the responsibility handed to you…A problem occurred with one of the men (that I was in charge of) and instead of releasing him, I wasted the time of superiors by asking them to intervene. This damaged the confidence that my superiors had in me, and upset my superintendent because I had disregarded the respect that he had for me.” (J. K., 2000)

“I realized this summer that as much fun as being in a city like San Francisco and being able to make good money, I desperately wanted to return to Purdue. I now know that when I graduate I want to be close to my friends and family…” (A. N., 2000)

“The most valuable thing that I learned was not realized when on the job but while looking back and evaluating my experience. I found the most important thing is that I need to take charge of my own learning…I came to this realization when looking back and seeing what I was disappointed that I did not learn or do.” (J. H., 2000)

Revealing <u>Abstract Conceptualization</u> Experience

“Throughout this internship, I learned one extremely valuable thing: The plans may be printed in black and white, but when it comes time to build them, there are many shades of gray that come into the picture. This was brought to my attention many times throughout the internship, but one time exemplifies this learning experience.
In the $17 million middle school, there is a lot of stained and scored concrete. It sounds simple on the plans. You pour the slab, score it, and then stain it. Where is the problem?
The problem is since this is exposed concrete, and heavy equipment, such as lifts, will be running across it, it would be next to impossible to prevent any chipping, cracking, or gouging from occurring.
You could put plywood over the concrete after you stain and score it to protect the concrete. Problem solved. Not exactly, what happens when rocks work their way under the plywood and then chip the concrete?
You could hold down the concrete a couple of inches, come back and top it off, then stain and score it. If that is the case how do you set the structural steel to the correct elevation on the emdebs [sic]? What exactly do you do?
These are just a few of the possible solutions to the particular problem. As you can see there are indeed problems introduced into the picture that plans do not account for.” (R. K., 2000)

Revealing <u>Active Experimentation</u> Experiences:

“The most valuable thing I learned this past summer was how to communicate on the phone. I did a lot of it and I finally became good at it.” (B. G., 1999)

"The most important thing I learned this summer is the fact that one has to compare the specifications to the take off sheet to make sure that all items are covered and nothing is forgotten. I learned the importance of this through (repetition) and made it a habit." (S. H., 1999)

"The most valuable thing I learned during this internship period was to have proper coordination of subcontractors…I learned this through hands on experience." (J. H., 1999)

"…communication was the key learning for the summer. I was able to observe how my superiors dealt with individuals to accomplish their goals. I was able to take what I saw through them and apply it to my own dealings with co-workers and the subcontractors I had to work with." (C. M., 1999)

"The most valuable thing I learned this summer was time management and organization. Because I lived relatively far from my project, I had very little time to waste…I learned this lesson from making mistakes and not always finishing up tasks I wanted to complete." (S. K., 1999)

"The primary thing I feel most proud to have learned was not that I was learning to estimate and learn more about the project management side, rather it was how I was learning to do these tasks, as a full time employee would." (B. R., 2000)

"The most valuable thing I learned this internship period was how to run a jobsite. I learned this because I was lucky enough that my superintendent went on vacation for a week. I ran the entire site by myself with a little help from the office…I did everything that a real superintendent would have done." (B. T., 2000)

"The most valuable thing I learned all summer was the importance of proper planning and scheduling for a project…That is something that cannot be taught in a class. I had to be out in the field, attending the superintendent and jobsite meetings, doing paper work, and working with the crews to learn this." (H. W., 2000)

"The most valuable thing I learned this internship period would definitely have to be how to manage/run a project and deal with people. I was able to learn all of these things by actually being 'thrown' on the job without much prepping or knowledge of the project. I was able to learn by a hands-on approach as opposed to a theoretical approach." (J. C., 2000)

"I learned how to look beyond minor errors, set questions and future RFIs aside, and approach the work in a conceptual manner until the mishaps can be rectified. I learned about this when I was working with…prints and was faced with prints that were somewhat incomplete." (J. H., 2000)

Revealing Self-efficacy Development:

"…over the past twelve weeks…I was able to apply skills (learned in my construction classes) and knowledge to my daily duties. Although at times some tasks were challenging and involved higher levels of responsibility, I was able to successfully accomplish everything that was assigned to me." (J. A., 1999)

"The most valuable thing I learned this internship period was how to run a jobsite. I learned this because I was lucky enough that my superintendent went on vacation for a week. I ran the entire site by myself with a little help from the office…I did everything that a real superintendent would have done." (B. T., 2000)

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