Project based learning in an applied construction curriculum

Darren Hayes Lamb

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PROJECT BASED LEARNING IN AN
APPLIED CONSTRUCTION CURRICULUM

A Project
Presented to the
Faculty of
California State University,
San Bernardino

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts
in
Education:
Career and Technical Education

By
Darren Hayes Lamb
June 2003
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Approved by:

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2/22/03 Date
ABSTRACT

This project addresses the integration of a career and technical (vocational) construction curriculum with academic curriculum. Career and technical (vocational) curriculums in the past have been developed to address specific content. This construction curriculum integrates inherent academic aspects. It was believed an integrated construction curriculum could motivate low achieving and at-risk students by creating a project-based environment in which the students see the connection between technical skills and real life. This project creates a connection between curriculum and real-life skills, and shows students a need exists for understanding what is being taught and therefore increases the student motivation and participation. The increase in motivation and participation increases the comprehension of concepts being taught, therefore increasing the multiple-choice test scores of students. The combined academic and career and technical (vocational) curriculum of this project should help students perform better on standardized tests. This project offers a solution to the current political cry for better student performance and a highly-educated, high-tech workforce.
ACKNOWLEDGMENTS

There are many people to thank for the assistance I have received in my journey to this point. My parents instilled in me an attitude that I could do anything I wanted to even if I choose to take the long and winding route. Dr. Ronald Pendleton reawakened the spirit of education and fun in my soul even though I think he used one pun too many in doing so. The Bulldog, Dr. Joseph Scarcella, kept nipping at my ankles along the way to insure my continued forward progress. Tim Thelander gave freely of his computer expertise and time and made this project a joy to create even with a broken finger. My children, Caitlin and Stephen, who put up with the loss of time that I had to spend with them. And, finally my wife Janet, who put up with me when I packed research to read on our honeymoon and was a tireless editor. I hope you all realize the contribution you have made to this project and to me.
DEDICATION

To my lovely wife, who married me at the beginning of this project and put up with me throughout its challenges.

I couldn’t have done it without her.
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CHAPTER ONE

BACKGROUND

Introduction

The content of Chapter One presents an overview of the project. The contexts of the problem are discussed followed by the purpose, significance of the project, and assumptions. Next, the limitations and delimitations that apply to the project are reviewed. Finally, definitions of terms are presented.

Purpose of the Project

The purpose of the project was to develop an integrated construction curriculum, containing contextual and project-based learning activities, around the construction of a wall section of a house. The lessons include math, science, language arts and vocational aspects that are to be team-taught in a project-based environment.

Construction classes are an innovative way to teach to the academic standards. Students in a career and technical (vocational) education setting can learn academic and career and technical (vocational) content. Building a home involves math, science, language arts, and art skills along with the trade and career and technical
(vocational) skills. Students learn these skills in the context of learning to build a house and the lessons become contextual because the project has real life connections. Teaching in this way improves the retention of all skills and increases student performance on multiple-choice tests (Hamer, 2000).

Context of the Problem

The context of the problem was to address the need for the integration of academic content in a construction curriculum at a current high school. The focus of the project was to show how a construction course could fill this need while addressing the need to improve standardized test scores. Because high school administrators are looking for alternative ways to teach core curriculum classes, teachers are being asked to raise standardized test scores or lose funding. Raising test scores in academically low achieving and at-risk students is one of the easiest ways to improve overall test performance. The question is how can schools improve test scores of low-achieving and at-risk students? Especially, when these students are uninterested and unmotivated in traditional school setting and are not invested in test results. There are reports of students bubbling in
patterns or designs on standardized test answer sheets instead of actually reading the test questions. Parametric Technology Corporation even used the knowledge of this situation in an advertisement in the October 2002 educational journal Techdirections to promote their software (back cover). The ad shows an answer sheet that has the shape of a car bubbled in and says "if your students are doing this they are ready for our software".

Traditionally, lecture-based classes are not considered the most effective way to teach students. Lecture-based teaching is considered a form of passive learning, with the assumption that listening equals learning. Most students learn more and achieve higher test results when the class is taught in a contextual and project-based environment. When taught in this manor students see the relevance of what is being taught and understand the concepts behind the task (Hamer, 2000). There is a need to develop a way to teach core curriculum in a project-based and contextual style.

In creating a project-based curriculum that is tailored to this project, in this case building a wall, many students experience the relevance of learning the information being taught. Students must master numerous academic concepts in order to be able to complete basic
tasks in home construction. The importance of reading, adding, subtracting, and multiplying fractions in construction is tremendous. The ability to teach these skills in a both a math class and a construction class not only allow students to see the importance of fractions but use active-learning by making the concept relate to a real job related situation.

Teaching all academic curriculums can be achieved in the same way. All academic curriculums relate to construction and can be taught combined with the career and technical (vocational) component. Earth Science, Chemistry and Language Arts can easily relate to construction of a wall.

Significance of the Project

The significance of the project was to show that construction curriculum have academics relevance. The nature of the tasks and skills in a project-based construction curriculum include academic skills. Construction curriculum also shows students a need for learning the academic skills because the student sees a direct connection to real life. Integrating academics into construction curriculum allows the students to see practical applications of concepts being taught. The
practical applications of the integrated project-based curriculum will allow the student to learn in a contextual manner. The use of the construction setting makes the education relevant because the student will perceive the information being presented as necessary for employment after graduation and therefore be motivated to learn the entire interrelated academic and career and technical (vocational) concepts. The increased motivation and student participation in an integrated curriculum could be used to increase the test scores of academically low achieving and at-risk students.

Assumptions

The following assumptions were made regarding the project:

1. Every student has the ability to learn if the information and concepts are presented in a format the student can comprehend.

2. Every student needs to have an understanding of the concepts related to the curriculum, not just recite rote memory (Schools of California Online Resources for Education [SCORE], 2002).

3. Education should encourage students to think for themselves, and draw conclusions (SCORE, 2002).
4. Students will choose to learn if given the chance and presented with a situation and in an environment where they have control (Blumenfeld, et al., 1991).

5. Empowerment of the student by giving them control over what they learn will motivate them better than outside control (Buck Institute for Education, 1999a).

6. Errors and mistakes are not wrong but part of the natural learning process (Blumenfeld, et al., 1991).

7. Students need to be reinforced when mistakes are made to allow them freedom to make mistakes (Green, 1998).

Limitations and Delimitations

During the development of the project, a number of limitations and delimitations were noted. These limitations and delimitations are presented in the next section.
Limitations

The following limitations apply to the project:

1. The main limitation to the study is cost. Everything related to a construction class is expensive.
   - Tools for building are very expensive and need to be continually updated as technology changes the way homes are constructed.
   - Material costs continually increasing making budgeting from year-to-year a chaotic nightmare and program cost skyrocket.
   - Land costs have increase to the point where it is nearly impossible to purchase land in order to build a home in a classroom situation.

2. Availability of building sites is a limitation. Locations for building need to be identified close to the school in order to facilitate team-teaching. In the current market the likelihood of a lot in close proximity is not high.

3. Building to scale in the classroom reduces the real-life connection the students would receive in actual home construction.
4. The availability of teachers in the current high school setting would make team-teaching one class highly unlikely.

Delimitations

The following delimitations apply to the project:

1. The construction of the home can be done in scale relieving the limitation of cost of material, tools and land.

2. By requiring students to building the home to 1/4 scales the math concepts increase.

3. The possibility of volunteering student work in return for a work location, such as a Habitat for Humanity worksite if available, allows cost to be kept to a minimum and brings in the concept of community service.

Definition of Terms

The following terms are defined as they apply to the project.

Active Learning - encouraging students to become involved in the material by applying theory to real-life situations in a dynamic manner (Hamer, 2000).

At-risk - a student in danger of dropping out of school (Carr & Jitendra, 2000).
Collaboration - working together to accomplish a common intellectual purpose in a manner superior to what might have been accomplished working alone (Simkins, 1999).

Contextual Learning - a format in which knowledge is presented within a framework that is familiar to the student. New knowledge relates to knowledge already learned (Souders & Prescott, 1999).

Experiential Techniques - provide the student with the opportunity to go beyond conceptual discussion by using concepts in specific real-world contexts (Hamer, 2000).

Hypermedia - the Internet, which allows for the arranging and rearranging of pieces of information based on the learners needs and background knowledge (Carr & Jitendra, 2000).

Jigsaw Technique - when one student in a sub-group becomes an "expert" in one area and then the student "experts" are responsible for teaching everyone else on the team (Utay & Utay, 1999).

Multimedia (MM) - video, CD-ROM, DVD, or audiotape that provides linear stimulation that is not controlled by the learner (Carr & Jitendra, 2000).
Nonexperiential Techniques - encouraging the students to actively process course material (Hamer, 2000).

Passive Learning - students passively listen to or take notes without actively being involved in the material. Passive learning is based on the assumption that lecturing equals learning (Hamer, 2000).

Project-Based Learning (PBL) - a comprehensive approach to classroom teaching and learning that is designed to engage students in investigation of authentic problems. Students pursue solutions to non-trivial problems by asking and refining questions, debating ideas, making predictions, designing plans and/or experiments, collecting and analyzing data, drawing conclusions, communicating ideas and findings to others, asking new questions and creating artifacts (Blumenfeld et al., 1991).

Uniform Building Code (UBC) - the most widely adopted model building code in the United States. Codes used by government units charged with enforcement of building regulations (International Conference of Building Officials [ICBO], 1998).
Organization of the Thesis

The thesis portion of the project was divided into four chapters. Chapter One provides an introduction to the context of the problem, purpose of the project, and significance of the project, limitations and delimitations and definitions of terms. Chapter Two consists of a review of relevant literature. Chapter Three documents the methodology used in developing the project. Chapter Four presents the conclusions and recommendations drawn from the development of the project. The Appendices for the project consists of: Appendix A, Integrated Curriculum to Building a Wall; Appendix B, Pertinent Uniform Building Code (UBC); Appendix C, Lamb Construction Contractors License. Finally, the Project references.
CHAPTER TWO

REVIEW OF THE LITERATURE

Introduction

Chapter Two consists of a discussion of the relevant literature. The relevant literature reviewed was separated into seven subsections. Specifically, Standardized Tests consists of literature covering the origins and problems with standardized tests. Lecture-based Instruction consists of literature covering this traditional teaching format and its disadvantages. Contextual Learning consists of literature covering what contextual learning is and why it is effective. Contextual and Communication Technology consists of literature covering the use of computer technology in contextual learning. Integrating Academics and Construction consists of literature covering the integration of academic and vocational construction curriculum. Real World Connection consists of literature covering the importance of real life connection in curriculum and schools. Project-Based Learning consists of literature covering what project-based learning is, what makes it effective and some of its drawbacks.
Standardized Tests

Jonathan Rees in his article in “Radical Pedagogy” (2001) states that Frederick Taylor’s time and motion studies in the late 1800s were adapted to American schools. Taylor’s studies, which he termed scientific management, were on efficiency in a factory setting. Taylor’s ideas were implemented to simplify the task that each employee was doing and rearrange it into a production process that increased efficiency and output of the worker. Taylor’s collection of strategies was later coined Taylorism and used in the formation of the current school formation (Rees, 2001). Taylorism ideas were used in every aspect of educational administration, from better use of buildings and classroom space to how to standardize the work of janitors. One aspect of Taylorism is the idea of assessment. Students are treated like workers, they should be able to do ”X” amount of work in ”Y” amount of time and move onto the next task.

Out of this mentality of assessment came the standardized test for students as a measurement of learning. These tests have even been used as an assessment of teaching quality and funding status. Schools that now perform low on tests are at risk of losing funding (Rees, 2001). The stress on students and teachers is changing how
teaching is done. In some cases, students are being taught to choose what looks to be the right answer from the choices instead of actually reading the passage on the exam. The multiple choice and short answer questions that make up these tests require only a superficial understanding of complex concepts to answer them correctly, and they provide no rational for teachers to reinforce more complex concepts that take additional effort for the students to understand (Rees, 2001). "Scientific Management in the modern classroom does not respect the idea that teachers know what to teach their students or how best to teach it" (Rees, 2001, p. 1). Even though both political parties support standardized testing, they are blind to the debilitating effects on teachers. Standardized tests require less critical thinking by the students so teachers are not engaged in critical thinking in order to teach the material. Curriculum standardization for the standardized tests discourages the teacher from thinking for themselves. The standardized curriculum converts the teacher from a skilled professional to an educational delivery system. This may be one of the reasons for teacher burnout at a time when many districts are facing acute teacher shortages (Rees, 2001).
Another aspect of standardized test is that by reinforcing rote memory instead of complex concepts, schools are turning out bored students. "Bored students become bored citizens with no understanding of where America has been and with no basis to judge where it is going in the future" (Rees, 2001, p. 4).

Lecture-Based Instruction

"For many students, high school is simply an obstacle to hurdle to get to real-life, rather than a site for serious learning. High school students often feel in a state of protracted deferment: real life is always on the horizon but they never get there" (Souders & Prescott, 1999, p. 1). Research indicates that critical thinking and problem solving skills are not typically addressed in the classroom. A number of studies indicate that in a typical classroom, 85% of teacher's questions are at the recall or simple comprehension level (SCORE Internet Classroom, 2002).

The lecture is the traditional instructional format of schools. The lecture format "promotes passive learning because learning occurs while students passively listen to and take notes on a lecture without being engaged in the lecture material. Passive learning is based on the
assumption that lecturing equals learning” (Hamer, 2000, p. 1). Hamer has set up the premise that a lecture may include some active learning techniques, but the lecture is still nonexperiential because it only encourages the student to actively process the course material and nothing beyond. Interviews of students in traditional lecture classes gave the clear message that students learned the least from lectures, more from exercises and definitely most from fellow students (Lenschow, 1998). Teaching in this instruction method only encourages the lowest levels of cognitive processing because students only perform basic work like reading, reviewing and memorizing. “As a consequence, their knowledge of the subject matter may be topical, fleeting, and superficial. Students can’t apply what they have learned and are not stimulated to study on their own or go beyond the information given” (Buck Institute for Education, 1999b, ¶ 6).

The Survey of Necessary and Comprehensive Skills (SCANS) and Goals 2000 reports recommend instruction that develops a student’s effective problem solving skills (SCORE, 2002). “Students must be meaningfully engaged in learning activities through interaction with others and worthwhile tasks” (Kearsley & Shneiderman, 1999, p. 20).
By engaging the student in learning one causes intrinsic motivation to learn because the learning environment and activities are meaningful. Teaching and learning are most powerful when they are meaningful, integrated, and challenging (Diffily, 2002). Our responsibility as educators is to imagine and create places of learning. A place of learning should foster aesthetics, civility, ethics, openness, conversation, security, stewardship/public responsibility, craftsmanship, and individual liberty and allow the student to realize their full potential (Diffily, 2002).

Contextual Learning

Instead of learning passively by way of the lecture, teaching should be contextual and engaging. Education must be more meaningful and relevant to student’s lives. The classroom must be a place where all students have equal opportunity to learn. What we need is an approach that brings relevance and meaning to the classroom and addresses a wide diversity of learning styles (Souders & Prescott, 1999).

Learning is most effective when information is presented in a framework that the student is familiar with. Contextual learning is based on this approach. Think
of knowledge as a puzzle with each piece of the puzzle representing a bit of knowledge acquired in the past. The mosaic created by the puzzle represents the sum total of experience and understanding one has of the world. Attempting to learn a new concept is adding a piece to the puzzle. If the concept is presented in a framework of reference it makes sense. The puzzle piece fits into the framework. It not only fits but also sheds light and understanding on the surrounding puzzle pieces (Souders & Prescott, 1999). Contextual learning approaches use the same processes used by the mind to gain understanding and assimilate information. Presenting the information in a way the brain can better assimilate helps the student in retaining the information (Souders & Prescott, 1999). The brain is a parallel processor and learning engages the entire physiology; thoughts, emotions, imagination, predisposition, and physiology operate together as the brain interacts with and exchanges information with its surroundings (Crowell, Caine, & Caine, 1998).

**Contextual and Communication Technology**

Today’s technology makes information more accessible to students and enables them to successfully perform more technologically complex tasks (Carr & Jitendra, 2000).
Technology allows students to explore, construct, and easily alter information and resources with the computer. Once students are familiar with the procedures needed to access information, they may be willing to explore alternatives actively. Students may be motivated by the amount of information and easy access and may even explore past the actual curriculum set by the teacher (Blumenfeld et al., 1991).

The idea of communication technology in the classroom can be broken down further to distinguish between two types. "Hypermedia is a non-sequential, computer-based technique that may be seen as an application manager that allows for the arraigning and rearranging of chunks or nodes of information. Multimedia provides a linear stimulation that is not controlled by the learner" (Carr & Jitendra, 2000, p. 40). Hypermedia is a source that allows the student to control the method and amount of information presented. It also allows the student to research farther than intended by the instructor if they are interested. The Internet and interactive programs are examples of hypermedia. Multimedia is limited to exactly what the instructor or producer wanted to convey with little interaction and no incentive for further research.
Videotapes, CD-ROM, laser disks and audiotapes are examples of multimedia.

Integrating Academics and Construction

Construction curriculum integrates the presentation of academic subject matter with work-force applications. The curriculum blends the head skill of the academics with the hand skill of building a house (Dare, 2000). Integrating academics into vocational curriculum, like construction, has a positive affect on the attendance rates, dropout rates and graduation rates of low achieving and at-risk students (Brown, 2000).

It is wrong to make career and technical (vocational) education compete against academics because they are part of the same idea. Career and technical (vocational) teachers are integrating math, science and English into their courses. Exposure to all aspects of education gives students a broad perspective of where their chosen field has been and where it is headed. Employers will notice the difference (Reis, 1995).

Real World Connection

Connecting the academic world to the real world is essential whether the use of technology, contextual learning, or a combination of all three. It is "critical
that students see the connection between what they are doing and the real world in which they live" (Simkins, 1999, p. 10). Connecting curriculum to real-life allows the students to see that time spent learning academic skills has a purpose and is necessary to compete for jobs after graduation (Souders & Prescott, 1999). Real-life connections also help establish a need for a skill and when students see a need for a particular skill, they learn it more quickly and remember it for a longer period of time. Repeatedly using a skill increases the probability that a student will become proficient (Diffily, 2002). Real-life connections not only make better students but also prepare them for the real work that awaits them. Students with such ingrained skills are better prepared for occupations. They are able to complete tasks even when a supervisor doesn’t have time or knowledge to communicate with the worker what to do. They are prepared for the explosion of knowledge which gluts the world today (SCORE, 2002).

Project-Based Learning

"Project-based learning (PBL) blends traditional subject-matter goals and objectives with authentic learning environments. Social issues in their schools,
their communities, and the world provide students with excellent project topics that require them to explore information, identify issues and problems, and apply information-processing skills to development of a meaningful project" (Lamb, Smith, & Johnson, 1997, p. 6). PBL is a curriculum development and delivery system that recognizes the need to develop problem solving skills as well as the necessity of helping students to acquire necessary knowledge and skills. PBL utilizes real world problems, not hypothetical case studies with neat convergent outcomes. It is in the process of struggling with actual problems that students learn both content and critical thinking skills (SCORE, 2002). PBL also requires students to identify what they must learn, work together to reach a common goal, apply research skills, use higher-order thinking skills and then integrate all of this knowledge to complete the given project (Utay & Utay, 1999).

Motivation

PBL is motivating just by its nature, because students define the nature of the project even if they don’t choose the topic. They have a sense of control over their learning that is absent in traditional classroom instruction (Kearsley & Shneiderman, 1999). Project design
can allow students to exercise choice and control regarding what to work on and the level of difficulty. Researchers have argued that choice and control are critical to enhance motivation of students to work on classroom tasks (Blumenfeld et al., 1991). "Students are more likely to take part in PBL when projects focus on questions that they perceive as valuable and are challenging" (Blumenfeld et al., 1991, p. 384). The combination of student-generated questions with standards-based principles and concepts within a context research skills development is an appealing mix that motivates both students and teachers (Rosenfeld & Ben-Hur, 2000). Students are positive about PBL because it is more motivating than traditional classes. Students find the non-traditional format gives them freedom to create a project that they believe in and have commitment to (Lenschow, 1998).

**Communication**

PBL also improves communication skills because students work in pairs or in teams, with each student goal is to make a unique contribution to the final work (Simkins, 1999). "Working with others requires that students be able to discuss ideas, communicate clearly, consider alternatives systematically, monitor their own
understanding, compare their point of view with that of others, and ask clear questions” (Blumenfeld et al., 1999, p. 377). Some sites even use a “Jigsaw technique”, where each student on a team picks a relevant topic to become an expert in. Each expert then presents that topic to the entire team (Utay & Utay, 1999).

**Student Ability**

PBL helps both at-risk and gifted children. The nature of PBL group setting lets each student contribute what they are good at. Each student has skills that will be brought to the forefront in the PBL setting. Students that are better at hands-on concepts can head up that end of the project and students that are better at research can concentrate on that aspect of the project. Everyone is able to contribute to the project. Different skill level students are able to work together and contribute significant amounts to the project. Focusing on each student’s strengths and skills may be the key to successful and meaningful educational programming.

"At-risk students in this program developed confidence and autonomy as a result of PBL, making it a well worth the time and effort involved” (Carr & Jitendra, 2000, p. 44). PBL is also suited to the needs of gifted children. Projects provide the time and the framework for
differentiated education. The gifted can be challenged to learn advanced content, and exercise higher process or thinking skills (Diffily, 2002).

**Teacher**

PBL also changes the role of the teacher. "The instructor takes a back seat while students initiate and produce, facilitate, evaluate and produce a project that has meaning to them" (Green, 1998, p. 21). Teachers are more likely to be found coaching students and less likely to be lecturing (Simkins, 1999). The teacher is not the disseminator of knowledge but assumes the role of coach (Utay & Utay, 2001). The challenge for the teacher is to be able to assume effectively the role of mentor and coach rather than dispenser of solutions. Being actively involved in the issues and discussions of the class and then coaxing out what is meaningful and relevant to the students and the curriculum is crucial (Green, 1998).

**Test Scores**

Test scores increase with the use of PBL and contextual learning. Dannet Babb reported (2001) that the schools in Co-nect schools in her study increased project-based learning and the integration of technology. "Co-nect schools' SAT-8 Math scores significantly increased from 1997 to 1998 and significantly increased
from 1998 to 1999. There was a significant difference between the Co-nect and non-Co-nect schools on the 1999 Florida Writes and 2000 FCAT MATH scores with Co-nect schools scoring higher than the non-Co-nect schools" (Babb, 2001, p. 62). Test scores increase because the student understands the context of the problem. Projects in which students pursue long-term investigation of significant questions and answers have the potential to motivate students and help them better understand subject matter content (Blumenfeld et al., 1991). Students taught using semi-structured and experiential learning activities offered by PBL perform better on multiple-choice final exams than students taught using lectures technique (Hamer, 2000).

**Drawbacks**

PBL is not without drawbacks. In order for PBL to be successful the teacher must create a comfortable, risk-free classroom environment (Green, 1998). Students are going to make mistakes and need to realign their project during the course of study. Students need to see errors and false steps as learning opportunities rather than as indicators of low ability (Blumenfeld et al., 1991). The failure to create a safe environment will hamper students' motivation and creativity.
PBL also require substantial changes in teachers' thinking about and dispositions toward classroom structure, activities, and tasks. Previous curriculum innovations have demonstrated that changes are not easy to achieve (Blumenfeld et al., 1991). It is likely that many teachers will have difficulty because of their knowledge and beliefs about learning and teaching. Teacher will no longer be able to implement instruction that relies heavily on textbooks and worksheets drill and practice. Classroom management routines that are based on lock-step scheduling and whole class activities need to be revised to allow for group activity. Teachers often view learning as a process of obtaining information rather than an active process of knowledge construction. They often view motivation as a problem of developing positive attitudes rather than enhancing cognitive engagement and classroom structure (Blumenfeld et al., 1991). Teachers need to tailor existing projects or develop new projects to meet the specific needs and constraints of their classroom, school and community. Also, they will need to develop plans for designing and implementing projects in their specific contents. Technology can help provide support for planning such design and carrying out those plans, but a true change in the design of current classroom structure
is necessary (Blumenfeld et al., 1991). Perhaps the biggest challenge faced by teachers in PBL is how to enable them to design measurement of student growth that is both valid and practical. Teachers are adept at analyzing students' behavior and providing appropriate feedback in the course of instruction, even knowing if a student is achieving the competencies of the class, but being able to record that knowledge on a grade sheet is not necessarily an easy thing to do (Simkins, 1999).

Summary

Teaching is still being done in a lecture style, but lecturing does not mean learning. Standardized test are being relied on to assess students' knowledge and the competency of the teachers. There is very little connection between subjects or connections to real-life situations and tasks. Learning should be contextual in nature; it should be built upon prior knowledge with each new item or concept relating to knowledge already accumulated. PBL provides the students with the necessary connections and reality tie-ins to engage and challenge them into learning. PBL motivates through the feeling of control and the reality-based nature of the projects. Students must learn to communicate in order to decide on
the project and to work through the tasks necessary to complete the projects. Skill level is not a limiting factor in the success of the project or the student, every level of student will be able to participate and add a unique component to the project.

The role of the teacher changes from leader to coach in PBL because the teacher is a resource person not the disseminator of all the information. Teachers need to change their attitudes and concepts of the classroom to allow the students to own their projects and learn new ways to assess the learning that is taking place.

PBL may bring up test scores on the standardized tests because it teaches the concept behind the question. Students have knowledge of the concept and how the information interconnects. They are better able to retrieve the knowledge because of this understanding. Students will also receive a better education and graduate as intelligent, thinking citizens better able to deal with the demands of today’s society and take part in the formation of tomorrow’s challenges.

The literature reviewed in chapter two was used to develop a contextual project-based curriculum with the methodology explained in chapter three.
CHAPTER THREE

METHODOLOGY

Introduction

Chapter Three documents the steps used in developing the project. Specifically, the curriculum development process including the curriculum structure and content validity was presented. The population being severed was also discussed. The chapter concludes with a summary.

Development

The next section provides an overview of the curriculum development process. Governing board's specific guidelines for the curriculum are presented in the resources section. The intended design and purpose of the project is covered in the design section. Next is a curriculum outline showing outlines for construction, math and science content. The section concludes with a summary.

Resources and Content Validation

The specific guidelines for the project were outlined by a number of different resources.

The Colton Redlands Yucaipa Regional Occupational Program (CRYROP) curriculum outline was one of the resources used in establishing the project. The CRYROP has a curriculum review committee that updates all of the
curriculums to insure that they are current in both in industry standards and vocational standards as required by educational code.

Advisory boards made up of advisors from local industries also meet annually with CRYROP and it’s instructors to insure that current industry standards, procedures and needs are addressed in the current curriculum and any changes that may incur in the curriculum. The advisory committee for the construction curriculum currently has two representatives from local hardware and lumber suppliers, two representatives from local construction firms, one representative from the local heavy equipment operators union and one representative from the vocational education field. These representatives were asked to serve by the staff of the ROP because of their knowledge of the construction field and their commitment to the education of students in vocational education.

The Uniform Building Code (UBC) of 1997 was also used as a resource in creating this project. The UBC is the codes by which all building is inspected in Southern California. All construction needs to adhere to the UBC and therefore its incorporation into the project is crucial.
Two different textbooks were also used for resources: *Wood Technology and Processes* (Hammond, Donnelly, Harrod, & Rayner, 1980) and *Carpentry* (Koel, 1997). *Wood Technology and Processes* is the current textbook used by CRYROP. *Carpentry* is the current textbook used by the carpenters union in its apprenticeship program.

The experience and knowledge of a State of California licensed general contractor Darren Lamb, License Number 785589, was also instrumental in the development of the project. Mr. Lamb has 20 years experience in the construction trades and has built 19 residential homes and one commercial unit with students and volunteers.

Lastly, the standards from the California Department of Education were used to align the curriculum with current academic standards.

**Design**

The design of the project was to use all of the resources listed to develop a curriculum that instructed students in the skills necessary to build the exterior and interior walls of a residential structure. The curriculum included applied mathematics, science and language arts skills along with the vocational skills tasks to be team taught in a contextual environment. Students would be building a partial section of a residential structure to
1/4 scale using appropriate construction techniques and following the current codes. Students will have to calculate scale sizes for all materials to be use. Students will work in a team of three or four and will design the plans for the structure within given parameters.

Teaching the math concept needs to be tailored to the construction class. Students will be working with 1/2s, 1/4s, 1/8ths and 1/16ths in the construction class/site so the math teacher must teach with the same factions until the concept is learned. Students will learn the concept by both class work and practical application. Once the concept of fractions is learned in the construction class, the math teacher can bring in other denominators and show the students how to work with any fraction.

Teaching all academic curriculums can be achieved in the same way as the math components with similar results if the curriculum is combined with the career and technical (vocational) component.

Population Served

The project was developed for students 16 year of age through adult who would be trained in a classroom and lab setting. The intention of the curriculum was to serve
academically low achieving and at-risk students, but in no way was it intended to be exclusive to that population. The curriculum is appropriate for students ranging from those wanting to learn more about structures to those student that wish to pursue a career in home building.

Project Content

Each of the content areas listed are to be taught in a team-teaching environment with the intention that each component is taught as the students are performing the hands-on task that it related to.

Construction Content

1. Framing of walls.
   a. Names of wall members.
   b. Spacing of wall members.
   c. Attachment of wall members to plates.
   d. Attachment of wall to footing.
   e. Wall to wall attachment including top plate.
   f. Plumbing and squaring of walls.

Math Content

1. Addition and subtraction of fractions.
   a. Concentrate on 1/2s, 1/4s, 1/8ths and 1/16ths until concept is mastered.
2. Multiplication and division of whole numbers and fractions.

3. Scale.
   a. What is scale?
   b. How to figure 1/4 scale.

4. Centering on 16-inch marks.

5. Pythagorean Theorem.
   a. 3-4-5 triangle squaring technique.

Science Content

1. Structure of a tree.
   a. Why use wood as a building material.
      i. Xylem vs. Phylum.
      -Heartwood vs. strength.
      ii. Growth cycle of a tree.
      -Climate studies through growth rings.

2. Recycling
   a. Plywood and other wood products.
      i. Reduction in costs.
      ii. Strength

3. Friction.
   a. Why does a nail hold?
      i. How effective is friction?
      ii. How can holding powers be increased?
   b. Wood fiber.
i. What other substance would act like wood fiber?

4. Shear
   a. What is shear effect?
      i. Earthquake effect.
      ii. Plate tectonics.
   b. Cause of shear.
   c. Procedures required in preventing shear.

5. Water shed and Erosion.
   a. What effect can water have on structure?
   b. Procedures for preventing water damage.

Language Arts Content

1. Vocabulary

2. Outline the step-by-step process involved in building a wall.


Summary

The project was designed using the guidelines of a number of different boards or committees and the resources of the UBC, textbooks and a licensed general contractor. The CRYROP Curriculum Committee and Advisory Board set guidelines that insured that curriculum teaches skills that meet both vocational standards and work-place
requirements. Incorporation of the UBC guidelines insured that all skills conform to current acceptable state codes and students would be familiar with code requirements when working on a jobsite. Using two different textbooks and the experience and knowledge of a general contractor as additional resources insured that the curriculum would be current with present industry codes and standards.

The project was designed to integrate academic skills with vocational skills. Building the structure to scale allowed the integration of more math skills and creates the added benefit of cost reduction. The construction, math and science skills necessary to build the structure are listed in outline form and are taught in a team manner so that students see how the academic and construction task relate to each other.

The design of the project was to teach the students the integrated curriculum in a way that they see the inter-relationships between the academic and vocational curriculum and see the need for learning both. The project was designed to show 16 year olds to adult age learner the need for academic skills even in a vocational world. The design would motivate at-risk and low achieving student by showing them the need for academic skills even if they had chosen a vocational career path.
CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

Introduction

Included in Chapter four was a presentation of the conclusions gleamed as a result of completing the project. Further, the recommendations extracted from the project are presented. Lastly, the Chapter concludes with a summary.

Conclusions

The conclusions extracted from the project follows.

1. All students benefit from a project-based curriculum because of its contextual nature of the material.

2. Project-based curriculum creates advantages over lecture-based curriculum because it is based on real-life situations and tasks.

3. Project-based curriculum motivates students because the nature of the project has real-life application and all subject matter is presented in relationship to the project.

4. Project-based learning increases multiple-choice test scores because it motivates students and teaches the concept behind the question.
5. Project-based curriculum teaches students academic and career and technical (vocational) standards and prepares them for the workplace.

6. Construction based projects, like the building of a wall, create an environment where students learn both academic and career and technical (vocational) standards at the same time, not only reinforcing the standards but allowing the students to see a practical reason for learning both academic and vocation-technical subject matter.

Recommendations

The recommendations resulting from the project follows.

1. Students should be taught in a contextual project-based curriculum.

2. Project-based curriculum should replace lecture-based curriculum wherever possible.

3. Project-based curriculum should have real life tasks and skills built in and all subject matter should be related to those skills and tasks.
4. Teach the concepts to the problems and tasks to better prepare the students for multiple-choice exams.

5. Teach in a project-based manner that prepares the student for the workplace by insuring that both academic and technical-vocations standards are taught.

6. Teach project-based curriculum that is directly related to workplace skills to allow students to experience what a career would entail.

Summary

Chapter four reviewed the conclusions extracted from the project. Lastly, the recommendations derived from the project were presented.
APPENDIX A

INTEGRATED CURRICULUM FOR

BUILDING A WALL
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INTRODUCTION

This project is part of a larger curriculum of teaching residential house construction and is intended to be taught in an integrated, contextual, project-based format. The project of building the wall is the focus and the entire curriculum is related. The purpose of this focus is to give the students a real life reference for everything that is being taught. By showing the students this reference, the curriculum will be current and important, creating an atmosphere where the students are motivated to learn all aspects that are being taught.

The career and technical (vocational) and academic curriculum that follows is designed to be team taught with all students and teachers working together in one large classroom. Instead of breaking the students up into smaller class sizes and lecturing about each subject the teachers work side by side with the students working their subject into the overall project.

The actual building of the structure will be in 1/4 scale with the students calculating the proper size of all materials needed.

The time frame of this project is approximately three weeks.

Framing of a Wall

Framing of the wall is broken down into six lessons.

1. Names of the wall members.
2. Spacing of the wall members.
3. Attachment of wall members to plates.
4. Attachment of wall to footing.
5. Wall to wall attachment.
6. Plumbing and squaring of wall.

All worksheets and other information needed will be included after the appropriate lesson.
Names of Wall Members Lesson Plan

**Student Performance Objective:** By the end of the lesson the student will be able to:
Properly name the members of a wood and a metal framed wall.

**Student assessment:** Students will pass a test created from the wall framing worksheet.

**Anticipatory set:** Instructor will explain the importance of proper terminology and construction of the wall. The concept of building inspection and structural integrity will be discussed to relay the importance of lesson.

**Instructional component:** The lesson will be student discovery as students work through the worksheet and start to construct wall members from scaled material. Subject matter to include rough opening size, header size, actual vs. nominal size, window and door header height and stud length.

**Checking for understanding:** Students will label the wall members as they construct them and the instructor will check over the labeling and the worksheet test.

**Closure:** The instructor will review all wall members and proper sizes.

**Materials Needed:** Wall Members Worksheets and Wall Member Test for entire class, Overhead of Wall Members Worksheet, Overhead projector, and wood cut to 1/4 scale size for students to cut scale members from.
Wall Members Worksheet

TYPICAL EXTERIOR 2"X 4" STUD WALL SHOWING CONSTRUCTION DETAILS

![Diagram of a typical exterior wall showing construction details]

Figure 43-1. A typical exterior wall showing corners, door and window openings.

The let-in brace originally shown in the drawing is no longer permitted by code in California. The fire-blocking now illustrated is currently required by code.

Members of the Wall

Outside corner | Trimmer studs | Cripple Studs
Window Header | Door Header | Inside Corner
Bottom Plate Studs | Double Top Plate | Top Plate

The stud next to the Trimmer Stud is known as the King Stud.
Wall Framing Test

Identification

1. Outside corner
2. Bottom plate
3. Window header
4. Cripple studs
5. Common studs
6. Inside corner
7. Door header
8. Fire-blocking
9. Double top plate
10. Trimmer studs
11. King Stud

12. What is the typical stud nominal size?
13. Is it recommended that a header be solid material or sandwiched 2x material?
14. What is the residential height for a header?
Spacing of Wall Member Lesson Plan

**Student Performance Objective:** By the end of the lesson the student will be able to correctly space studs on 16 inch centers.

**Student Assessment:** Students will correctly laying out a bottom plate with proper markings and proper spacing.

**Anticipatory Set:** The instructor informs students that they are ready to start constructing the wall after insuring proper spacing.

**Instructional Component:** The lesson will be a demonstration with the instructor explaining the layout and the proper markings. The purpose of 16 inch on center will be explained and demonstrated.

**Checking for Understanding:** The instructor will insure that students are using the correct procedures by checking spacing on scale model.

**Closure:** Instructor will be a review of the correct spacing and markings as the students build their scale wall.

**Materials Needed:** Handout of wall marking diagram for entire class, overhead of wall marking diagram, and overhead projector.
Figure 43-14. Marking outside and inside corners in stud-and-block construction.

Figure 43-15. If the first stud of an exterior wall is to be placed at 15½ inches from the end of the corner, and the other studs follow 16" O.C. layout, the edges of standard-size panels will fall over the centers of the studs. In this example, a 4' wide panel is shown. If the panel were placed horizontally, an 8' or 12' length would also break over the center of a stud.

Figure 43-16. When the second exterior wall is laid out, the 15½" mark should be measured from the outside edge of the panel thickness on the first wall. The corner of the starting panel of the second wall will then line up with the edge of the first wall panel. The opposite edge of the panel will break on the center of a stud.
Figure 43-13. Section of wall framed from the layout. The framing members are nailed where the plates are marked.
Attachment of Wall Members to Plates Lesson Plan

**Student Performance Objective:** By the end of the lesson the student will be able to properly attach wall members to both bottom and top plate insuring that the plate is nailed with the correct size nail and that both wall member and plate are flush at the edge.

**Student Assessment:** Students will be the demonstration of proper attachment of wall members to plates. Wall members and plates must be flush and have proper nailing.

**Anticipatory Set:** The instructor explains the importance of proper nailing and flush in wall construction.

**Instructional Components:** This is a student demonstration lesson. The main concepts are friction of nail on wood as holding power and the concept of flush.

**Checking for Understanding:** The instructor will check the construction of the wall to insure that it is properly nailed and flush.

**Closure:** Instructor will review the concept and importance of flush and proper nailing in construction of the wall.

**Material needed:** 18 gauge brad nailer with 3/4 inch nails, compressed air for nail gun.
Attachment of Wall to Footing Lesson Plan

Student Performance Objective: By the end of the lesson the student will be able to properly attach a wall to a foundation.

Student Assessment: Student will demonstrate the proper attachment of wall to foundation with scale model.

Anticipatory Set: Instructor will explain importance of proper attachment of wall to foundation and the students will be able to attach their walls to the foundation in the scale model.

Instructional Component: This is a demonstration lesson. The main concepts are: the transference of stability from the foundation to the walls, the importance of bolting bottom plate to foundation, proper location of bolts holes in bottom plate and the introduction of Simpson Structural walls and bolts.

Checking for Understanding: Instructor will check attachment of the walls to the foundation as students work on scale model.

Closure: Instructor will review the concepts and importance of attachment of wall to foundation.

Materials Needed: Simpson Strongwall Catalog, nuts for attachment to foundation bolts, drill, and drill bit slightly larger than foundation bolts.
Plumbing and Squaring of Wall Lesson Plan

**Student Performance Objective:** By the end of the lesson the student will be able to properly square and plumb a wall.

**Student Assessment:** Students will properly square and plumb walls on scale model.

**Anticipatory Set:** Instructor will explain the importance of square and plumb wall and explain that this is a necessary step before putting on roof members and siding.

**Instructional Components:** This is a demonstration lesson. The main concepts are square and plumb and how to achieve both in wall construction.

**Closure:** Instructor will review the main concepts in squaring and plumbing a wall.

**Materials Needed:** Level, framing square, and 100’ of string.
MATH CONTENT

The intent of the math content is to teach math through the building of a wall. The addition, subtraction, multiplication and division of whole numbers and fraction will start with the commonly used fractions in construction, mainly $\frac{1}{2}$s, $\frac{1}{4}$s, $\frac{1}{8}$ths, and $\frac{1}{16}$ths.

The math content is broken down into five lesson plans.

1. Addition and subtraction of fractions.
2. Multiplication and division of fractions.
3. How to calculate scale.
4. How to center on 16 inch centers.
5. The Pythagorean Theorem in a 3-4-5 Triangle.
Addition/Subtraction of Fractions Lesson Plan

**Student Performance Objective:** By the end of the lesson the student will be able correctly add and subtract whole numbers and fractions.

**Student Assessment:** Students will properly add and subtract whole numbers and fractions in the building of their scaled wall model.

**Anticipatory Set:** Instructor will explain the importance of fractions on a construction job site.

**Instructional Component:** Lesson will be a demonstration with student discovery. Main concepts are: addition and subtraction of whole numbers and fractions, fractions involved in reading a tape measure, and the use of a common denominator.

**Checking of Understanding:** Instructor will check student calculation and review any mistakes.

**Closure:** Instructor will review the use of a common denominator in addition and subtraction of fractions.

**Materials Needed:** Tape measures and a poster of an enlarged inch showing all fractions.
Multiplication/Division of Fractions Lesson Plan

**Student Performance Objective:** By the end of the lesson the student will be able properly multiply and divide whole numbers and fractions.

**Student Assessment:** Students will correctly multiply and divide whole numbers and fractions in the layout and construction of their scale wall model.

**Anticipatory Set:** Instructor will explain the importance of being able to multiply and divide fractions on a construction job site.

**Instructional Component:** Lesson will be a demonstration with student discovery. Main concepts covered: multiplication and division of fractions and the use of a common denominator.

**Checking For Understanding:** Instructor will review calculation made in layout and building of scale model and review any mistakes.

**Closure:** Instructor will review major concepts of the lesson.

**Materials Needed:** Tape measures and a poster of an enlarged inch showing all fractions.
Scale Lesson Plan

**Student Performance Objective:** By the end of the lesson the student will be able to describe what scale is and accurately calculate 1/4 scale.

**Student Assessment:** Student will correctly figure 1/4 scale for all wall members and fasteners used in layout and construction of scale wall model.

**Anticipatory Set:** Instructor will explain the importance of scale on blueprints and layout of buildings.

**Instructional Component:** This is a demonstration lesson with student discovery. Main concepts are: scale and how to calculate 1/4 scale.

**Checking for Understanding:** Instructor will review calculation made on scale worksheet and scale wall model and correct any mistakes with students.

**Closure:** Instructor will review scale and conversions to 1/4 scale.

**Materials Needed:** Architect scale and material scale worksheet.
Scale Worksheet

Name _____________________________________________

Figure the 1/4 scale for the following construction materials.

<table>
<thead>
<tr>
<th>Material</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>2x4</td>
<td>_____</td>
</tr>
<tr>
<td>2x6</td>
<td>_____</td>
</tr>
<tr>
<td>4x4</td>
<td>_____</td>
</tr>
<tr>
<td>4x6</td>
<td>_____</td>
</tr>
<tr>
<td>4x10</td>
<td>_____</td>
</tr>
<tr>
<td>4x12</td>
<td>_____</td>
</tr>
<tr>
<td>8ft lengths</td>
<td>_____</td>
</tr>
<tr>
<td>10ft lengths</td>
<td>_____</td>
</tr>
<tr>
<td>12ft lengths</td>
<td>_____</td>
</tr>
<tr>
<td>20ft Lengths</td>
<td>_____</td>
</tr>
<tr>
<td>16d nails (3 inches long)</td>
<td>_____</td>
</tr>
<tr>
<td>8d nails (2 3/8 inches long)</td>
<td>_____</td>
</tr>
</tbody>
</table>

Keep this worksheet in your notebook as a reference.
Centering on 16 Inch Center Lesson Plan

**Student Performance Objective:** By the end of the lesson the student will be able to correctly center studs on 16 inch centers.

**Student Assessment:** Students will correctly layout studs on 16 inch centers in the scale wall model.

**Anticipatory Set:** Instructor explains the importance of 16 inch on center in the later application of plywood sheeting and interior finishes.

**Instructional Components:** This is a demonstration lesson with student discovery. Main concepts are: finding the center of an object, multiples of 16, and dropping of 1/2 in order to center.

**Checking for Understanding:** Instructor will check layout and construction of scale wall model and correct any mistakes.

**Closure:** Instructor will review concept of 16 inch on center and the dropping of half to start wall.

**Material Needed:** Tape measure.
Pythagorean Theorem Lesson Plan

Student Performance Objective: By the end of the lesson the student will be able to accurately calculate the theorem and use the 3-4-5 triangle to square the walls on the scale wall model.

Student Assessment: Student will use a 3-4-5 triangle to square the walls of the scale wall model.

Anticipatory Set: Instructor will explain the uses of the 3-4-5 triangle on a construction site.

Instructional Components: Lesson is a demonstration with student discovery. Main concepts are: right angle triangles, Pythagorean Theorem, and the 3-4-5 triangle.

Checking for Understanding: Instructor will check students’ use of 3-4-5 triangle to square walls on scale wall model.

Closure: The instructor will review the Pythagorean Theorem and its uses.

Material Needed: Rafter Square and a tape measure.
Construction projects create opportunities to teach a tremendous amount of earth science along with other sciences. The scale wall model includes a foundation of concrete, which includes a chemical reaction to cure, and a number of features to prevent earthquake damage, which opens up a discussion about earthquakes and plate tectonics.

The science content is broken up into five lesson plans.

1. Structure of a tree.
2. Recycling and recycled products in construction.
3. Friction and wood fiber.
4. Shear, earthquakes and plate tectonics.
5. Water shed and erosion.

There are a number of great resources on the internet that are listed with each lesson plan. Any exercises and worksheets are included after the appropriate lesson plan.
Structure of a Tree Lesson Plan

**Student Performance Objective:** By the end of the lesson the student will be able to correctly identify the parts of a tree and be able to select wood from the proper section of the tree for the scale wall model.

**Student Assessment:** Students will be able to name different parts of a tree and select the proper wood for construction of model.

**Anticipatory Set:** Instructor informs students that not only is wood a perfect building material because of its properties but scientists have used the rings of a tree to do climate studies.

**Instructional Component:** This is a demonstration lesson. The main concepts are: section of a tree- xylem vs. phylum and heart wood vs. strength, the growth cycle of a tree, and what information can be obtained from the rings.

**Checking for Understanding:** Instructor will check students’ knowledge of section by questioning students as they select wood for their model.

**Closure:** Instructor will review sections of a tree and their properties.

**Materials Needed:** Cross section of a tree handout, sample of xylem wood, and sample of phylum wood.
You can tell a lot about a tree by looking at its rings. You can see when a fire burned parts of the tree. You can see when and where insects bored holes and tunnels in the trunk. You can even tell when there was plenty of rain, and when there wasn't. Thick rings indicate there was plenty of water that year; thin rings indicate it was a dry year. Scientist studying climate changes over hundreds of years have used the stumps of large redwood trees to gather information.
Recycling and Recycled Products Lesson Plan

Student Performance Objective: By the end of the lesson the student will be able to identify recycled products used in construction.

Student Assessment: Student will be able to select correct material in construction of the scale wall model.

Anticipatory Set: Instructor will review prices of sheet stock and lumber and reinforce the concept of recycling and cost reduction. The concept of increased strength in the recycled products will also be introduced.

Instructional Component: This will be a demonstration lesson. The main concepts are: recycling, the cost reduction of recycling, and the increased strength of recycled products.

Checking for Understanding: Instructor will check students' use of products as they construct scale wall model. Instructor will also have students set up and maintain recycling bins in the classroom, with students deciding what to do with proceeds.

Closure: Instructor will review the cost savings and products available because of recycling.

Materials Needed: Recycling bins, samples of Oriented Strand Board (OSB), Medium Density Fiberboard (MDF), particle board and CDX plywood.
Friction and Wood Fiber Lesson Plan

**Student Performance Objective:** By the end of the lesson the student will be able describe how wood fiber holds a nail and a screw.

**Student Assessment:** Student will use the correct fastener on the scale wood model.

**Anticipatory Set:** Instructor will explain the importance of properly fastening structure together.

**Instruction Component:** The lesson will be a demonstration lesson with student discovery. Main concepts are: friction and its side effects, surface area, and wood fiber's unique ability to create friction.

**Checking for Understanding:** Instructor will have students do a friction exercise and review the outcomes with students.

**Closure:** Instructor will review concept of friction and how to increase holding power.

**Materials Needed:** Friction activity instructions, two 2 foot sections of 2x4, two 16d nails, eight 8d nails, 2 three inch decking screws, a hammer, a screw gun, and a section of 2x4 with the nail grove showing.
Friction Activity

Material needed: two 2 foot long sections of 2x4, two 16d nails, two 3 inch decking screws, a hammer, a screw gun, eight 8d nails, and an 18 inch square piece of Oriented Strand Board (OSB).

1. Instruct the students to nail the 2x4 section together forming a “T” with the 16d nails.

2. Instruct two students to each grab a 2x4 and try and pull them apart. The students are allowed to twist and pull in order to separate the 2x4 section.

3. Time how long it takes to separate the two sections.

4. Repeat the process with the 3 inch screws and see how long it takes the students to separate the 2x4 sections.

Note: Don’t use the same holes that the nails were in and remove the nails before inserting screws.

The screw should have held longer that the nails. Why? Surface area of the screw was increased by the threads.

Now nail the 2x4’s into a “T” again and nail the OSB to the 2x4 “T” using the 8d nails. Align the top edge of the 2x4 “T” with on edge of the OSB, put four 8d nails through the OSB into the 2x4 evenly spaced along the top of the “T” and four 8d nails through the OSB into the 2x4 leg of the “T” evenly spaced. Have the students try to pull apart the 2x4 and OSB “T” again allowing them to twist the “T”.

The “T” should stand up to a lot more stress with the OSB nailed to it. Use this to tie into the next lesson plan about shear and earthquakes.
Shear, Earthquakes, and Plate Tectonics Lesson Plan

**Student Performance Objective:** By the end of the lesson the student will be able describe the causes of earthquakes and how to prevent damage on their model.

**Student Assessment:** Students will properly construct the scale wall and attach it to the foundation.

**Anticipatory Set:** Instructor will use the results of the friction activity to introduce the concept of shear and the earth plates’ activity.

**Instructional Component:** This is a demonstration lesson with student discovery. Main Concepts are: shear, plate tectonics, earthquakes, and what construction techniques are used to reduce or eliminate damage.

**Checking for understanding:** Instructor will review the students’ use of shear and wall to foundation attachment and why it is needed.

**Closure:** Instructor will review the causes of earthquakes, the type of plate boundaries and movements.

**Additional Resources:** The U.S. Geological Services website on plate tectonics:  

The University of Nevada Seismic Lab’s website:  
http://www.seismo.unr.edu/ftp/pub/louie/class/100/plate-tectonics.html
There are three main plate tectonic environments: **extensional**, **transform**, and **compressional**. Plate boundaries in different localities are subject to different inter-plate stresses, producing these three types of earthquakes. Each type has its own special hazards.
At spreading ridges, or similar *extensional* boundaries, earthquakes are shallow, aligned strictly along the axis of spreading, and show an extensional mechanism. Earthquakes in extensional environments tend to be smaller than magnitude 8.

At *transforms*, earthquakes are shallow, running as deep as 25 km; mechanisms indicate strike-slip motion. Transforms tend to have earthquakes smaller than magnitude 8.5. The San Andreas Fault in California is a nearby example of a transform, separating the Pacific from the North American plate. At transforms the plates mostly slide past each other laterally, producing less sinking or lifting of the ground than extensional or compressional environments.

At *compressional* boundaries, earthquakes are found in several settings ranging from the very near surface to several hundred kilometers depth, since the coldness of the subducting plate permits brittle failure down to as much as 700 km. Compressional boundaries host Earth's largest quakes, with some events on subduction zones in Alaska and Chile having exceeded magnitude 9.
Water and Erosion Lesson Plan

Student Performance Objective: By the end of the lesson the student will be able describe the damage done by water and wind erosion and how to prevent it.

Student Assessment: Student will describe wind and water damage and build their scale wall model to prevent both.

Anticipatory Set: Instructor will explain the damage that can be done by wind and water erosion over time using the Grand Canyon as an example.

Instructional Components: This is a demonstration lesson. The main concepts are:
water erosion of soil, wind erosion of soil, and the prevention of erosion.

Checking for Understanding: Instructor will check the design and construction of scale wall model the see that erosion concerns are being corrected.

Closure: Instructor will review the concept of erosion and the damage that it can do.


Additional Resources: U.S. Dept. of Agriculture’s wind erosion website:
http://www.weru.ksu.edu/

The U.S. Global Change Research Information office’s soil erosion website:
http://www.gcrio.org/geo/soil.html
LANGUAGE ARTS CONTENT

The language arts content of lesson is set up in three sections.

1. Vocabulary.

The vocabulary will be words from the subject contents in this project.
Vocabulary Lesson Plan

**Student Performance Objective:** By the end of the lesson the student will be able correctly write the definition of a given word on a test.

**Student Assessment:** Student will correctly write the definition of a given word in a short phrase form on a test.

**Anticipatory Set:** Instructor will tell story about use of the wrong term causing a problem and express the need to know the proper terminology.

**Instructional Component:** This will be a student discovery lesson. The students will receive a blank worksheet and need to work through notes and class information to find answers.

**Checking for Understanding:** Instructor will check over the worksheet and insure that all students have the correct answer before administering test.

**Closure:** Instructor will review any incorrect answers from student test.

**Materials Needed:** Vocabulary worksheet and vocabulary test (both sheet and test are the same).
Vocabulary Worksheet

Name ________________________________________________________

1. Erosion:

2. King Stud:

3. Xylem of a tree:

4. Double Top Plate:

5. Recycling:

6. Lithosphere:

7. Extensional Plate Boundary:

8. Transform Plate Boundary:

9. Compressional Plate Boundary:
10. Surface Area:

11. Trimmer Stud:

12. Cripple Stud:

13. Denominator:

14. Earthquake:

15. Numerator:

16. Door header:

17. Thermal plumes:

18. Asthenosphere:

19. Richter scale:
20. Pangaea:

21. Gondwanaland:

22. Mid-Atlantic Ridge:

23. Volcanic Hot Spots:

24. Outside corner:

25. Square:

Resource sites:

The U.S. Geological Services website on plate tectonics:

The University of Nevada Seismic Lab’s website:
http://www.seismo.unr.edu/ftp/pub/louie/class/100/plate-tectonics.html
Step-by-Step Outline Lesson Plan

Student Performance Objective: By the end of the lesson the student will be able to write a step-by-step process in outline form on building a wall.

Student Assessment: Student will write a step-by-step process in outline form that is correct in both content and grammar.

Anticipatory Set: Instructor will demonstrate the process of developing a step-by-step process by having students give steps for the instructor to put on a coat that is draped over their arm. The instructor will do exactly what students tell them.

Instructional Components: This is a demonstration lesson. The main concepts are: step-by-step instructions and writing in an outline form.

Checking for Understanding: Instructor will review step-by-step outlines for content, grammar, and form, as the students work on them.

Closure: Instructor will review importance of step-by-step direction.

Material Needed: Coat.
Step-By-Step Paper Lesson Plan

**Student Performance Objective:** By the end of the lesson the student will be able to write a paper that is correct in grammar and content.

**Student Assessment:** Student will write a paper that is correct in content and grammar describing a step-by-step process.

**Anticipatory Set:** Instructor demonstrates a step-by-step process written for a dado cut. The purpose of the demonstration is to show the students the ease of learning with step-by-step directions.

**Instructional Components:** This is a demonstration lesson. The main concepts are: grammatical writing and content.

**Checking for Understanding:** Instructor will check first draft of paper to insure student understanding and correct use of grammar.

**Closure:** Instructor will review any reoccurring grammatical errors and review the process of writing a paper from an outline.

**Materials Needed:** MLA Guide.
REFERENCES


APPENDIX B

PERTINENT UNIFORM BUILDING CODE (UBC)
Introduction

The following is the Uniform Building Codes (UBC) that directly relate to the construction of walls in residential structures. This appendix shows the reasoning behind the information in the construction curriculum. The pertinent UBC is included to show the importance of building a structure the proper way and to show the students exactly what the building inspector is looking for when they come on a job site. Understanding of the importance of the code and the consequences of not following the code are crucial to the completion of a construction project.

The code has been written by the International Conference of Building Officials (ICBO) and scanned directly from the 1997 Dwelling Construction Under the Uniform Building Code. Use of the code in the classroom will show students the reasoning for skills and tasks and familiarize them with terminology and phrasing in the code. This will enable students to be better prepared for jobs in the construction trades if they choose to follow that career path.

1997 Uniform Building Code (UBC)

Workmanship

All members shall be framed, anchored, tied and braced so as to develop the strength and rigidity necessary for the purposes for which they are to be used. For details of framing, see Figure 6. (Sec. 2304.4.1)

Spacing and Penetration of Nails

All spacing and edge and end distances shall be such as to avoid splitting of the wood. Holes for nails, when necessary to prevent splitting, shall be bored of a diameter smaller than that of the nails, (Sec. 2318.3) Tables 23-II-B-i and 23-II-B-2 comply with the Uniform Building Code for number of nails for connecting wood members.

Columns or Posts

Columns and posts located on concrete or masonry floors or decks exposed to the weather or to water splash or in basements, and which support permanent structures, shall be supported by concrete piers or metal pedestals projecting above floors unless approved wood of natural resistance to decay or treated wood is used. The pedestals shall project at least 6 inches (152 mm) above exposed earth and at least 1 inch (25 mm) above such floors.

Individual concrete or masonry piers shall project at least 8 inches (203 mm) above exposed ground unless the columns or posts which they support are of approved wood of natural resistance to decay, or treated wood is used. (Sec. 2306.5)
Wood and Earth Separation

Wood used in construction of permanent structures and located nearer than 6 inches (152 mm) to earth shall be treated wood or wood of natural resistance to decay. Where located on concrete slabs placed on earth, wood shall be treated wood or wood of natural resistance to decay. Where not subject to water splash or to exterior moisture and located on concrete having a minimum thickness of 3 inches (76 mm) with an impervious membrane installed between concrete and earth, the wood may be of any species.

Where planter boxes are installed adjacent to wood frame walls, a 2-inch-wide (51 mm) air space shall be provided between the planter and the wall. Flashings shall be installed when the air space is less than 6 inches (152 mm) in width. Where flashing is used, provisions shall be made to permit circulation of air in the air space. The wood frame wall shall be provided with an exterior wall covering. (Sec. 2306.8)

Headers

Headers and lintels shall be properly designed to support dead loads and design live loads. See Figure 7 for typical framing details. (Sec. 2320.11.6)

Wall Construction—Wood

Wall and Partition Framing

1. Size, height and spacing.

The size, height and spacing of studs shall be in accordance with Table 23-IV-B except that Utility grade studs shall not be spaced more than 16 inches (406 mm) on center, nor support more than a roof and ceiling, nor exceed 8 feet (2438 mm) in height for exterior walls and load-bearing walls or 10 feet (3048 mm) for interior nonload-bearing walls.

2. Framing details.

Studs shall be placed with their wide dimension perpendicular to the wall. Not less than three studs shall be installed at each corner of an exterior wall.

EXCEPTION: At corners a third stud may be omitted through the use of wood spacers or backup cleats of \(\frac{3}{8}\)-inch-thick (9.5 mm) wood structural panel, \(\frac{3}{8}\)-inch (9.5 mm) Type 2-M particleboard, 1-inch-thick (25 mm) lumber or other approved devices which will serve as an adequate backing for the attachment of facing materials. Where fire-
resistance ratings or shear values are involved, wood spacers, backup cleats or other devices shall not be used unless specifically approved for such use.

Bearing and exterior wall studs shall be capped with double top plates installed to provide overlapping at corners and at intersections with other partitions. End joints in double top plates shall be offset at least 48 inches (1219 mm).

**EXCEPTION:** A single top plate may be used, provided the plate is adequately tied at joints, corners and intersecting walls by at least the equivalent of 3-inch by 6-inch by 0.036-inch-thick (76mm by 152 mm by 0.9 mm) galvanized steel that is nailed to each wall or segment of wall by six 8d nails or equivalent, provided the rafters, joists or trusses are centered over the studs with a tolerance of no more than 1 inch (25 mm). When bearing studs are spaced at 24-inch (610 mm) intervals and top plates are less than two 2-inch by 6-inch (51 mm by 152 mm) or two 3-inch by 4-inch (76 mm by 102 mm) members and when the floor joists, floor trusses or roof trusses which they support are spaced at more then 16-inch (406 mm) intervals, such joists or trusses shall bear within 5 inches (127 mm) of the studs beneath or a third plate shall be installed. Interior nonbearing partitions may be capped with a single top plate installed to provide overlapping at corners and at intersections with other walls and partitions. The plate shall be continuously tied at joints by solid blocking at least 16 inches (406 mm) in length and equal in size to the plate or by 1/8-inch-by-1 1/2-inch (3.2 mm by 38 mm) metal ties with spliced sections fastened with two 16d nails on each side of the joint. Studs shall have full bearing on a plate or sill not less than 2 inches (51 mm) in thickness having a width not less than that of the wall studs. Wall framing detail is shown in Figure 7. (Sec.2320.11)

**Bracing**

In Seismic Zones 0, 1, 2 and 3, where the basic wind speed is not greater than 80 miles per hour (mph) (129 km/h), dwellings shall be provided with exterior and interior braced wall lines. Spacing shall not exceed 34 feet (10 363 mm) on center in both the longitudinal and transverse directions in each story.

In Seismic Zone 4, dwellings shall be provided with exterior and interior braced wall lines. Spacing shall not exceed 25 feet (7620 mm) on center in both the longitudinal and transverse directions in each story.

**EXCEPTION:** In one- and two-story dwellings, interior braced wall line spacing may be increased to not more than 34 feet (10 363 mm) on center in order to accommodate
one single room per dwelling not exceeding 900 square feet (83.61 m²). The building official may require additional walls to contain braced panels when this exception is used.

See Section 2320 in the Uniform Building Code for additional special requirements specific to the seismic zone.

Wall bracing is required in accordance with Table 23-IV-C-1. (Sec. 2320.11)

Braced wall lines shall consist of braced wall panels which meet the requirements for location, type and amount of bracing specified in Table 23-IV-C-1 and are in line or offset from each other by not more than 4 feet (1219 mm). Braced wall panels shall start at not more than 8 feet (2438 mm) from each end of a braced wall line. All braced wall panels shall be clearly indicated on the plans. Construction of braced wall panels shall be by one of the following methods:

1. Nominal 1-inch by 4-inch (25 mm by 102 mm) continuous diagonal braces let into top and bottom plates and intervening studs, placed at an angle not more than 60 degrees or less than 45 degrees from the horizontal, and attached to the framing in conformance with Table 23-11-B-I.

2. Wood boards of 5/8-inch (16 mm) net minimum thickness applied diagonally on studs spaced not over 24 inches (610 mm) on center.

3. Wood structural panel sheathing with a thickness not less than ~16 inch (7.9 mm) for 16-inch (406 mm) stud spacing and not less than ~ inch (9.5 mm) for 24-inch (610 mm) stud spacing in accordance with Tables 23-11-A-I and 23-IV-D-1.

4. Fiberboard sheathing 4-foot by 8-foot (1219 mm by 2438 mm) panels not less than 1/2 inch (13 mm) thick applied vertically on studs spaced not over 16 inches (406 mm) on center when installed in accordance with Section 2315.6 and Table 23-11-J.

5. Gypsum board [sheathing 1/2 inch (13 mm) thick by 4 feet (1219 mm) wide, wallboard or veneer base] on studs spaced not over 24 inches (610 mm) on center and nailed at 7 inches (178 mm) on center with nails as required by Table 25-I.

6. Particleboard wall sheathing panels where installed in accordance with Table 23-IV-D-2.

7. Portland cement plaster on studs spaced 16 inches (406 mm) on center installed in accordance with Table 25-I.
8. Hardboard panel siding when installed in accordance with Section 2310.6 and Table 23-11-C.

Method I is not permitted in Seismic Zones 2B, 3 and 4. For cripple wall bracing, see Section 2320.11.5.

For Methods 2, 3, 4, 6, 7 and 8, each braced wall panel must be at least 48 inches (1219 mm) in length, covering three stud spaces where studs are 16 inches (406 mm) apart and covering two stud spaces where studs are spaced 24 inches (610 mm) apart.

For Method 5, each braced wall panel must be at least 96 inches (2438 mm) in length when applied to one face of a braced wall panel and 48 inches (1219 mm) when applied to both faces.

All vertical joints of panel sheathing shall occur over studs. Horizontal joints shall occur over blocking equal in size to the studding except where waived by the installation requirements for the specific sheathing materials.

Braced wall panel sole plates shall be nailed to the floor framing and top plates shall be connected to the framing above in accordance with Table 23-11-B-1. Sills shall be bolted to the foundation or slab in accordance with Section 1806.6. Where joists are perpendicular to braced wall lines above, blocking shall be provided under and in line with the braced wall panels.

Alternate braced wall panels.

Any braced wall panel required by Section 2320.11.3 may be replaced by an alternate braced wall panel constructed in accordance with the following:

1. In one-story buildings, each panel shall have a length of not less than 2 feet 8 inches (813 mm) and a height of not more than 10 feet (3048 mm). Each panel shall be sheathed on one face with 5/8-inch-minimum-thickness (9.5 mm) plywood sheathing nailed with 8d common or galvanized box nails in accordance with Table 23-II-B-1 and blocked at all plywood edges. Two anchor bolts installed in accordance with Section 1806.6, shall be provided in each panel. Anchor bolts shall be placed at panel quarter points. Each panel end stud shall have a tie-down device fastened to the foundation, capable of providing an approved uplift capacity of not less than 1,800 pounds (816.5 kg). The tie-down device shall be installed in accordance with the manufacturer's recommendations. The panels shall be supported directly on a foundation or on floor framing supported directly on a foundation which is continuous across the entire length of the braced
wall line. This foundation shall be reinforced with not less than one No. 4 bar top and bottom.

2. In the first story of two-story buildings, each braced wall panel shall be in accordance with Section 2320.11.4, Item 1, except that the plywood sheathing shall be provided on both faces, three anchor bolts shall be placed at one-fifth points, and tie-down device uplift capacity shall not be less than 3,000 pounds (1360.8 kg).

**Foundation Cripple Studs**

Foundation cripple studs shall not be less in size than the studding above and, when exceeding 4 feet (1219 mm) in height, shall be the size required for an additional story. Foundation studs of bearing walls and partitions shall be thoroughly and effectively braced. Cripple walls having a stud height exceeding 14 inches (356 mm) shall be braced in accordance with Table 23-IV-C-2. Solid blocking or wood structural panel sheathing may be used to brace cripple walls having a stud height of 14 inches (356 mm) or less. In Seismic Zone 4, Method 7 is not permitted for bracing any cripple wall studs. (Sec. 2320.11.5)

**Fire-blocking and Draft-Stops**

Fire-blocking and draft-stopping shall be installed to cut off all concealed draft openings (both vertical and horizontal) and shall form an effective barrier between floors, between a top story and a roof or attic space, and shall subdivide attic spaces, concealed roof spaces and floor-ceiling assemblies.

Fire-blocking shall be provided in the following locations:

1. In concealed spaces of stud walls and partitions, including furred spaces, at the ceiling and floor levels and at 10-foot (3048 mm) intervals both vertical and horizontal.

**EXCEPTION:** Fire blocks may be omitted at floor and ceiling levels when approved smoke-actuated fire dampers are installed at these levels.

2. At all interconnections between concealed vertical and horizontal spaces such as occur at soffits, drop ceilings and cove ceilings.

3. In concealed spaces between stair stringers at the top and bottom of the run and between studs along and in line with the run of stairs, if the walls under the stairs are unfinished.
4. In openings around vents, pipes, ducts, chimneys, fireplaces and similar openings which afford a passage for fire at ceiling and floor levels, with noncombustible materials.

5. At openings between attic spaces and chimney chases for factory-built chimneys.

Except as provided in Item 4, fire-blocking shall consist of 2 inches (51 mm) nominal lumber or two thicknesses of 1-inch (25 mm) nominal lumber with broken lap joints or one thickness of $\frac{23}{32}$-inch (18.3 mm) wood structural panel with joints backed by $\frac{23}{32}$-inch (18.3 mm) wood structural panel or one thickness of $\frac{3}{4}$-inch (19.1 mm) Type 2-M particleboard with joints backed by $\frac{3}{4}$-inch (19.1 mm) Type 2-M particleboard.

- Fire blocks may also be of gypsum board, cement asbestos board, mineral fiber, glass fiber or other approved materials securely fastened in place. Loose-fill insulation material shall not be used as a fire block unless specifically fire tested. (Sec. 708.2)

Draft-stopping shall be provided when there is usable space above and below the concealed space of a floor-ceiling assembly so that the area of the concealed space does not exceed 1,000 square feet ($93 \text{ m}^2$). Draft-stopping shall divide the concealed space into approximately equal areas.

Draft-stopping materials shall not be less than $\frac{1}{2}$-inch (12.7 mm) gypsum board, $\frac{3}{8}$-inch (9.5 mm) wood structural panel, $\frac{3}{8}$-inch (9.5 mm) Type 2-M particleboard or other approved materials adequately supported. Openings in the partitions shall be protected by self-closing doors with automatic latches constructed as required for the partitions. (Sec. 708.3)
APPENDIX C

LAMB CONSTRUCTION LICENSE.
State of California

Contractors State License Board

Pursuant to Chapter 9 of Division 3 of the Business and Professions Code and the Rules and Regulations of the Contractors State License Board, the Registrar of Contractors does hereby issue this license to:

DARREN LAMB CONSTRUCTION

to engage in the business or act in the capacity of a contractor in the following classifications:

B • GENERAL BUILDING CONTRACTOR
HIC • HOME IMPROVEMENT CERTIFICATION

Witness my hand and seal this day,

October 10, 2000

Issued October 10, 2000

James Goldstone
Registrar of Contractors

785589
License Number

Signature of Licensee

Signature of Licensee Qualifier

This license is the property of the Registrar of Contractors, is not transferable, and shall be returned to the Registrar upon demand when suspended, violated, or invalidated for any reason. It becomes void if not renewed.

October 11, 2000

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REFERENCES


