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Impact of Learning Theory Methods on Undergraduate Retention and Application of Software in a Studio Setting

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IMPACT OF LEARNING THEORY METHODS ON UNDERGRADUATE RETENTION AND APPLICATION OF SOFTWARE IN A STUDIO SETTING

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Title: Impact of Learning Theory Methods on Undergraduate Retention and Application of Software in a Studio Setting

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The transition from an academic atmosphere to the professional world is an important step in a college student's life. The use of traditional teaching methods has been the subject of ongoing research into how well they prepare students for this transition.

The evolution of technology and the state of the nation's economy continually require entry-level employees to display broader skillsets. Competencies such as critical thinking, creativity, and technical accuracy are three off the primary attributes of a well-prepared college student transitioning into a creative or design industry. Within traditional teaching methodologies, technical accuracy has been the primary outcome of the learning environment. These traditional methods often fall short in preparing students for other the necessary competencies.

This study explores the application of two teaching methodologies – behaviorist and constructivist – and their effects on accuracy, retention, and behavior among college students in an interior design studio classroom setting. Two separate groups of participants engaged in a learning experience that followed either a behaviorist methodology or a constructivist methodology. Participants learned software and completed an electronic drawing that was assessed for accuracy and creative embellishment by the researcher. Additionally, participants submitted surveys after each learning session that described their experience from the perspectives of learner confidence, value of learned skills, and difficulty of the learning session. Finally, learner behavior was analyzed through visual observations made by trained individuals during the learning sessions.

Data showed a clear difference in many of the assessed categories between the methodologies applied. While accuracy levels were high in both approaches, in most other categories, students participating in the constructivist-based groups exhibited higher scores. It is recommended that creative studio classes implement a hybrid approach that utilizes facets of both behaviorist and constructivist methodologies, and also that further research be conducted with larger groups of learners with a wider array of prior academic performance levels. Findings were encouraging in support of an academic goal to better preparing students for a professional transition.

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CHAPTER I

INTRODUCTION

Overview

Teaching at the college level grows more challenging as technology advances and expectations for transitioning entry-level employees rise. Students find that simply learning technology from a technical perspective does not properly prepare them for the workforce, and many teachers are challenged to add additional levels of instructional content into curriculums. Creativity, critical thinking, and interpersonal teamwork skills are all value-added characteristics of a marketable individual, and teaching these concepts is becoming more important to prepare students for post-graduation.

Instruction is typically applied in either a behaviorist or constructivist manner, sometimes as a combination of the two. The behaviorist approach can be simply described as rote learning. A teacher provides content in the form of lecture or written material, and it becomes the individual's responsibility to memorize or process the information. Assessment of this method usually takes the form of a written or oral examination where the student restates the information learned. In a constructivist-structured classroom, teachers are more likely to use methods beyond lecture and written text, and place greater emphasis on project-based learning, teamwork, and individualized goal-setting. Students have greater control over the process by which content is learned, since this approach values a more self-directed style of learning that is largely facilitated rather than directed. The participation within the learning environment puts more responsibility onto students for the outcomes of instruction.

Teaching in a studio setting brings about a unique challenge for instructors, especially where software is involved in the curriculum. A teacher must provide a learning environment that supports technology instruction as well as application of the technology to a greater purpose. An additional level of need arises in instances where creativity is an expected output of learning. Not only is creativity subjective in nature, but also is strongly tied to both the individual and the learning environment.

The Interior Design (INDS) curriculum at Indiana University of Pennsylvania (IUP) has traditionally implemented a behaviorist approach to learning, both in lecture-based classrooms as well as studio-based. The ever-changing requirements of potential employers on graduating students are challenging those teaching the curriculum in a way that requires alternate teaching methods. It is no longer sufficient for students to learn the standard processes of a computer-based design program and be competitive in today's professional society. Further, the ability to demonstrate critical thinking and creativity are paramount to a student's transition into the workforce. These skills are not easily taught, monitored, or evaluated using a behaviorist approach. This study will demonstrate the application of software instruction in a behaviorist method and a constructivist method, and explore the differences in student achievement, retention, and creativity that each presents.

Behaviorist Approach

Lecture-based delivery and demonstration is often utilized as a standard behaviorist approach to learning, where the student is seen as an unreflective responder (Boghossian, 2006). For lower-level foundation classes that have learning goals limited to simple knowledge transfer, this is accepted as an effective approach. This can also be the case with technology curriculum that intends to teach the mechanical processes of software or process.

Rajendran & Clarke (2011) describe Building Information Modeling (BIM) software as a digital way to “walk into a building, walk through the lobby, remove the ceiling tiles and look at the utilities in the ceiling space - before the building is even built (p.45).” For a studio-based class, learning goals often reach beyond process and software into creativity and self-expression without the instructional system to support it. INDS students who are learning BIM at IUP are subject to this approach - the assessment phase of the course is based upon accurate representations of preconceived space drawings pulled directly from a textbook. Ediger (2012) discusses the process in which material is learned under a strictly behaviorist approach. With assessments that are generalized, students have far less control over the learning process. Differentiated instruction (a method of tailoring instruction to students with multiple levels of prior knowledge and learning abilities within a single classroom) is difficult to apply in a classroom in which behaviorist pedagogy is in place. A specific amount of content has been determined necessary in preparation for assessment, leaving little room for individual monitoring and coaching within the constraints of classroom learning. Pugsley (2011) asserts the controlling nature of this teaching methodology, that behaviorism has a more limited success in the attainment of learning goals in the 21st century classroom. The behaviorist approach in the studio setting provides a setting where students follow step-by-step instructions to learn technical skills. Textbooks are highly utilized in this regard, especially those that provide tutorials and detailed examples of technique. In a typical interior design studio that follows this methodology, students work to achieve the same result, such as creating an electronic drawing of an executive meeting room, a financial planning office, a hotel room, or even a residential home. Key features of the program are introduced through lessons that may take an entire semester, depending on the course layout. The final drawing is illustrated in the textbook, so students are able to compare their product to the original before submitting it to the instructor for evaluation.

Constructivist Approach

At the core of the constructivist approach, the individual is supported in his or her journey of constructing knowledge (Kalina & Powell, 2010). The constructivist approach allows for human emotion, social interaction, and a more empowered sense of learning to bring about greater gains to the learner. This is especially important in a learning environment that teaches software, particularly because, while technology has allowed user interfaces to become easier to learn, the complexity and depth of many design programs has greatly increased. Vygotsky's (1978, 1986) social constructivist theory supports the implementation of project-based learning and peer-based teaming and assessment. Given the requirement for more effective teaching methods and better results, the researcher wishes to assess if this approach will allow for a more accurate and creative learning process. The constructivist approach serves as the polar opposite of the behaviorist theory. Where the behaviorist method bases achievement on the ability for a student to reiterate lectured content or written text accurately, the constructivist method digs deeper into the construct of the learning environment and gives students the opportunity to participate in a learning experience with goals that he or she shares more responsibility for setting and achieving. Palincsar (1998) references a radical version of constructivism in which the idea of objective knowledge is completely discarded and knowledge is purest when it comes as a result of peer engagement. While the application of this progressive version of constructivism would be risky, an interpretation of the core value can be utilized to bring about a richer learning experience. Green & Gredler (2002) suggest that the wide array of constructivist beliefs can be condensed into two foundational theories as applied to curriculum development: 1) Learners gain more valuable knowledge through peer engagement, and 2) the implementation of constructivist methods will require a great modification to classroom dynamics. In this approach, as it pertains to interior design, students are introduced to computer software by short lessons during the first week or two of the semester, where the instructor highlights key components or functions within the program (e.g. drawing an interior wall, providing seating, or determining that a space meets federal requirements for universal design). Students are then assigned a project with basic requirements, such as the setting, where they can apply evidence-based design research to generate space, scale, and interior elements. While constructing the space electronically, students are simultaneously learning the software skills and applying creative licensing to their product. Each student's project will be slightly to moderately different from his or her peers', and no final example is available for them to see ahead of time prior to submitting to their instructor.

Rationale for the Study

Meneely & Danko (2007) acknowledge a relationship between design students and technology wherein the technical factors meld with cultural and personal dynamics to influence creativity. At the post-secondary level, creative and technical studio courses cross many disciplines within the arts accept students from different backgrounds and learning styles. For this reason, a challenge teachers are facing in post-secondary education is a continuing demand for differentiated instruction within classrooms. Not all students will have the same background in the content being taught, and this is especially true within classes teaching technology. As a trend, students continue to be more technology-savvy as society grows in digital capability, however the levels of knowledge in regards to software are still widely varied from student to student. Those enrolled in software-based studio courses are typically asked to provide evidence of learning through the application of technical skill, critical thinking, and creativity. With the traditional behaviorist model, technical skill is easily assessed. Creativity and critical thinking are more difficult to assess, due to their inherent subjectivity. The constructivist model, in theory, builds in aspects of learning and interaction that could make these subjective elements more achievable by students.

Rationale for the Sample and Focus

Faculty of design courses in higher education must be equally creative in balancing hand drafting and Computer-Aided Drafting and Design (CADD) skills while promoting levels of retention. Students preparing for entry into the interior design field have been required to increase the level of digital competency throughout their post-secondary education. While skills such as hand-drafting and hand-rendering were sufficient for students to master decades ago, students must now add enhanced electronic skills and software to their portfolios (Pektas & Erkip, 2006). To align itself with national patterns that have reduced face-to-face time between students and faculty, IUP has adapted a university-wide deduction of ten minutes from every lecture hour. Coupled with the need to teach various software platforms beyond the standard methods of hand-drafting and rendering, it challenges students enrolled in Interior Design studio courses in the successful retention of a growing amount of material. The goals of the Interior Design program at IUP as related to digital software education are twofold: 1) Teach the student how to use the software, and 2) teach the student how to use the software in the context of higher-order thinking with an emphasis on creativity. The first concept involving teaching the software has become part of the standard curriculum, and is easily taught and assessed using the current behaviorist teaching approach. The second moves deeper into the need for students to learn technical skills as a basis for learning to communicate creatively and efficiently – skills that employers in the design field expect as core competencies.

The Council for Interior Design Accreditation (CIDA) *2011 Professional Standards* document lists the following competencies for students. Requiring that they demonstrate the ability to:

1. *identify and define relevant aspects of a design problem (goals, objectives, performance criteria).*
2. *gather, evaluate, and apply appropriate and necessary information and research findings to solve the problem (pre-design investigation).*
3. *synthesize information and generate multiple concepts and/or multiple design responses to programmatic requirements.*
4. *demonstrate creative thinking and originality through presentation of a variety of ideas, approaches, and concepts.*

This study aims to explore the possibility that through the application of a constructivist teaching method, software can be taught in a way that better supports accuracy and retention, and creativity output can be measurably increased.

Background

Students majoring in Interior Design at the higher education level are faced with a growing need to infuse creativity with technology. Building Information Modeling and Computer Aided Drafting programs such as AutoCAD, Revit, SketchUp, and 20/20 enable the student to express their visual designs on the screen and further by print. These four programs are widely recognized throughout the interior design and architecture industries as paramount to conducting business in various sections. This shift in dependence on technology places a heavy burden on the student and the instructor. Like most studio-based art and media courses, theory development and the fine art aspects of interior design remain historically vital to developing one's craft; however, this shift adds another layer of digital communication interwoven into curriculum without a corresponding expansion in delivery time. As a result, either curriculum should be modified, or more likely, delivery methods need to be modified to better support conceptual learning.

Disciplines that are based in the design and creation of built environments require increasingly agile development teams. Construction of new living and commercial spaces (as well as the redesign and retrofitting of old spaces) has been elevated to a higher level of complexity with new layers of needs such as environmental influences that have blazed the trail for green design and a strong push toward understanding and implementing efficiency.

Students of the built environment are placed in a position of learning a typically rigid curriculum and producing even more typically rigid results. The concept of a standard curriculum is constantly at war with the unpredictability of a student's creative potential. Given the unpredictable pathways that students in a studio setting are apt to follow, it is not surprising to find that these students require a learning method that is both rigid and flexible (Tucker & Morris, 2012).

As the goal of any educational institution is to prepare a student for transition to the professional world, instructors and teachers bear the responsibility of ensuring that curriculum application is both accurate and beneficial to the current state of the particular academic program and its student base. Accrediting bodies, such as CIDA, provide valuable guidance in preparing students for a successful transition to the professional world. CIDA (2011) requires all accredited Interior Design Programs to include (for its enrolled students):

1. *opportunities to solve simple to complex design problems.*
2. *exposure to a range of design research and problem solving methods.*
3. *opportunities for innovation and creative thinking.*
4. *opportunities to develop critical listening skills.*

Rigor and determination in these five areas are vital to the progression of a degree program so that prepared students are prepared to thrive in a professional atmosphere.

The Interior Design Program at IUP faces this same concern within the development and revision of its curriculum. The researcher wishes to compare two methods of teaching studio courses to determine whether either or both have the potential to produce the amount of creativity and accuracy necessary for a student to transition into a profession in which built environments are of primary concern. Students enrolled in a studio course experience only three hours and twenty minutes of instruction per week. It is hypothesized that the application of a modified teaching method that encourages attributes of a social constructivist approach will allow students to better retain technical skill, allowing for further critical thinking development and creativity.

Purpose of the Study

The intent of this study is to explore how behaviorist and constructivist approaches to learning impact the student's level of retention in software-based studio classes. Support for both methods will be derived from data showing an undergraduate student's ability to retain and accurately utilize BIM software; which has an increasing presence in contemporary studios. Additionally, this study will assist in providing a better comprehension of alternative methods of teaching technology to Interior Design students. Currently, all Interior Design courses at Indiana University of Pennsylvania (IUP) are being taught in the classroom, however, a future demand will most likely arise for faculty to offer online instruction of select courses. Results from this study will be beneficial to gain insight in the student's retention level of a specific technology when this need arises.

IUP's Bachelor of Science degree in Interior Design contains a mixture of studio and lecture courses in the major, along with Liberal Studies and other electives. Interior Design educators must recognize the most efficient way of introducing a new technology into the curriculum, since new content must be incorporated into a current Interior Design course at this time, as there is no room to rearrange the curriculum.

Research Questions

This study aims to determine the level of impact of Learning Theory Methods on an undergraduate's retention and application of software in a studio setting. The researcher plans to relate the infusion of project-based learning in a constructivist approach with an increase in student retention of software knowledge. This is a means to an end, one that might allow software to become more of a support to higher-level learning than it currently is within the construct of interior design instruction at IUP. With this intent, the following research questions are proposed:

> ***RQ1:*** *What is the effect of instructor interaction on a student's ability to apply and retain knowledge in a studio setting, as measured by rubrics that assess accuracy?*

> ***RQ2:*** *Does the instructor's choice of a constructivist approach versus behaviorist impact students' behavior during and attitude towards studio-based learning, as measured by student surveys, observed learning indicators, and creative output?*

These questions will be explored through four experimental learning sessions between two similar learning groups (see Figure 2). The researcher plans to use observation and survey data to discover the impact of teaching methodologies and learning environments on student achievement, retention, creativity, and behavior.

Introduction to the Methodology

To present plausible and value-added data, a comparison study will be performed consisting of two separate experiments; one in which an instructional model founded in behaviorist strategy is implemented, and another in which a constructivist strategy is utilized. The two groups will be determined using matched pairing from demographic surveys, ensuring a balanced sampling for each group.

The foundation for this experiment lies within the context of teaching methodologies implemented in studio-based post-secondary courses. While the results of the experiment could theoretically be applied to multiple disciplines that teach creative studio-based courses, the Interior Design curriculum is targeted in this study. The goals of the experiment are to provide evidence surrounding both a behaviorist and constructivist method of teaching and to determine which of the two methods are better suited for promoting retention and higher-order thinking among students in a studio setting through assessments of accuracy, creativity, and observations of learning behaviors exhibited. Further, this study will utilize a quantitative-based approach to explore the effects on retention skills of undergraduates using BIM.

Human retention of information will be identified via Lang's (2006) limited processing model. Technical evaluation of the project will be performed using the

Evaluation Protocol found in Appendix J of this document. Self-efficacy will be determined through observations as well as data extracted from the post-test surveys administered at the conclusion of each session. Nielsen et al. (2010), tie Bandura's (1977) concept of self-efficacy to students who need to use technology and develop self-confidence to express and communicate intended designs. While transferring hand-sketched ideas to the electronic platform on a PC, students are essentially learning another language to communicate and conceptualize ideas. As this study examines two different teaching methods, data showing self-efficacy for future retention, both perceived and actual, are essential to determine the success of each method. Assessment of the completed projects will translate as evidence for retention, and perceived self-efficacy will translate as evidence for confidence in the creative application of learned concepts.

Conclusion

This study aims to deepen understanding surrounding the current and future needs of studio-based creative studio classrooms as technology evolves and requirements of student retention grow more complex. Chapter two will offer context for the experiment, providing a knowledge base and literature review around core development ideas including teaching methodologies, application of instruction in a creative atmosphere, and learning theory. Chapter three will discuss methods for conducting this study. Chapter four will provide evidence using data from a two-part experiment involving the teaching of a studio lesson utilizing two different methods. Chapter five will offer conclusions and recommendations based upon findings.

CHAPTER II

REVIEW OF LITERATURE

Overview

Creativity, critical thinking, and interpersonal teamwork skills are essential to those entering modern-day professional society. The economy constantly dictates and shapes the ideal makeup of the efficient and valuable employee. Those seeking longevity in the creative atmosphere must be able to effectively utilize software to support an overarching application of intangible skills. Critical thinking has become an important competency that employers seek. Self-direction, motivation, and other interpersonal skills are further at the forefront of hiring requirements. For a technology-centered career, technical ability holds merit. For a creative technology career such as Interior Design, technical ability must be inherent and act as a supporting rung for these intangible factors.

Learning digital skill as it relates to the Interior Design field is not only imperative from a visual drawing and rendering standpoint, but more appropriately as for the whole of visual communication. Students venturing into this career path must grasp technology from a multi-level approach; technical ability of software, media design for presentation, and a combination of the two for portfolio development and maintenance. For a young adult with little to no software experience, it can be a daunting task simply to acclimate themselves with required software, let alone develop his or her visual palette.

Over the past decade, class times have decreased while class sizes increased, a commonality to many post-secondary institutions. Efficiency of teaching is becoming more pertinent to the success of the curriculum, but this does not address the need to further engage students and place more of the responsibility for academic achievement on an intrinsic motivational platform.

Behaviorist Learning Environment

Boghossian (2006) notes that the behaviorist model focuses primarily on external, observable motivations and assesses achievement by analyzing response data, both written and oral, of the student. He further explains that the behaviorist model openly rejects the interpersonal components of classroom learning. Fischer (2001) lists four global issues within the field of education in response to entry into the information age:

1. *Lack of creativity and innovation*
2. *Inability to cope with change*
3. *Insufficient support for school-to-work transition*
4. *Domination of the "gift wrapping" approach to educational reform*

These elements are direct legacies from a purely behaviorist model of instruction. Fischer talks about the nature of these four elements as they pertain to the progression of educational curriculum and the issues that they bring to the modern student. The *lack of creativity and innovation* is a concept that Fischer describes as something that inhibits students from being taught how to "work smarter, not harder." In today's society, an employer is typically not looking *just* for an employee that knows the most about a particular subject, especially if that knowledge comes with a lack in other areas such as creativity and critical thinking. Fischer refers to *coping with change* to describe the historical value of the behaviorist model in preparing the student for what was typically a lifelong career. Today, career changes are frequent, job changes much more so, and students need to be prepared to be nimble and tenacious in their learning. He goes on to talk about the lack of preparation for the level of collaboration and teamwork necessary for a professional transition. This concept is paramount in reviewing if a behaviorist-grounded teaching method is appropriate for a particular subject or content area.

Below is a visual representation of the behaviorist approach to curriculum development, created by Shepard (2000).

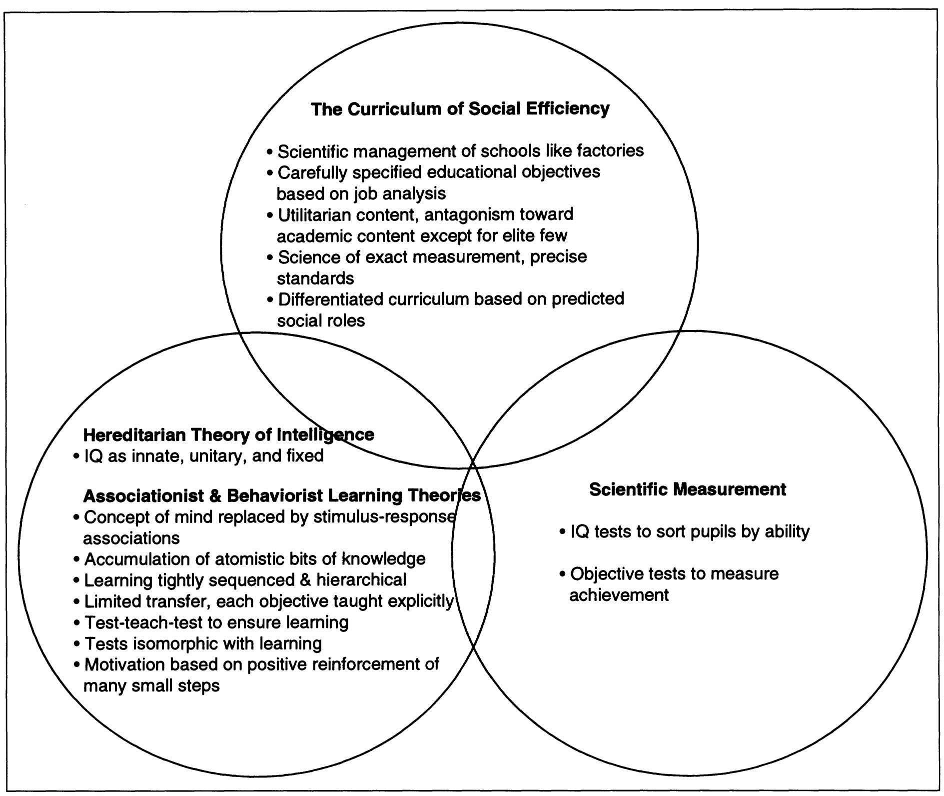

Figure 1. Venn Diagram Illustrating the Behaviorist Approach (Shepard, 2000)

Shepard (*Ibid*.) listed key components of a behaviorist teaching method that described both content and assessment:

1. Learning occurs by accumulating atomized bits of knowledge.

2. Learning is tightly sequenced and hierarchical.

3. Transfer is limited, so each objective must be explicitly taught.

4. Tests should be used frequently to ensure mastery before proceeding to the next objective.

5. Tests are isomorphic with learning (tests=learning).

6. Motivation is external and based on positive reinforcement of many small steps.

As Shepard describes, this methodology is limited in its capability for teaching critical thinking. To teach critical thinking, students must be given multiple avenues and/or levels of success that he or she must be allowed to follow based on self-discovery. Ediger (2012) describes the behaviorist learning environment as a highly sequential methodology that relies solely on the prescribed learning activities of the instructor, which allows little to no participation of the learners in the process by which content id delivered. No subjective elements are involved in delivery or assessment during the learning process, which intentionally leaves little room for interpretation by the student (Boghossian, 2006). This approach can be quite limiting in classrooms that intend to deliver content that would benefit from student input or subjective assessment such as design elements or creativity (Pugsley, 2011)

It is easy to see how instruction under the behaviorist model depends greatly on data and standardized testing. This standard process of teaching small parts of content in a repeating fashion has merit in a certain level of implementation. Many concepts within science and mathematical curriculum are not debatable, and teaching with this approach is necessary and valid. Classrooms grounded in behaviorism place the student in the role of a consumer – information is presented and either learned or reiterated and practiced until learned. Active participation of the student is limited for the most part to the assessment phase, where he or she demonstrates the learned content to the teacher. In order to be "fair," testing of content must be identical so that no student has a perceived advantage over another by way of an alternate assessment element.

Constructivist Learning Environment

The Constructivist Learning Environment (CLE) is a learning environment where social interaction, dynamic inquiry, and metacognitive reflection are paramount to the student's success (Sultan et al., 2011). They cite scholars (Taylor & Fraser, 1991; Johnson & McClure, 2000; McClure & Gatlin, 2007) in discussing the following five elements that support the implementation of a CLE. First, drawing on students' personal lives and out-of-school experiences sets the basis for connecting learning to the outside world, promoting relevancy. Second, students must realize that scientific knowledge is theory-based and that human experience allows this theory to socially and culturally evolve. Third, students must be given a "voice." This is not to say that disruption is allowed within the learning environment to a detrimental level. It simply means that students should be encouraged to participate in their learning experience and submit suggestions and inquiry when they feel unchallenged or confused. Fourth, like the previous element, students should not only be encouraged to support the learning environment, but also engage in discussion that surrounds the learning goals and assessment criteria. Finally, the concept of bringing students into the discussion around the environment as a whole is the most influential foundation to a CLE, promoting the idea of negotiation and tying the student's performance to not only theory, but also social and academic interaction between peers and the teacher. Establishing a CLE in the classroom traditionally run as theory-based or lecture must begin with the application of new teaching methods that support this change.

Honebein (1996) quotes Cunningham, Duffy, & Knuth (1993) and Knuth & Cunningham (1993) in listing the seven pedagogical goals that designers of constructivist learning environments aim to achieve:

1. Provide experience with the knowledge construction process.

2. Provide experience in and appreciation for multiple perspectives.

3. Embed learning in realistic and relevant contexts.

4. Encourage ownership and voice in the learning process.

5. Embed learning in social experience.

6. Encourage the use of multiple modes of representation.

7. Encourage self-awareness of the knowledge construction process.

Utilization of these concepts can provide a successful learning environment where students not only learn the content presented, but also participate within the learning environment as more than just students. Allowing students the opportunity to participate in the selection of content as well as the primary mode of learning, places a recognizable responsibility for the quality of learning to be achieved. The CLE provides a way to explore different solutions to problems that students might face in real-world scenarios. A main foundation for these seven goals is to provide students with a sense of ownership over their collective and individual learning experiences, motivating students to breathe more life into the process and share the rewards.

Jonassen and Rohrer-Murphy (1999) further support this concept by offering the interdependent components of a CLE – they label them as "problem-project spaces, related cases, information resources, cognitive tools, and conversation/collaboration tools." In essence, the foundation of a CLE is setting an environment where project-based learning can thrive. The learners must be provided a vehicle for research, and be exposed to real-world scenarios that relate directly to the content being delivered. With the group-learning construct that facilitates and encourages peer feedback and discussion, learners can begin to feel responsible for their own learning experience.

Implementing a CLE in a classroom where a traditionally behaviorist model has been used is not an overnight transition. First, the perception of traditional learning must be challenged from the instructor's standpoint. Both the instructor and student must be harmonious in sharing a positive classroom climate, even while the basis for each is typically different; students rely on social approval and recognition, while instructors rely on management of student behaviors, information processing, and learning outcomes

(Myers & Rocca, 2001). Largely, this shift in climate is brought about unawares to the learner, at least in the beginning stages. A change in inquiry method, increase in cooperative learning activities, the addition of dedicated time that allows peer discussion and debate can quickly begin the transformation to a student-centered learning environment.

CLE integration often falls short of the potential for impact (Shaw, 2011). Meneely & Danko (2007) discuss the tendency for curriculum to focus too much on learning how to use software alone, and not enough on the application of software in real-world learning exercises. This brings light to the inevitable need to modify the process of developing studio curriculum, and more importantly, the application of such curriculum.

In the case where a CLE is implemented, technology is often used in research and exploration in conjunction with problem-solving techniques that aid individual learning (Hannafin et al., 1997). The typical studio course in which software is taught utilizes a step-by-step learning process, focusing more on the application of technical concept over the application of that concept to a greater goal. In many cases, so much emphasis is placed on regurgitation of learned technical skills that students have little or no applicable knowledge of how to utilize the new skill in his or her career path.

Project-based learning brings the onus of learning to the student (Boondee et al., 2011). Students are required to interact with peers, form learning communities, and assume more of the responsibility for achieving learning goals than they might have in a traditional lecture format. Students' perception of achievement, understanding of learning, and the interaction with others within the academic environment are prime factors that allow learning goals to be achieved (Panasan & Nuangchalerm, 2010). This application of cooperative learning is a foundational practice that will begin to shift the traditional classroom to one of student-centered learning.

Five elements combine to form the base for cooperative learning: positive interdependence, social skill, individual accountability, group processing, and face to face promotive interaction (Boondee et al., 2011; Trytten, 1999; Johnson & Johnson, 1994; Slavin, 1987; Sharan & Sharan, 1976, 1992; Kreijns et al., 2003). These elements, if supported and encouraged, will allow students to begin exploring the dynamic of their group, examine their personal contribution to the overall goals of the group, and ultimately realize the importance of the group's success as a learning objective. The climate of cooperative learning techniques breeds student confidence if applied with care and precision. Students that have confidence in their technology-based skillset are more likely to use these skills to achieve a more globalized goal around their individual and group design intentions (Neilsen et al., 2010). A method to employ this confidence is evident in the application of group dynamics. For example, a student required to design an entire space will gain a broad knowledge of many separate concepts. Conversely, a group of students that each have a focus on small parts of a whole will allow for greater technical skill gains as well as conceptual design knowledge (Wallick & Zaretsky, 2010).

Savery & Duffy (1995) assert that collaborative groups can test the understanding of students by providing a vehicle for "enriching, interweaving, and expanding" the learning goals of a group learning experience. Group learning is a method that moves beyond individual understanding and adds a dynamic of social interaction. In studio-based classes, this can be valuable as a tool to bring about higher-level thinking.

Traditional classrooms have more opportunities to employ this concept, but as Hannifin et al. (1997) suggest, schools often provide context and intent to teach and nurture critical thinking and/or problem solving, but remain focused on a behaviorist model of instruction where declarative knowledge is the primary goal of learning.

Learners are as likely to be influenced by their learning environment to grow human memory and intelligence as they are by the content being presented (Dede, 1996). The many perspectives and backgrounds displayed by other participants in the learning environment are invaluable to setting the foundation for a greater foundation of learning for the group as a whole. An environment that promotes a collaborative academic relationship with peers has been shown to influence deeper learning, critical thinking, and a strong retention of content (Kreijns et al., 2003; Garrison et al., 2001; Johnson & Johnson, 1999). Honebein (1996) discusses how learning in a social or collaborative environment forces this idea of multiple perspectives. He further discusses how these collaborative learning experiences aid in seating learners into various roles of practitioners, including teamwork, leadership, negotiation, and cooperation.

Cognitive Load Theory

Cognitive Load Theory (CLT) is used to predict learning capability and influence teaching methodologies. Research on CLT can have a strong influence on the affects of certain instructional approaches to curriculum that teaches subjective content. Cognition and learning are subjects that have been analyzed extensively to influence teaching methods and inform and advance understanding from a scientific perspective (Collins, Greeno, & Resnick, 1992). CLT relies on the research of how delivered content affects the mind and uses this research to influence modes of instruction (Van Merrienboer & Sweller, 2005).

Cognitive load is critical to designing activities that do not overload a learner's ability to comprehend or retain information. CLT analyzes the amount of cognitive activity a learner experiences on a given instructional task (Paas & Van Merrienboer, 1994). Research on CLT influences non-technical competencies of a learner, including comprehension and problem solving (Collins et al., 1992).

Cognitive load and the effect it has on a learner's ability to comprehend information can have a great influence on his or her success in a classroom environment. The acknowledgment of the relationship between cognitive and the working mind can have a positive influence on a student's ability to retain information. Regardless of the type or amount of content being delivered, it is the interaction of the elements of learning that determines the amount of cognitive load experienced at any given time (Paas, Renkl, & Sweller, 2003). The application of improper teaching strategies can unintentionally engage learners in multiple cognitive processes, which in turn increases short-term (or *working*) memory load (Mousavi, Low, & Sweller, 1995). Further, Miller (1956) and Baddeley (1992) suggest that working memory loads peak at seven simultaneous items for the average learner, and Kirschner (2002) believes that a number of core processes that are already running reduce that number to three simultaneous items.

BIM, CAD, and many design software packages today are exponentially more powerful and intricate than they were five years ago. Awareness of cognitive load among learners when a foreign software is being taught is a concept that can drastically improve retention levels among the average college student. By ensuring students are focused on learning content in small pieces instead of multitasking, students can be more receptive to content and will likely recall more information when asked in a future learning experience.

Comprehension and Retention

It is a responsibility of both administrators and teachers to ensure a student experiences a smooth transition into the university atmosphere (Lau, 2003). Research has shown that many students enter college with a lack of comprehension ability (Taraban, Rynearson, & Kerr, 2000). Comprehension is an ability often overlooked when designing college-level academic lesson plans and activities. Today's professional world places demands on employees that are more easily achieved if their comprehension skills are higher (Williams, Ari, & Santamaria, 2011). Too often, professors and teachers do not have the time to assess comprehension skills of students entering the college-level classroom, and this wide variation in initial ability has a strong impact on student performance (Sherfield, Montgomery, & Moody, 2005). Students are becoming more aware of their own comprehension abilities, which relates to academic performance in that students are learning new ways to support their own learning styles (Taraban et al., 2000).

An important consideration for introducing new material in a college-level classroom is providing the material in a manner that allows students to succeed, regardless of their current level of reading comprehension. Taking note of the prior experience of students is a way teachers can provide avenues of learning that are conducive to efficient learning and retention (Lei et al., 2010). Group learning and interaction is a process that allows for students of various academic and comprehension levels to share knowledge, allowing for deeper connections with both content and the learning environment (Goldenberg, 1992). This concept also allows students to act as instructors to one another, which supports the development of individual ownership of the learning process (Lei et al., 2010, Gourgey, 1998).

The use of learning aids and study guides has attributed to learning environments that support comprehension and retention (Khogali, Laidlaw, & Harden, 2006). Prior knowledge in software has been described as an attribute that is rarely accounted for during lesson planning (Lei et al., 2010). The use of textbooks as learning aides is an important consideration. Often, college students are required to purchase and use high-level texts, and the variation in comprehension skills among students makes the text less effective for some (Taraban, Tynearson, & Kerr, 2000). Traditional textbook reviews are primarily focused on accuracy and content. Durwin and Sherman (2008) found that not only does accuracy of content have a strong effect on its usefulness to the average learner, but also that readability and how much a student "likes" a book have a similar effect. Publishers frequently offer chances for teachers that use textbooks to provide feedback on the content and delivery, so a textbook's quality can improve over time (Durwin & Sherman, *Ibid.*).

Creativity and Motivation

Craft (1999) states that "Creativity is an essential life skill, which needs to be fostered by the education system(s) from the early years onward," (p. 137). A study analyzing feedback from employers on recent graduates' perceived competencies found creativity to be the most lacking attribute among the graduates assessed (Reid & Petocz, 2004).

In a study involving the instruction of technology to students, four teachers found that it was pertinent to rely less on "algorithmic approaches" and more on problem-solving abilities if creativity within technical instruction is to be cultivated (Rutland & Barlex, 2008). In this study, as can be expected in most public education settings, students exhibited a wide array of core self-motivation and creativity. Numerous and in-depth frameworks for differentiated instruction exist for secondary education, and many are successful due to the strict application of required curriculum. Removal of traditional extrinsic physical motivators such as parents, friends, and mentors combined with the introduction of a perceived personal and academic freedom makes such frameworks less applicable to the post-secondary arena. Studies have shown that learners without extrinsic motivation perform at a higher level when differentiation, ownership, and relevance are addressed as part of the content delivery (Zemke & Zemke, 1988). Students that understand why they are learning specific technical skills are more likely to feel empowered and find new and innovative ways to apply those skills within the context of the learning goals.

Student motivation is paramount to success within the post-secondary academic environment. While some would conclude that it is the responsibility of the student to conjure intrinsic motivation to succeed, such motivation can and should be supported through progressive teaching methods. In a repeated study performed in his classroom, Sass (1989) concluded that eight characteristics of teachers are most recognized and appreciated by the student, leading to increased intrinsic motivation: Enthusiasm, relevance, appropriate difficulty level, active involvement, organization, variety, rapport, and use of appropriate examples.

Four of the eight factors suggested by Sass (*Ibid.*) are paramount for building the foundation of an interactive, positive, learning experience as it relates to a technical studio course: Enthusiasm, relevance, appropriate difficulty level, and active involvement. Enthusiasm refers to the instructor's energy level, and the level of excitement the general teaching style generates. Enthusiasm, as a motivator, would be more important in a general education setting, such as a lower-level post-secondary introduction class where students were not motivated by the value of the content. Conversely, in a motivational atmosphere, a student will be more inclined to perform beyond the technical competency area of learning and begin to display intangible learning traits such as critical thinking and interpersonal team building. Relevance allows course content to be applicable to the learner's academic and career goals. Appropriate difficulty level simply requires the course content to be differentiated and catered to the level of the student's skill and knowledge level. Actively involved students are more likely to feel the sense of empowerment necessary for a positive learning experience. These are the foundations for implementing a project-based learning approach to the course content. Seemingly simple, the correct combination of these factors can greatly influence the level of motivation, efficiency, and global application of desired skillsets.

Studies have shown that fostering creativity within learning requires an environment that is social, situated, and interactive. (Lave & Wenger, 1991; Wenger, 1998). Theory, talent, and creativity are three pillars of the successful design student. At one time, creativity was a soft skill that was either owned or not owned, according to the observer. Design agencies hired and fired based on this immeasurable skill – it was either present in portfolio and work or it was absent. While creativity may seem to some as the most intangible of the three, in reality, even if it is not inherent in one's makeup, it can be harnessed, if not learned. Haseeb (2011) believes promoting creativity should be a purposeful process within a workflow. Creativity is the result of an applied four-step process: preparation, incubation, illumination and verification (Sullivan, 1987). The preparation phase can be best described as the simple application of knowledge without a true "goal" in mind. For the interior design student, it might be working with new materials and colors or honing hand-rendering skills. Incubation is a sometimes conscious, mostly subconscious phase where ideas are forming and growing within the designer's mind. Illumination is the "aha" moment when the idea crystallizes in his or her mind, and verification is the fruition of the idea. A teacher's role in encouraging creativity has changed as technology has evolved, and distinct teaching traits have been assigned to a creative learning environment. The relationship between the instructor and students was found to have a strong influence on the creative output potential within a classroom (Chambers, 1972). It was found that teachers who acted more as a facilitator and leader (and less the all-knowing expert) were more likely to engage students in highly creative situations (Edwards, 2001). This creative process can be nurtured within the construct of a motivational learning environment; more specifically, within a constructivist learning environment.

CHAPTER III

METHODOLOGY

Overview

This study employed an experimental approach to identify individual retention skills of undergraduates using BIM software (AutoDesk Revit). It utilizes two main learning theories, intertwined with Lang's (2006) model of Limited Capacity Information Processing. A behaviorist approach was used for a Control group, while a constructivist approach was used for an Experimental group. This comparison of teaching methodologies is important to the future of studio courses in the undergraduate setting which utilize software and technology, especially as technology advances and software becomes more powerful. It will identify the effects that each teaching approach has on students' ability to retain information, exhibit creativity, and display positive behavioral indicators while participating in the learning process.

Below is a process chart showing a high-level view of the experiment.

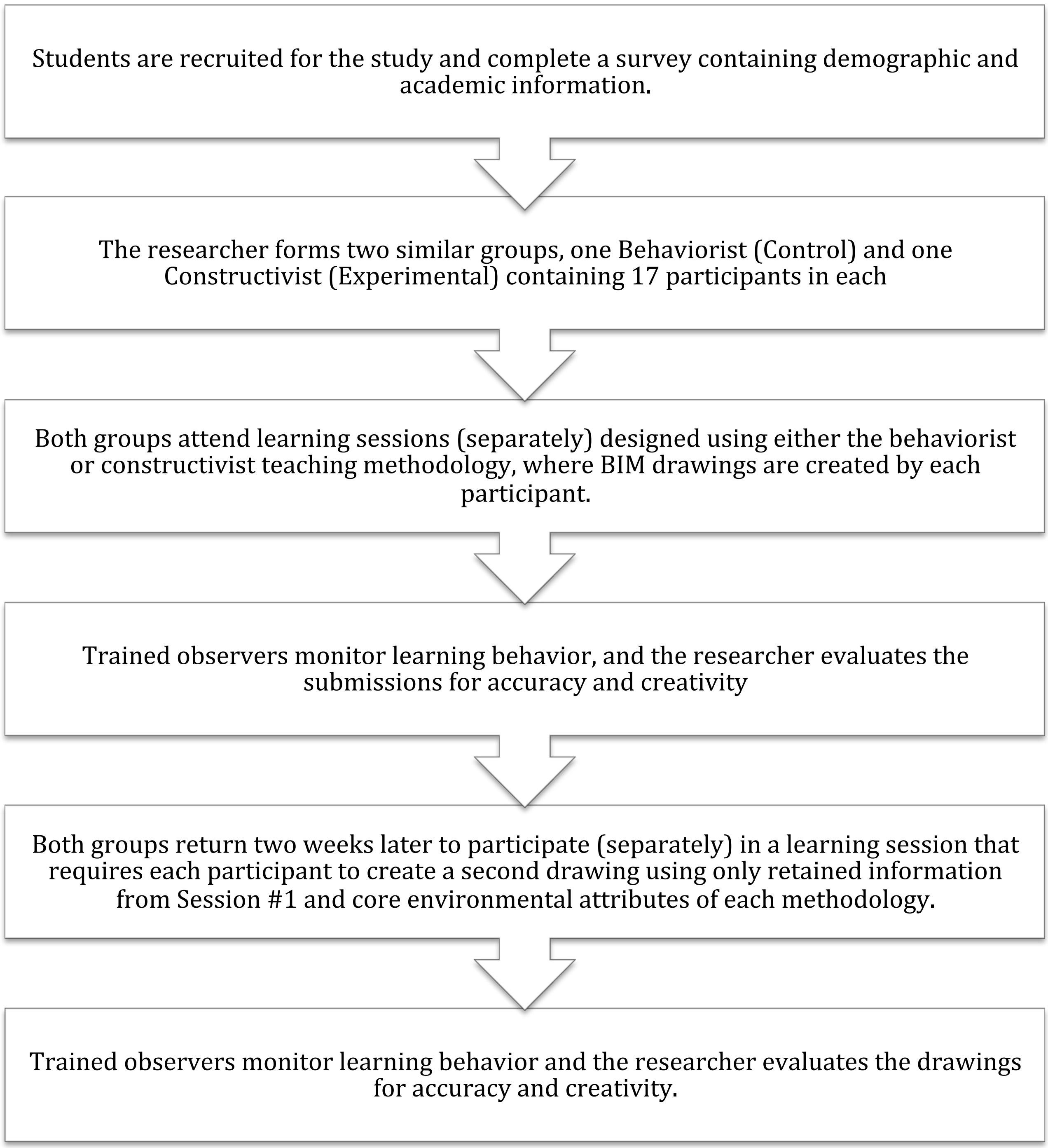

Figure 2. Overview of the Experiment

Boghossian (2006) suggests that a behaviorist learning environment is appropriate for content delivery in which no subjective or creative element of the environment or content is expected or interpreted. For technical assessment, the behaviorist teaching method has been historically successful. In the case of teaching software in a studio setting, students can be given assignments that are aimed at technical skill building, and the objectivity of technical assessment allows a teacher to analyze this student work with a general rubric.

Students wishing to find employment in the Interior Design field, or any creative field, are increasingly required to exhibit far more than technical ability. Creativity, critical thinking, and interpersonal skills have become as important as knowing software and digital processes. Beyond technical ability, CIDA (2011) requires that:

> *Entry-level interior designers need to apply all aspects of the design process to creative problem solving. Design process enables designers to identify and explore complex problems and generate creative solutions that support human behavior within the interior environment.*

The CLE is a technology-based academic environment where social interaction, dynamic inquiry, and metacognitive reflection are paramount to the student's success (Sultan et al., 2011). Within this type of environment, students have a greater chance of employing their own creative abilities, coupled with learning and retaining course outcomes. In today's studio classroom, teachers are challenged to find ways of building creative processes and teaming skills into a curriculum that has been traditionally taught from an objective standpoint. This study is being conducted to explore methods of teaching these subjective skills while preserving the integrity of the core curriculum.

Behaviorist Modules

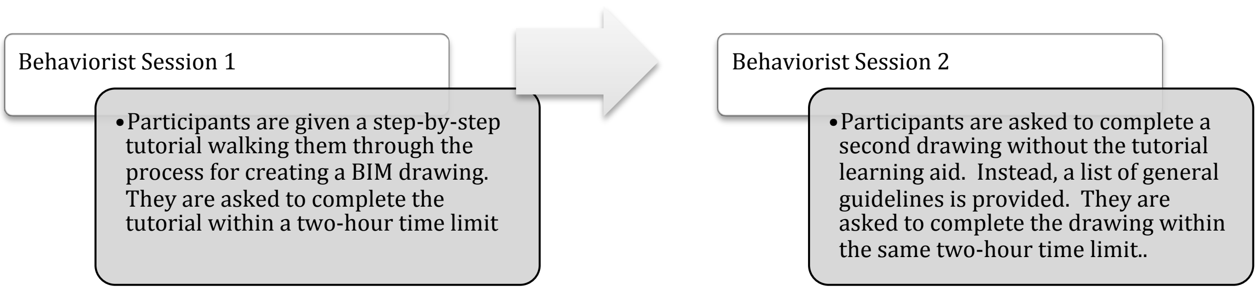

Figure 3. Overview of the Learning Sessions for the Behaviorist (Control) Groups

Currently, software instruction within the Interior Design curriculum at IUP is taught primarily with a behaviorist approach. An impact designed within the experiment is that actual curriculum practiced at the university is the basis for the experiment's instructional content. As such, the Control group was provided instruction that mimics the current teaching method. This module was designed to include a step-by-step, paper-based tutorial that will take the group members through a technical learning process. The Control group participated in two learning sessions. In Session 1 of the behaviorist module, participants used the tutorial to create an architectural drawing. In Session 2, participants were asked to repeat the procedure (executing the same drawing) without the tutorial, provided only with general technical requirements. Behaviorist practices are based on individual response, and for this reason, limitations were implemented that align themselves with typical behaviorist methodologies. First, the Control group did not have the ability to engage in discussion with other participants in the session. Second, no outside references or access to the Internet were permitted. This allowed the researcher to analyze the success of each participant's project solely on the individual's ability to follow instructions, retain written information, and submit evidence of each.

Constructivist Modules

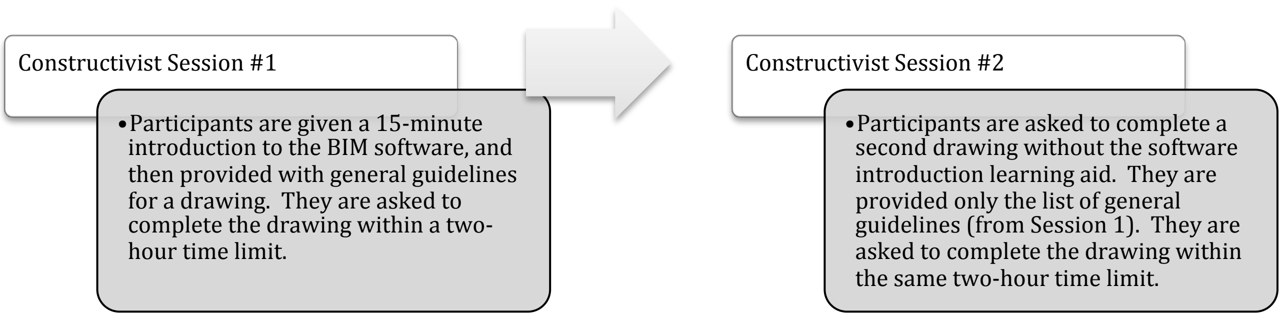

Figure 4. Overview of the Learning Sessions for the Constructivist (Experimental) Group

The Experimental group participated in two sessions where a constructivist method was applied. The physical product of these sessions was comparable to that of the Behaviorist modules, with the exception of the content delivery and learning process. During the beginning of each constructivist session, the instructor provided a short demonstration of the tools (within the software) that participants would be using to create their individual drawings. Students were able to take notes, and then allowed to begin working on their drawing. Unlike the behaviorist modules, students were able to interact, ask each other questions, and provide feedback. This open format without particular direction was designed to place more responsibility for learning on the shoulders of the participants rather than relying so heavily on provided documentation and directions.

Like the Behaviorist group, the participants of the Constructivist group submitted their design product at the end of the session for technical assessment.

Sampling and Volunteer Recruitment

This study required nonprobability purposive and volunteer sampling to procure appropriate participants. The study was open to undergraduates at IUP who were (1) enrolled in the Interior Design program, and (2) have completed at least one semester of computer-aided drafting software instruction. Students who have completed *INDS 218 – Drafting for Construction II* at Indiana University of Pennsylvania, for example, were prime candidates. This prerequisite was necessary to ensure the experiment could run without the need for instruction in the most basic context.

The researcher personally visited various Interior Design classes and announced her intention to recruit students. Once in front of the class, a prepared script was followed closely (Appendix A).

Everyone in the class was given an individual sign-up sheet (*Appendix C – Volunteer Sign-Up Sheet*) during the announcement so that no student felt influenced to participate based upon his or her peers. If the student did not wish to participate, they simply handed in a blank form. Those who did wish to participate submitted their name, IUP email address, and preferred dates for participation. Additionally, volunteers were given an informed consent form (*Appendix B – Informed Consent Form*) for review, and asked to sign a consent form (*Appendix D – Voluntary Consent Form*).

Students were aware that dinner would be provided, simply for their participation. This incentive was offered to compensate the individuals for time spent during the modules, and was not intended to influence behavior or work ethic within the instructional modules. All participants were enrolled in the Interior Design program, and therefore students and, in some cases, advisees of the researcher. No other incentives were provided; participants were not awarded extra-credit towards any interior design course.

Learning Group Assignment

Participants who volunteered for the study were each given a survey prior to the module delivery that consisted of questions regarding demographic data, level of academic progression, GPA, and prior knowledge within the context of the instructional content to be delivered. Additionally, participants answered questions about their self-efficacy, experience, and comfort level with BIM software as well as technology in the classroom. This information was pertinent to accurately balance the two subgroups with participants that have a varying range of experience. The survey was sent by email via *SurveyMonkey.com* after students submitted the volunteer applications. This survey can be found in *Appendix E – Pre-Session Demographic Survey*.

When a volunteer submitted a survey, it was reviewed by the researcher. Participants were assigned to groups using paired matching to assure reasonably similar groups. This pairing was based on their year in school and previous completion of a course which utilized a specific drafting software, AutoCAD. The combination of this data placed each volunteer in a classification of either "*Upper Division*" or "*Lower Division*." "Lower Division" participants were typically sophomore level students who were familiar with AutoCAD but no other design software. The label "*Upper Division*" was applied to participants at the junior and senior level, who by nature of their progression through the Interior Design curriculum had added experience in multiple architectural design software packages. Volunteers from these two classifications were dispersed as equally as possible between the Control and Experimental groups.

Two groups were formed consisting of approximately twenty (20) undergraduates each: one group was taught using a behaviorist approach (Control group) and one group using a constructivist approach (Experimental group). Once the Control group and Experimental group were assigned participants, each participant was assigned an identification number, Crimson 1 through Crimson 25 for the Control group, or Slate 1 through Slate 25 for the Experimental group. The assignment of the identification numbers was important for both data tracking and for confidentiality and anonymity. Further detail regarding confidentiality and privacy protection can be found on page 41.

As part of the volunteer sign-up process, students were asked to indicate preferred dates for participation. These data (participants' selected dates) were used to determine the most convenient dates for the study to take place. Once the four dates were determined (two for the Control group and two for the Experimental group), two emails were sent – one to each group, notifying each of the suggested dates for the two sessions. Volunteers were asked for a reply confirming acceptance of the dates or expressing concern or the inability to attend.

Behaviorist (Control) Group – Learning Sessions

The Control group engaged in learning sessions on Thursday, April 19, 2012 and two weeks later on Thursday, May 3, 2012. In preparation for the first learning session, the researcher had labeled workstations with identification numbers corresponding to the participants involved in that particular session. As participants arrived to the first session, they were given a small card with their identification number, and asked to sit at the corresponding workstation for the duration of the session. During the first session, each participant in the Control group (Group Crimson) was given a printed copy of a tutorial for drawing a basic commercial building. This group did not receive any verbal instructions. The tutorial can be found in *Appendix F – Step-by-Step Tutorial*. Participants were instructed to electronically draft the commercial building model using AutoDesk Revit and the supplied tutorial. They were asked to notify the instructor when finished, at which time the project was saved to a folder on the participant's computer and the printed tutorial was handed in. After finishing, each participant was handed a printed copy of a post-session survey to be completed prior to leaving. This survey contained questions about the participant's feelings about the session, including whether or not he or she felt: 1) the module was difficult, 2) comfortable using the software as a result of the session, 3) that he or she had learned a great deal as a result of the session, 4) that he or she could use the skills learned in a future project, 5) the skills learned during the session would be applicable in another class, and 6) the skills learned during the session would be applicable in a future or current job. This survey can be found in *Appendix I – Post-Session Survey*. This session was slated to last no more than two hours, and most participants were finished prior to the two-hour mark. Prior to leaving the session, participants were reminded of the second session date and time.

During the second session, the instructor followed the same preparation steps as the first session, and the participants were instructed to draw the same commercial building as was drawn in the first session. In this session, however, the students were not given the step-by-step tutorial. Rather, the instructor provided a whiteboard with general requirements, such as the size of the building, minimum number of windows, interior specifications, and a handful of other guidelines. These specific guidelines can be found in *Appendix G – Building Guidelines*. Participants were asked to notify the instructor when finished, at which time the project was saved to a folder on the participant's computer. After finishing, each participant was handed a printed copy of the post-session survey, identical to the one completed after Session 1, to be completed prior to leaving.

Constructivist (Experimental) Group – Learning Sessions

The Experimental group also engaged in learning sessions two weeks apart on Sunday, April 22 and Sunday, May 6, 2012. To ensure a comparable environment and process, the researcher used the same preparation techniques including labeled workstations and participant identification numbers. During the first session, the instructor presented a twenty-five minute introductory lesson on AutoDesk Revit, teaching the use of basic tools and functionality that would be necessary to draw a simple commercial building. After the lesson, participants had 10 minutes to ask general questions. At this time, the instructor revealed a whiteboard with general requirements for the drawing, identical to the guidelines given to the Control group in their second session (*Appendix G – Building Guidelines*), and instructed the participants to complete the drawing using the guidelines. As this group was engaged in a constructivist learning environment, they were allowed to talk with each other, ask questions (only to other participants, not the instructor), and provide feedback and guidance to one another. While this interaction was permitted, each participant had to complete his or her own drawing, and at no time was one student allowed to physically aid another in the drawing process. Trained observers ensured the integrity of the individual work. They were asked to notify the instructor when finished, at which time the project was saved to a folder on the participant's computer. After finishing, each participant was handed a printed copy of the post-session survey, identical to the one given to the participants in the Control group, to be completed prior to leaving. This session was slated to last no more than two hours, and most participants were finished by one hour of studio time. Prior to leaving the session, participants were reminded of the second session date and time.

During the second session, the instructor followed the same preparation steps as the first session, and the participants were instructed to draw the same commercial building as was drawn in the first session. In this session, however, the students were not given the introduction lesson by the instructor. Rather, the instructor provided the whiteboard with general requirements, identical to the guidelines in the first session (*Appendix G – Building Guidelines*). Participants were asked to notify the instructor when finished, at which time the project was saved to a folder on the participant's computer. After finishing, each participant was handed a printed copy of the post-session survey, identical to the one completed after Session 1, to be completed prior to leaving.

Learner Observation

An important factor in the collection of data was the role of the independent observers who monitored all instructional modules. Observers were recruited based on their education and/or experience in online and digital learning. Most of the observers were colleagues from IUP in the Communications Media Department. The researcher, with guidance and direction from her dissertation committee, developed a printed tool for recording visual indications of mood changes, stress, and other positive and negative signs of behavioral changes exhibited by participants during the learning sessions. Four observers were scheduled for each learning session, which allowed for focused attention on no more than five students for the duration of the session. Prior to the session, each observer was educated on the use of the recording tool, as well as the visual indications and how to determine when they should be coded. Some of the visual indications included confusion, disruptive behavior (both positive and negative in nature), nervous behavior, body movement, among others. A detailed description of these indications can be found in *Appendix H – Learning Stress Observation Record*. This monitoring was helpful in developing a conceptual approach to the differences that are present between a behaviorist and a constructivist environment.

Confidentiality, Treatment of Subjects, and Data

Data from this study were extracted from physical surveys completed by the participants as well as observational data sheets from both learning sessions. Any information procured from paper-based surveys was immediately entered by the researcher into an electronic database (a Microsoft Excel spreadsheet), and checked for accuracy, at which point the paper copies were destroyed by the principal investigator.

The spreadsheet contained student names (Column A) and corresponding student identification numbers (Column B). The *Names* column (Column A) was temporary – its only purpose was to match students to their identification numbers for both sessions.

When both sessions were completed and the data were entered, the principal investigator deleted Column A of the spreadsheet in its entirety, thereby removing the student names from the data and eliminating any connection between the student and data stored. This aided in protecting the student's confidentiality. All data were stored consistent with Indiana University of Pennsylvania's subject and data protection policies.

CHAPTER IV

RESULTS

Overview

This chapter will analyze and discuss data drawn from surveys and observational recordings during four learning sessions. This study compared two teaching methodologies, behaviorism and constructivism, to explore the impact each has on student performance in an Interior Design studio course. Two groups of volunteer learners were formed, and each were engaged in learning sessions that used either a behaviorist or a constructivist approach.

The first group of learners (the Control group) participated in two learning sessions in which the instructor used a behaviorist approach and methodology. The first session included a step-by-step tutorial that was intended to walk the students through the process of creating an electronic drawing using Building Information Modeling (BIM) software. In order to gauge retention, the second session was identical but without the tutorial. Students were required to rely only on recalled knowledge for this session.

The second group of learners (the Experimental group) participated in two learning sessions where the instructor employed a constructivist approach. In the first session, students were given a short introduction to the BIM software, and were allowed to devise and implement their own method to create the end product, which was specified using general guidelines around the requirements of the drawing. The second session was identical to the first, excluding the short software introduction. Like the Control group, this was to gauge retention levels.

Prior to the study, participants were asked to submit demographic and academic historical data via a pre-session survey. The survey consisted of questions about age, grade point average, comfort utilizing technology, experience with studio classes, and experience with software instruction. Below is a table summarizing this information.

Table 1

Comparisons of Mean Scores of Group Demographics

Variables	Behaviorist (Control)	Constructivist (Experimental)
Age	21.00	20.76
GPA	3.11	3.09
Comfort level with technology	4.71	4.71
Prior use of software in undergraduate courses	1.82	1.76
Completion of undergraduate studio courses	2.53	3.00

Note: N = 34

In order to produce valid data, it was a goal to ensure that both groups of students contained participants very closely related in these key characteristics. Participant ages between the Behaviorist (Control) group and Constructivist group were very similar. The Mean score for the Behaviorist group was 21.00 (meaning 21 years of age), and the Mean score for the Constructivist group was 20.76.

Grade point averages (GPA) for each participant were measured at the time of the first learning session, and were also similar. The Behaviorist group produced a Mean score of 3.11 (out of a 4.0 GPA scale), with the Constructivist group scoring slightly lower at 3.09.

Scores for the participants' comfort with technology (survey data prior to study) were identical with a Mean score of 4.71 (meaning that the average participant responded by saying that he or she feels very comfortable using technology, and uses it often). Also nearly identical were the Mean scores for the number of prior courses completed that taught software as the primary core of the class. Behaviorist participants scored a Mean 1.82 and the Constructivist participants scored 1.76, which means that the average participant in both groups responded by saying that he or she has taken between 6 and 10 courses that had taught software prior to the study. Data about prior studio course participation was also similar with the Behaviorist group scoring a Mean 2.53 and the Constructivist group a 3.00, which means the average participant had completed between 6 and 10 studio-based courses prior to the study.

Research Question 1

What is the effect of instructor interaction on a student's ability to apply and retain knowledge in a studio setting, as measured by rubrics that assess accuracy?

The first research question was developed to compare and measure the effects of an instructor's role in both a behaviorist and constructivist setting. This exploration focused primarily on students' ability to create technically accurate electronic renderings within a specified time limit, with and without a learning aid.

Table 2

Comparisons of Group Scores in Evaluation Accuracy

Variables	Behaviorist (Control)	Constructivist (Experimental)
Mean Score of Session 1 – *Evaluation Accuracy*	4.00	4.71
Mean Score of Session 2 – *Evaluation Accuracy*	4.12	4.59
Difference of Mean Score from Session 1 – Session 2	-0.12	0.12
Standard Deviation of Session 1	1.17	0.47
Standard Deviation of Session 2	0.99	0.79
Difference of Standard Deviation from Session 1 – Session 2	0.18	-0.32

Note: N = 34

**Evaluation Accuracy* was measured on a scale of 1-5, 1 being *Not at all Accurate* and 5 being *Extremely Accurate.*

$H_{1.1}$ - For Session 1, the Behaviorist group's *Evaluation Accuracy* scores will be higher than the Constructivist group's scores.

The behaviorist methodology uses direct instruction and repetition to aid information processing. In this light, the participants were asked to use a step-by-step tutorial to create their drawings (each participant had the same tutorial with the same end product). As a result, it was assumed that the accuracy level of specific drawing elements explained in the tutorial would be higher than the Constructivist group results, as the constructivist methodology uses a more subjective approach to information processing. Additionally, the Constructivist group participants were provided instructions that were far more general in nature.

Utilizing a t-test, ($t = -2.30$, $df = 32$, $p = 0.03$), results indicated the hypothesis was not held and the prediction was reversed. During Session 1, the group score in *Evaluation Accuracy* was significantly lower for the Behaviorist (Control) group compared to the Constructivist (Experimental) group. This reversal in outcome could be the result of multiple factors. The introduction that was given in the constructivist learning Session 1 may have been a catalyst for understanding that provided a foundation for the performance of the group. In the constructivist approach to teaching, the use of a general overview is used to better equip a variety of learning styles exhibited by students, and may contribute to a higher level of learner engagement. It could be argued that the ability for students to work with each other and provide feedback allowed for a learning environment that included peer review and editing phases.

$H_{1.2}$ – For Session 2, the Behaviorist group's *Evaluation Accuracy* scores will be lower than the Constructivist group's scores.

The Behaviorist group's mean score improved slightly, though still not to the level of the Constructivist group. Shepard (2000), lists the six key components of the behaviorist teaching method, the last of which is that "motivation is external and based upon positive reinforcement of many small steps." This external motivation took the form of a walkthrough tutorial provided to the Behaviorist participants in Session 1. Since the learning sessions were designed to assess retention when comparing a behaviorist method with a constructivist method, neither group had access to the learning aids of the project for Session 2. This included the step-by-step tutorial for the Behaviorist group and the introductory presentation for the Constructivist group. It was expected that the Constructivist group would score higher because of learning the material through their own exploration.

Utilizing a t-test, ($t = -1.53$, $df = 32$, $p = 0.14$), the Behaviorist (Control) group *Evaluation Accuracy* score was lower than the Constructivist (Experimental) group score during Session 2, as predicted. These results were not significant ($p = 0.05$). While both groups were without the learning catalyst, the core nature of the learning environment likely had an effect on outcomes in each Session 2. As in Session 1, the Behaviorist group was required to work alone and rely on recall of learned information from Session 1, whereas the Constructivist group could use prior knowledge as well as the peer learning community. The *Evaluation Accuracy* rating, especially for Session 2 of each group, was applied to a drawing that both groups were given general requirements for producing. Both groups' second sessions were more reliant on retention of knowledge learned from the first session. In the behaviorist approach, an emphasis was placed on information reiteration in order to assess learning, and in Session 1, the Behaviorist participants relied on a step-by-step tutorial that assisted in producing the first drawing. These instructions on how to create a product only provided indirect instructions on how to utilize the software, so the removal of the tutorial left students at a potential disadvantage for Session 2, where the software would have to be used without instructions.

$H_{1.3}$ - The Behaviorist group *Evaluation Accuracy* scores will decline from Session 1 to Session 2.

This hypothesis was derived from the expectation that knowledge of the software would not be as easily comprehended in the Behaviorist group's first session due to the structure of the behaviorist learning environment, and would result in a decrease in technical accuracy. Since the Behaviorist group's software instruction was built into the tutorial, the reliance on memory of linear processes during Session 2 would make recollection difficult. Without the ability to work in peer groups and attain feedback, it was assumed that the achievement scores would decrease.

A t-test was conducted, ($t = -0.34$, $df = 16$, $p = 0.74$), and the results determined a slight reversal of *Evaluation Accuracy* scores for the Behaviorist (Control) group between sessions. There was a change in the Mean score from 4.00 to 4.12, however, these findings were not significant ($p = 0.05$). This reversal could be the result of prior knowledge having a more positive effect than expected on the outcome of the group in session two. Additionally, Session 1 included a built-in familiarization of the software, whereas the participants in Session 2 were not learning new software and relied on prior experience with the material. The natural environment of the behaviorist approach focused more on helping the learner to produce an end result that was exactly the same as the other students in Session 1, but the second session provided a general requirement list that was that was more achievable with some prior knowledge of the software.

$H_{1.4}$ - The Constructivist group *Evaluation Accuracy* scores will increase from Session 1 to Session 2.

This hypothesis was created based on the assumption that students in the Constructivist group would exhibit a stronger retention of information in the second session as a result of the nature of the constructivist learning approach. The constructivist method promotes group interaction and higher-order thinking, and given prior knowledge learned in Session 1, the guidelines provided for the end product in Session 2, and the ability to work with other students within the learning session, expectations were that the Mean score would increase between Sessions 1 and 2.

In order to calculate results, a t-test was used ($t = 0.52$, $df = 16$, $p = 0.61$). The results indicated a reverse in the prediction. There was a slight drop in the Mean score from 4.71 to 4.59, however, the findings are not significant ($p = 0.05$). These results are based on a naturally subjective assessment of general requirements. Students participating in both Session 1 and Session 2 of the Constructivist group were working with these requirements and likely created end products that were either slightly or significantly different between the sessions. This natural modification was expected as the result of a more open learning environment and learning goals. The constructivist approach (in this case) places less significance on individual outcomes as it does for general achievement as the result of a learning community approach in the classroom.

Since the results declined, but were still in a high achievement category, the difference is not significant.

Table 3

Comparisons of Group Scores in Completion Time

Variables	Behaviorist (Control)	Constructivist (Experiment)
Mean Score of Session 1 – *Completion Time*	57.24	49.53
Mean Score of Session 2 – *Completion Time*	35.24	31.00
Difference of Mean Score from Session 1 – Session 2	22.00	18.53
Standard Deviation of Session 1	15.14	9.20
Standard Deviation of Session 2	8.20	9.51
Difference of Standard Deviation from Session 1 – Session 2	6.94	-0.31

Note: N = 34

**Completion Time* was measured in minutes and seconds (30.30 = 30 minutes and 30 seconds).

$H_{1.5}$: For Session 1, the Behaviorist group's *Completion Time* will be higher than the Constructivist group's.

The Behaviorist group, in Session 1, was given a tutorial to follow for completion of the project. This tutorial was identical for every student in the group and, as a result, was predicted to take about the same time to complete for everyone. The Constructivist group was given an introduction to the software, and left to create their own product based upon general guidelines. This open format for the classroom was expected to widely vary the scores in *Completion Time* for each individual learner, from the perspective of when each felt his or her project was complete enough to turn in.

A t-test was conducted (t = 1.78, df = 32, $p = 0.08$), and the results indicated a slightly greater *Completion Time* from the Behaviorist group to the Constructivist Group. The Behaviorist group's *Completion Time* mean score during Session 2 was 57.24, which was higher than the mean score of the Constructivist's Group of 49.53. Although these results were not statistically significant ($p = 0.05$), they indicate an almost eight minute increase between the groups for Session 1. The results of this test were as expected, though the difference was not statistically significant due to the large Standard Deviation, particularly in the Behaviorist group's Session 1 (sd = 15.14). A strong indication from other data leads to the probability that the increase in embellishments (to be discussed later in this chapter) by the Constructivist group added to the overall *Completion Time*.

$H_{1.6}$: For Session 2, the Behaviorist group's *Completion Time* will be higher than the Constructivist group's time of completion.

Unlike the first session, both the Constructivist group and the Behaviorist group worked from general guidelines in order to complete the second session, which made the learning environments more similar during the second session. This alignment allowed data to accurately indicate retention levels and recall ability for both groups through *Completion Time* and accuracy statistics.

In order to calculate results, a t-test was used ($t = 1.40$, $df = 32$, $p = 0.17$). The results were predicted by the hypothesis, though not statistically significant. The Behaviorist group's *Completion Time* mean score during Session 2 was 35.24, which was higher than the mean score of the Constructivist's Group of 31.00. There was less than a five-minute difference between the groups for their recorded *Completion Time* score in Session 2. The level of embellishing and creativity employed between both groups likely had an effect on the *Completion Time* of both groups being similar for Session 2. Additionally, the Behaviorist group was required to work individually, which likely accounted for the higher *Completion Time* when compared with the Constructivist group.

Research Question 2

Does the instructor's choice of a constructivist approach versus behaviorist impact students' behavior during and attitude towards studio-based learning, as measured by student surveys, observed learning indicators, and creative output?

The second research question was developed to compare and measure the effects of an instructor's choice of teaching methodology. For this research question, the researcher focused on observed levels of stress, participants' reported levels of learning, difficulty, and confidence, as well as their evaluated score of *Design Embellishment*.

Table 4

Comparisons of Group Scores in Total Stress

Variables	Behaviorist (Control)	Constructivist (Experimental)
Mean Score of Session 1 – *Total Stress*	12.76	9.76
Mean Score of Session 2 – *Total Stress*	18.29	6.29
Difference of Mean Score from Session 1 – Session 2	-5.53	3.47
Standard Deviation of Session 1	6.67	5.11
Standard Deviation of Session 2	10.74	4.58
Difference of Standard Deviation from Session 1 – Session 2	-4.07	0.53

Note: N = 34

**Total Stress* was measured using indicators of learning stress. A score of 10 indicates that the group exhibited an average of 10 signs of stress per participant throughout the session.

$H_{2.1}$: For Session 1, the Behaviorist group's *Total Stress* scores will be higher than the Constructivist group's scores.

This hypothesis was derived from an analysis of the timeline of events within each of the sessions. Both the Behaviorist group and the Constructivist group were required to learn the software as well as create a product during the same session. The difference between the two is that the Behaviorist group was engaged in a process where they were learning the software as a result of the step-by-step tutorial, whereas the

Constructivist group was given a more general software lecture at the beginning. It is likely that cognitive load would have been higher during the Behaviorist session since the Behaviorist participants learned the software and created their drawings simultaneously, whereas the Constructivist group learned the software and created their drawing separately. This increase in cognitive load may have directly influenced learning stress levels.

Utilizing a t-test (t = 1.47, df = 32, p = 0.15), the results indicate a higher *Total Stress* score for the Behaviorist (Control) group than Constructivist (Experimental) group. While the Mean score for Behaviorist was 12.76 and the Mean score for Constructivist was 9.76, the results are not significant to indicate a strong increase (p = 0.05). While not significant, the increase in stress is an indicator of potentially reduced comprehension, which was found to be significant in Hypothesis 2.2. The Behaviorist stress score, with a Standard Deviation of 6.67, may have been reduced from its potential level by the fact that participants were given more detailed instructions than in the Constructivist group, which had a Standard Deviation of 5.11. The disbursement of specific content and specific instructions is a core value of the behaviorist approach to teaching.

$H_{2.2}$: For Session 2, the Behaviorist group's *Total Stress* scores will be higher than the Constructivist group's scores.

Referring to Hypothesis 2.1, it is likely that the Behaviorist group experienced a higher cognitive load in session one than the Constructivist group, which is often an inhibitor to comprehension and/or retention. While both groups were without their respective learning aids (Behaviorist group members were given a tutorial in Session 1, and Constructivist participants were given an introductory lesson) in Session 2, the format of the learning aid in Session 1 for the Behaviorist group may have contributed to a lack of comprehension. Since it was a step-by-step tutorial, students were not required to learn the software application in a way that would allow them to devise a product from scratch.

In order to calculate results, a t-test was used ($t = 4.24$, $df = 32$, $p = 0.00$). The outcome was as predicted by the hypothesis. The Behaviorist (Control) group *Total Stress* score for Session 2 (Mean = 18.29) were much higher than the Constructivist (Experimental) group score (Mean = 6.29). Additionally, the findings were statistically significant ($p = 0.05$). The Behaviorist group exhibited nearly three times the observed signs of stress as did the Constructivist group, which may have been influenced by the structure of the behaviorist learning environment in Session 1. The behaviorist approach in this experiment placed a strong dependence on the tutorial in Session 1. When asked to complete the same product in Session 2 without it, the lack of retention likely caused learning stress. Additionally, unlike the Constructivist group in Session 2, the Behaviorist participants were required to work individually, and were consequently restricted to only their own knowledge to assist in completing the project.

$H_{2.3}$: The Behaviorist group's *Total Stress* scores will increase from Session 1 to Session 2.

This hypothesis was generated from the assumption that the Behaviorist group retained less information presented in Session 1, and experienced exponentially more stress when asked to recall that information in Session 2. The behaviorist methodology supports a more structured and preconceived format for content delivery, and students within this group are less likely to learn the basic tools within the software used to create their drawings.

Utilizing a t-test, (t = -2.17, df = 16, $p = 0.046$), the prediction in the hypothesis was upheld. The Mean *Total Stress* score for Session 1 was 12.76 and the Mean score for Session 2 was 18.29. It was confirmed that students in the Behaviorist group experienced significantly increased stress levels in the second session. Stress levels may have increased as a result of a decreased ability to recall information learned in Session 1. As expected, the Behaviorist group was likely focused more on creating the product described in the tutorial than on learning the features of the software in Session 1. As a result, when the Behaviorist group was not provided the step-by-step tutorial during the second session, learning stress increased.

$H_{2.4}$: The Constructivist group's *Total Stress* scores will decrease from Session 1 to Session 2.

The Constructivist group was required to learn the software without a tutorial, only a short introduction. Consequently, it was the responsibility of the participants to decide how each would best be able to learn the software. This hypothesis was created with the assumption that since the participants were at least partially responsible for the method in which each would learn the software, that retention levels would be higher and stress levels reduced.

A t-test was conducted ($t = 2.71$, $df = 16$, $p = 0.02$), and the results indicated a statistically significant decrease in *Total Stress* scores for the Constructivist (Experimental) group from Session 1 to Session 2. The Mean score for Session 1 was 9.76, while the Mean score of Session 2 was 6.29. The data support the hypothesis. In a constructivist learning environment, learners engaged in an activity that involves comprehension and retention of content knowledge can exhibit reduced stress levels. Even with the removal of the learning aid, stress levels were significantly less in Session 2 for the Constructivist group. The open format of the learning environment also allowed for more creative licensing to be taken by each learner, and this freedom likely played a role in counteracting any stress that may have developed as a result of removing the learning aid.

Table 5

Comparisons of Group Scores in Learned Valuable Skills

Variables	Behaviorist (Control)	Constructivist (Experimental)
Mean Score of Session 1 – *Learned Valuable Skills*	3.18	3.41
Mean Score of Session 2 – *Learned Valuable Skills*	2.94	3.18
Difference of Mean Score from Session 1 – Session 2	0.24	0.23
Standard Deviation of Session 1	0.73	0.87
Standard Deviation of Session 2	0.56	0.73
Difference of Standard Deviation from Session 1 – Session 2	0.17	0.14

Note: N = 34

**Learned Valuable Skills* was measured on a Likert scale of 1-5, 1 representing that no skills were learned and 5 representing that many skills were learned.

$H_{2.5}$: For Session 1, the scores on the *Learned Valuable Skills* measure for the Behaviorist group will be lower than for the Constructivist group.

This hypothesis was derived from the idea that the learning experience of a student can have a direct effect psychologically on the student and whether he or she feels that the learning was successful. The concept that formed this hypothesis centers around the ability for a constructivist environment to foster skills that go beyond the standard academic content, including interpersonal skills, teamwork, peer feedback, and a general learning community atmosphere.

Utilizing a t-test ($t = -0.86$, $df = 32$, $p = 0.40$), the results indicated some modest support for the hypothesis, but were not statistically significant. The Mean score (3.18) for *Learned Valuable Skills* of the Behaviorist (Control) group was lower than the Mean score (3.41) for the Constructivist (Experimental) group in the first session. This lack of significant difference could relate directly to whether or not the students (from either group) felt the project was difficult. In fact, the easier that a learning objective is, the less likely a student is to feel skills were learned. In this case, it is likely that neither group found the project difficult from a technical perspective, possibly as a result of a higher level of prior knowledge.

$H_{2.6}$: For Session 2, the scores on the *Learned Valuable Skills* measure for the Behaviorist group will be lower than for the Constructivist group.

This hypothesis was derived from a similar concept discussed in Hypothesis 2.5, that the learning experience of a student can have a direct psychological effect on whether he or she feels that the learning was successful. The inability for the students to rely on the learning aids afforded in Session 1 would make retention an important factor in Session 2. The learning environment created from the constructivist approach may provide a greater pool of resources for the students to utilize in creating their drawings.

In order to calculate results, a t-test was used ($t = -1.06$, $df = 32$, $p = 0.30$). The findings, though not significant, were as predicted by the hypothesis. The Mean score for

Learned Valuable Skills of the Behaviorist group (Control group Mean = 2.94) was lower than the Constructivist group (Experimental group Mean = 3.18). Like Hypothesis 2.5, the difference between the Behaviorist group and the Constructivist group was not significant, though data still indicated that participants in the Constructivist group generally felt somewhat more successful in learning valuable skills during the learning session, and that both groups had an increase in perceived learning from one session to the next. It could be argued that the removal of the learning aid forced more of an individual effort to complete the project, which may have resulted in an increased feeling of learning success.

$H_{2.7}$: The Behaviorist scores on the *Learned Valuable Skills* measure will not change from Session 1 to Session 2.

The learning sessions for the Behaviorist groups were nearly identical in process between Sessions 1 and 2, the only difference being that in the second sessions no learning aids were provided. This similarity led to a hypothesis stating that no change in perceived success would occur between the two sessions. The behaviorist approach brings an additional level of individualism to the table, which likely placed a focus for the participants in Session 2 on recollection rather than skill building.

Utilizing a t-test ($t = 1.46$, $df = 16$, $p = 0.16$), the results indicated a decrease in the Behaviorist group *Learned Valuable Skills* from Session 1 (Mean = 3.18) to Session 2 (Mean = 2.94). While the difference across the sessions was not significant, using Spearman *rho*, with a significance level of 0.05, a moderate correlation ($r = 0.49$) was found. Participants who recorded a low level of learning during the first session recorded low levels during the second session; and those who indicated high levels of learning in the first session remained high. The individualistic nature of the behaviorist methodology combined with the removal of the learning aid likely brought about a decrease in *Learned Valuable Skills* at the end of the second session. With recollection and application using much of the participants' effort, little effort was placed on skill building.

$H_{2.8}$: The Constructivist scores on the *Learned Valuable Skills* measure will increase from Session 1 to Session 2.

In Session 1, students were not limited to individual work, and were able to control a great deal of the process by which they learned the information necessary to create the required end product. This led to an assumption that participants may experience an increase in perceived success between the two sessions. Additionally, the ability for students to work together and form a learning community might increase the chance of a student finding success in the learning session.

A t-test was conducted (t = 1.72, df = 16, p = 0.10), and the results indicated a slight decrease in the Constructivist scores for *Learned Valuable Skills* from Session 1 (Mean = 3.41) to Session 2 (Mean = 3.18). While the difference was not statistically significant, Spearman *rho* was used to determine a very strong correlation (r = 0.77) with a significance level of 0.00. Participants who reported a high level of learning after Session 1 reported a high level of learning after Session 2. Conversely, those who reported a low level of learning in Session 1 reported a low level of learning after Session 2. This slight decline in perceived success for the Constructivist participants could be due to a more valuable learning experience during Session 1. In reality, if the learning experience in Session 1 was high in value, it is likely that repeating the product creation process in Session 2 would provide less new skill development. If any participant felt he or she could not recall part of the information from the first session (regarding the software introduction), the experience would certainly decline.

Table 6

Comparisons of Group Scores in Perceived Difficulty

Variables	Behaviorist (Control)	Constructivist (Experimental)
Mean Score of Session 1 – *Perceived Difficulty*	1.76	1.35
Mean Score of Session 2 – *Perceived Difficulty*	2.12	1.47
Difference of Mean Score from Session 1 – Session 2	-0.36	-0.12
Standard Deviation of Session 1	0.75	0.49
Standard Deviation of Session 2	0.99	0.51
Difference of Standard Deviation from Session 1 – Session 2	-0.24	-0.02

Note: N = 34

**Perceived Difficulty* was measured on a Likert scale of 1-5, 1 representing a low difficulty level and 5 representing a high difficulty level.

$H_{2.9}$: For Session 1, the scores on the *Perceived Difficulty* measure for the Behaviorist group will be higher than the Constructivist group scores.

While both the Behaviorist group and the Constructivist group were ultimately creating the same end product, the process by which the product was created differed. Without prior knowledge of the software taught in the learning sessions (for both groups), the Behaviorist group *Perceived Difficulty* was predicted to be higher simply because of the process by which they were introduced to the software (integrated within the product tutorial). Additionally, in the behaviorist environment, individual assessment is typically the method used, and for that reason individual students are required to work only on their own projects. The access that Constructivist participants had to talking and working with each other during their session was expected to lower difficulty levels for their group.

Utilizing a t-test (t = 1.89, df = 32, $p = 0.07$), the results were as predicted by the hypothesis, but are not statistically significant. The Behaviorist's (Control group, Mean = 1.76, SD = 0.75) score of *Perceived Difficulty* for Session 1 was higher than the Constructivist's (Experimental group, Mean = 1.35, SD = 0.49).

$H_{2.10}$: For Session 2, the scores on the *Perceived Difficulty* measure for the Behaviorist group will be higher than the Constructivist group scores.

Similar to the concept discussed in Hypothesis 2.9, the *Perceived Difficulty* level was predicted to be higher in the Behaviorist group after Session 2. Both the Behaviorist and Constructivist groups were restricted to completing their projects without the learning aids in Session 2. In Session 1, the Behaviorist groups followed a specific path in order to achieve the learning goal, and the removal of the learning aid in Session 2 was expected to be a greater hindrance than in the Constructivist group.

In order to calculate results, a t-test was used (t = 2.39, df = 32, $p = 0.02$). The mean scores for *Perceived Difficulty* between the Behaviorist group and Constructivist group, during Session 2, were as predicted by the hypothesis. The Behaviorist group (Control group, Mean = 2.12) measured a higher score during Session 2 than the Constructivist group (Experimental group, Mean = 1.47). Additionally, these findings were statistically significant ($p = 0.05$). Without the learning aids, the Behaviorist group was left with fewer resources to utilize in the session. The Constructivist group also was without the learning aid used in Session 1, but the learning environment might have contributed to higher levels of retention. Additionally, the participants were still able to utilize the learning community, provide feedback, and ask questions among each other. This additional support system likely ensured the *Perceived Difficulty* level would be lower than that of the Behaviorist group.

$H_{2.11}$: The Behaviorist scores on the *Perceived Difficulty* measure will increase from Session 1 to Session 2.

Observing similar data as in Hypotheses 2.9 and 2.10, the Behaviorist group did not have access to the tutorial, and was restricted to individual recall in order to complete the second session. Given the individualistic nature of the behaviorist methodology, students would only be able to rely on personal achievement and retention of knowledge from Session 1 to Session 2. With the learning aid removed during the Session 2, it was assumed the difficulty level would increase.

This hypothesis was examined using a t-test ($t = -1.69$, $df = 16$, $p = 0.11$), the mean scores of the Behaviorist group's *Perceived Difficulty*, between Session 1 (Mean = 1.76) and Session 2 (Mean = 2.12), were as predicted by the hypothesis but were not significant. Using Spearman *rho*, a strong correlation ($r = 0.54$) was found, with a significance level of 0.03. These results point out that scores which were high in Session 1 remained high in Session 2, and recorded scores that were low in Session 1 remained low for Session 2. The data show that while the Behaviorist participants responded similarly in *Perceived Difficulty* between Session 1 and Session 2, the removal of the learning aid combined with restricted interaction likely ensured a more difficult Session 2 for the Behaviorist group.

$H_{2.12}$: The Constructivist scores on the *Perceived Difficulty* measure will not change from Session 1 to Session 2.

This hypothesis was derived from a prediction that the Constructivist participants would not experience a decrease in ability to problem solve and create as a result of the removal of the learning aid in Session 2. The learning community formed by a constructivist method of teaching aids in information processing, research, feedback, and overall ability in achieving learning goals.

A t-test was conducted ($t = -0.81$, $df = 16$, $p = 0.43$), and the mean scores of *Perceived Difficulty* slightly changed. The score for Session 1 of the Constructivist group (Mean = 1.35) was lower than Session 2 (Mean = 1.47). However, no statistical significance between these scores was determined ($p = 0.05$). In review, the removal of the learning aid likely had a minor effect on the *Perceived Difficulty* level in Session 2 of the Constructivist group. The constructivist environment, while allowing for more collaboration and a strategy for higher initial retention during Session 1, still required a certain amount of recollection that may or may not have affected the *Perceived Difficulty* level of the participants in Session 2.

Table 7

Comparisons of Group Scores in Perceived Confidence

Variables	Behaviorist (Control)	Constructivist (Experimental)
Mean Score of Session 1 – *Perceived Confidence*	2.65	3.35
Mean Score of Session 2 – *Perceived Confidence*	2.82	3.53
Difference of Mean Score from Session 1 – Session 2	-0.17	-0.18
Standard Deviation of Session 1	0.61	0.49
Standard Deviation of Session 2	0.73	0.51
Difference of Standard Deviation from Session 1 – Session 2	-0.12	-0.02

Note: N = 34

**Perceived Confidence* was measured on a Likert scale of 1-5, 1 representing a low confidence level and 5 representing a high confidence level.

$H_{2.13}$: For Session 1, the scores on the *Perceived Confidence* measure for the Behaviorist group will be lower than the Constructivist group scores.

Students' confidence in technology atmospheres have a great influence on the level of achievement and the utilization of skills to achieve learning goals (Neilsen et al., 2010). While both groups had little to no prior knowledge of the software being used during the session, the Constructivist group was given a short introduction on the use of the software as a standard environmental element of the constructivist approach.

Behaviorist participants were given only a tutorial that contained an integrated software tutorial and final product instructions. This led to the hypothesis that the Constructivist group would feel more confident in their learning.

Utilizing a t-test ($t = -3.72$, $df = 32$, $p = 0.00$), the *Perceived Confidence* scores for the Behaviorist group (Control group, Mean = 2.65) measured lower than the Constructivist group (Experimental group, Mean = 3.35) for Session 1. These results were statistically significant ($p = 0.05$). Data showed that the Constructivist participants felt considerably more confident in their learning than did those in the Behaviorist group. This is likely the result of more than one factor, including the software introduction that was given to the Constructivist group (which may have better framed the content to be learned), as well as the ability to work either individually or with other participants in the session.

$H_{2.14}$: For Session 2, the scores on the *Perceived Confidence* measure for the Behaviorist group will be lower than the Constructivist group scores.

The same concept as Hypothesis 2.13 supports 2.14. Honebein (1996) attributes intellectual development to be greatly supported and affected by the inclusion of social interactions as part of the learning process. The constructivist approach supports teamwork and collaboration in acquiring new knowledge. For this reason, a similar difference was predicted, where the Constructivist group would feel more confident during their second session than the Behaviorist group in their second session.

In order to calculate results, a t-test was used ($t = -3.27$, $df = 32$, $p = 0.00$). The Behaviorist group's scores for *Perceived Confidence* in Session 2 were lower than the Constructivist group's scores at a statistically significant level. The Behaviorist group (Control) scored a mean of 2.82, while the Constructivist group (Experimental) scored a mean of 3.53.

The difference in confidence scores is slightly greater between the groups in Session 2 than in Session 1. Without the tutorial (for the Behaviorist group) and the software introduction (for the Constructivist group), learner confidence was further apart as a result of the outcome of Session 2 relying completely on recalled information. Learner confidence for the Constructivist group was likely maintained due to the continued ability to work with others within the group had any participant wished.

$H_{2.15}$: The Behaviorist scores on the *Perceived Confidence* measure will decrease from Session 1 to Session 2.

This hypothesis was generated from an assumption that the confidence of the Behaviorist group would be affected by the removal of the learning aid in Session 2. This group completed Session 1 following a step-by-step tutorial. Essentially, illustrated instructions needed to complete the project were placed in front of the participant. Each individual knew what was expected of them and most likely was satisfied when they reached the last page. They may not have liked the actual design of the model, but they followed the task as it instructed them. For the second session, each participant needed to rely on their memory of the project they completed two weeks earlier. Without accessing the tutorial, it was thought that the retention rate would be low enough to provide this decrease in confidence.

A t-test was conducted (t = -0.77, df = 16, p = 0.46), and the results, while not significant, indicated a slight reverse of the hypothesis, indicated by an increase in *Perceived Confidence* scores from Session 1 to Session 2 of the Behaviorist (Control) group. The mean score of Session 1 was 2.65, while the mean score of Session 2 was 2.82. This reversal in outcome may be attributed to the retention rate being high enough to allow for modest learner confidence as found in Session 1.

$H_{2.16}$: The Constructivist scores on the *Perceived Confidence* measure will not change from Session 1 to Session 2.

The constructivist approach promotes collaboration and peer interaction, both for information gathering as well as feedback on quality and process. This hypothesis was generated as a result of the belief that confidence levels and ability to problem solve with other peers would make up for the loss of the learning aid from Session 1.

Utilizing a t-test (t = 1.38, df = 16, p = 0.19), the results were slightly different than predicted by the hypothesis. The Constructivist group's scores of *Perceived Confidence* increased from the first to the second session. The Experimental group scored a mean of 3.35 during Session 1, which was elevated slightly to 3.53 for Session 2. While not statistically significant, it is worth mentioning that although a learning aid was removed, the group as a whole showed an increase in confidence, which is a core attribute of the constructivist learning environment.

Table 8

Comparisons of Group Scores in Design Embellishment

Variables	Behaviorist (Control)	Constructivist (Experimental)
Mean Score of Session 1 – *Embellishment*	1.12	1.65
Mean Score of Session 2 – *Embellishment*	1.00	1.71
Difference of Mean Score from Session 1 – Session 2	0.12	-0.06
Standard Deviation of Session 1	0.33	0.49
Standard Deviation of Session 2	0.00	0.47
Difference of Standard Deviation from Session 1 – Session 2	0.33	0.02

Note: N = 34

**Design Embellishment* was measured on a scale of 1 or 2, with 1 representing that embellishments were not included in the final design and 2 representing that embellishments were included in the final design.

$H_{2.17}$: For Session 1, the scores on the *Design Embellishment* measure for the Behaviorist group will be lower than the Constructivist group scores

This hypothesis was generated from the assumption that the general learning format of each Session 1 group would result in a behaviorist product that would be standardized (by the use of the step-by-step tutorial) and a constructivist product that would be largely varied in style and creativity level. Savery and Duffy (1995) discuss the positive effects of a group learning experience, that these groups can have an "enriching, interweaving, and expanding" effect on the learning environment. The Constructivist group of learners, following constructivist core methodologies, had less of a restrictive process to follow, while opening the lines of communication between participants, bringing a wider array of opinions into a feedback cycle.

In order to calculate results, a t-test was used ($t = 3.67$, $df = 32$, $p = 0.00$). The results indicate support for the hypothesis at a significant level. The mean score of *Design Embellishment* for the Behaviorist (Control) group during Session 1 was 1.12, while the mean score for the Constructivist (Experimental) group was 1.65. These results are statistically significant ($p = 0.05$). Below are examples of models from both the Behaviorist group and the Constructivist group. Both represent the top tier in accuracy for their respective group. The increase in *Design Embellishment* can be compared from the Behaviorist to the Constructivist group. Both groups were given general requirements either through the tutorial (for the Behaviorist participants) or a guidelines list (for the Constructivist participants). In this session, the Behaviorist example below illustrates a general adherence to the project specifications (including two exit doors, two windows, seating for 20, and a restroom). The Constructivist example, however, shows a drawing that includes elements that go far beyond the requirements, such as a kitchen area, a bar, extra seating, and far more windows.

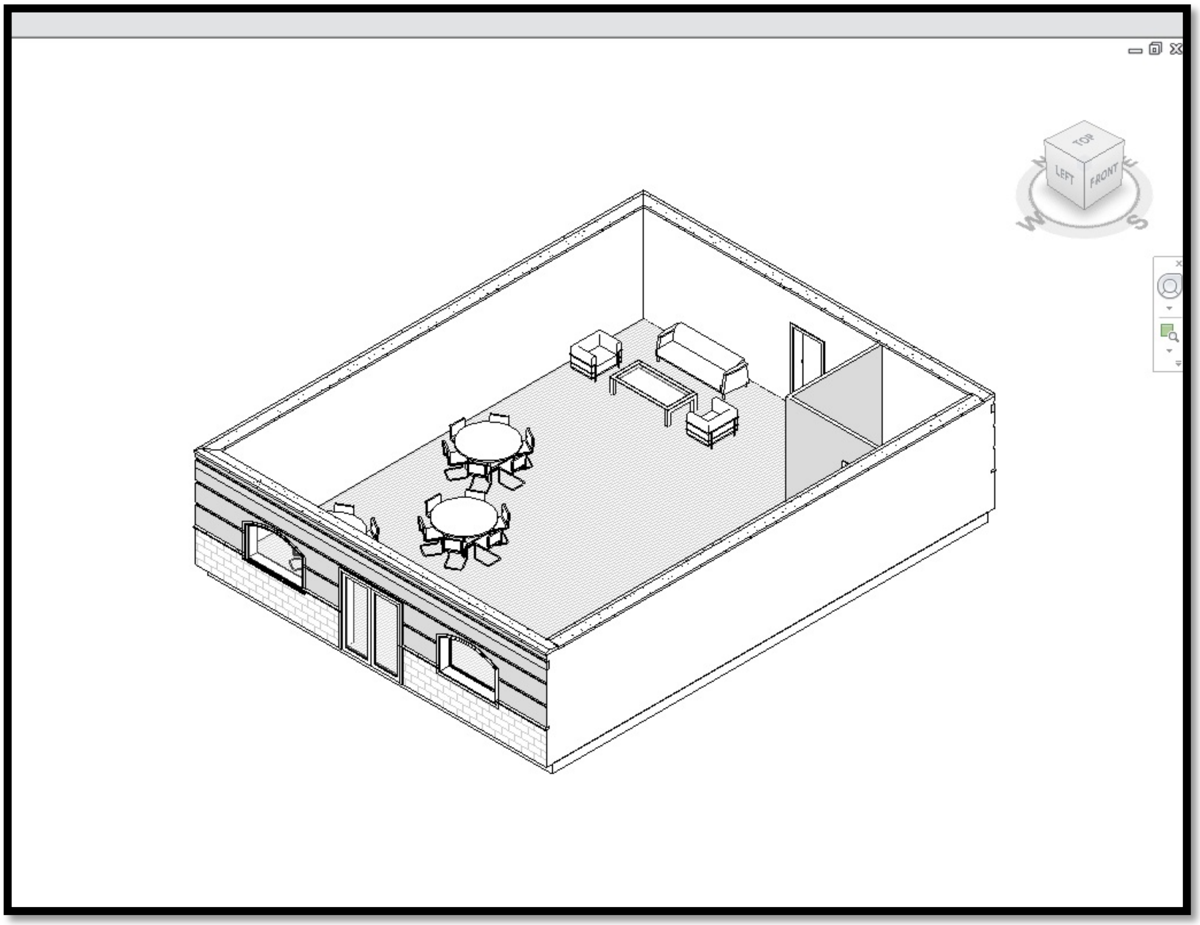

Figure 5. One of the better Behaviorist drawings from Session 1

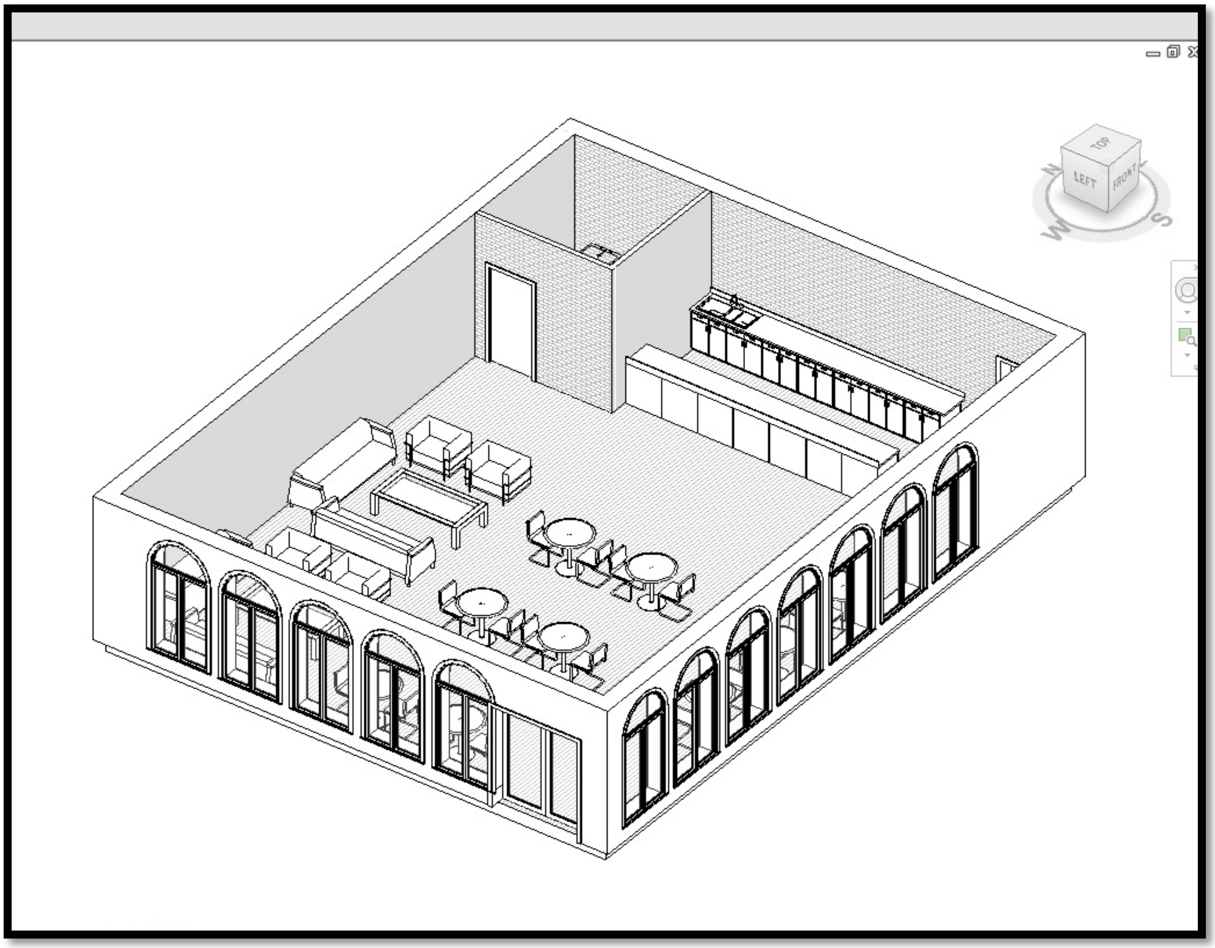

Figure 6. One of the better Constructivist models from Session 1

$H_{2.18}$: For Session 2, the scores on the *Design Embellishment* measure for the Behaviorist group will be lower than the Constructivist group scores.

Session 2 for both the Behaviorist and Constructivist groups included the removal of learning aids, which likely made the creation of the drawing more difficult. The goal of the constructivist approach is one that allows for more creativity and critical thinking. It was expected that maintaining the individualistic nature of the behaviorist environment in Session 2 would produce a lower *Design Embellishment* and creativity level for the Behaviorist group.

Utilizing a t-test ($t = 1.34$, $df = 32$, $p = 0.19$), the results indicate support of the hypothesis at a significant level. The mean score on the Session 2 *Design Embellishment* measure for the Behaviorist (Control) group was 1.00, while the mean score for the Constructivist (Experimental) group was 1.71. It has been concluded that the Constructivist group experienced less stress and was more accurate during Session 2 when compared with the Behaviorist group, which is likely due to the removal of the tutorial from the Behaviorist group. Neither group had tutorials or notes in the second session, only general guidelines for drafting their projects. Since the Behaviorist group had learned the software and the process for building the drawing simultaneously, the amount of information recalled was most likely less than that of the Constructivist participants. A greater divide in the amount of *Design Embellishment* was noted in Session 2, as shown in the models below - one from the Behaviorist group and one from the Constructivist group. In this session, both groups showed initiative to embellish, as can be seen in the examples below. While the Behaviorist example shows an adherence to the general guidelines, embellishments for the Constructivist group were even greater than the first session, which can be seen below with additions of a kitchen area, high cabinets, extra seating, and extra windows.

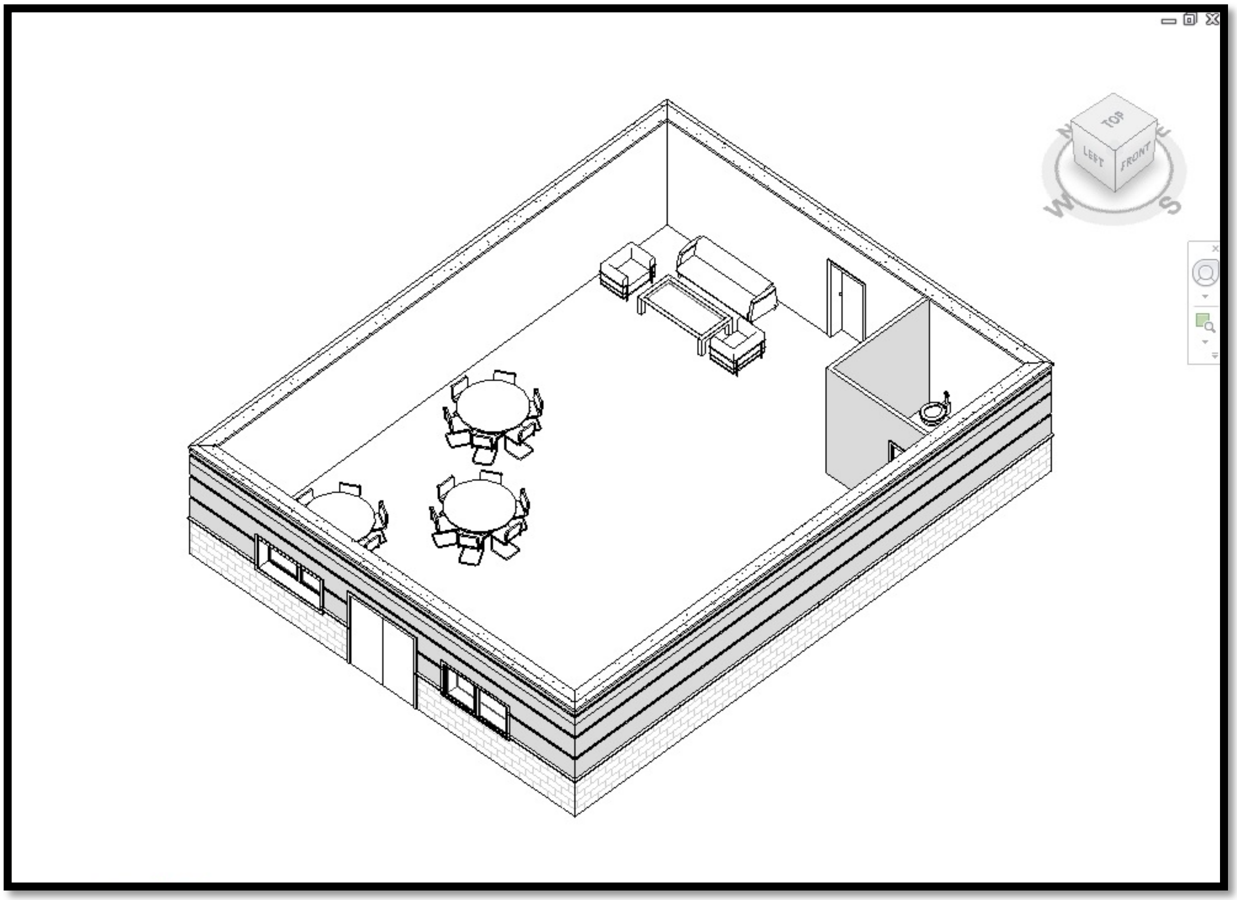

Figure 7. One of the better Behaviorist drawings from Session 2

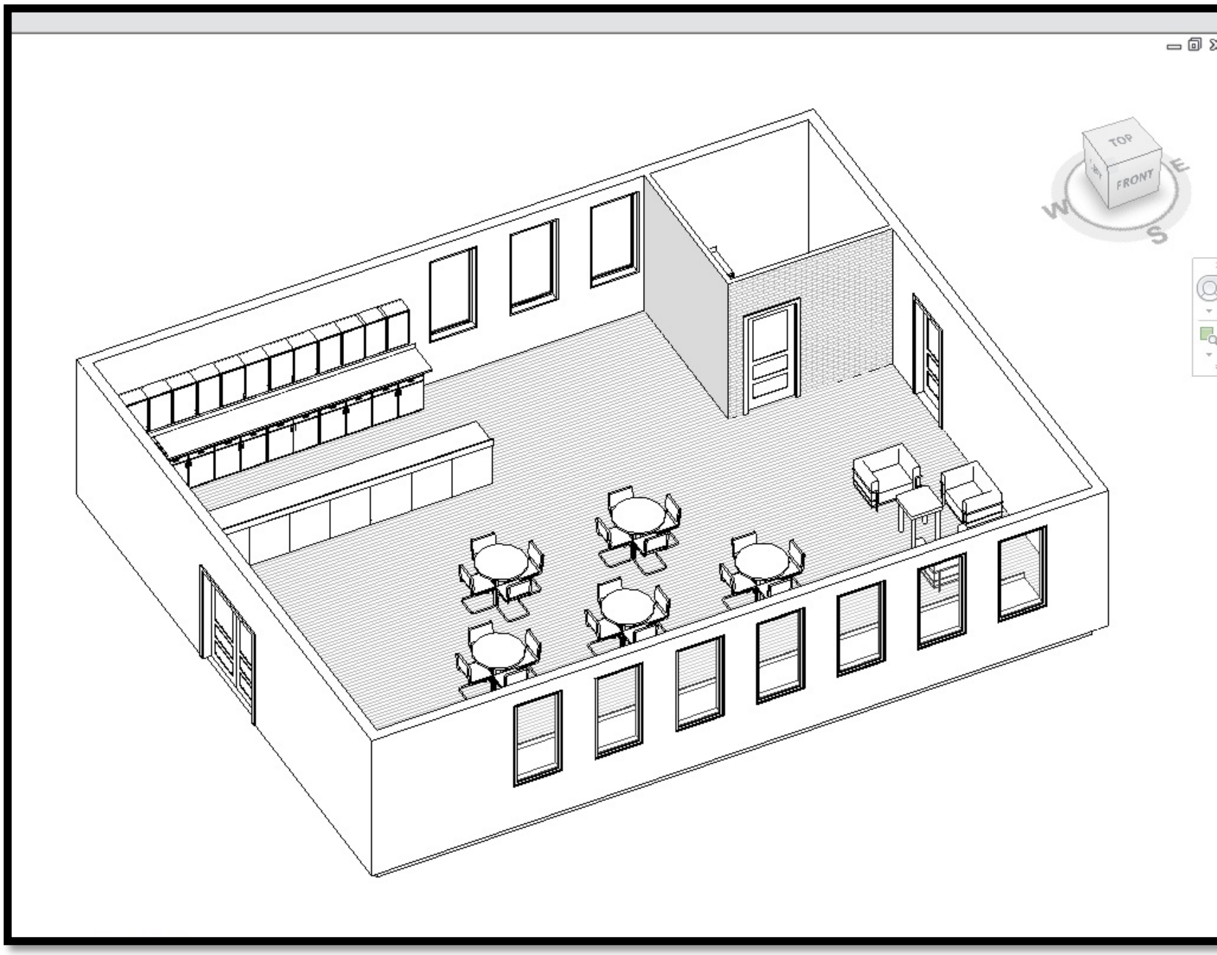

Figure 8. One of the Better Constructivist drawings from Session 2

CHAPTER V

DISCUSSION AND CONCLUSIONS

Overview

This study analyzed many attributes of the learning environment within a classroom utilizing a behaviorist approach and a classroom utilizing a constructivist approach. The overarching theme of this study is to add to research that explores the integration of traditional and progressive teaching methodologies in a way that ensures accuracy of content delivery, continues to support content retention, and in the case of the studio-based classroom, engages students in a learning experience that promotes critical thinking and creative achievement as part of the learning process.

Behaviorist Approach

As results were analyzed, it was clear that the behaviorist approach performed well in certain categories of assessment, the most important of these being the *Evaluation Accuracy* measure. In the behaviorist methodology, accuracy in knowledge transfer is paramount to the success of the approach. Shepard (2000) describes the behaviorist learning environment as one where small bits of knowledge are presented in a sequenced and hierarchical fashion, which supports comprehension from repetition. In this study, the Behaviorist group participated in two learning sessions, and in both cases the *Evaluation Accuracy* measure was high. This group was presented with a step-by-step tutorial in the first session to assess the effects of a standardized, sequenced approach to achieving learning goals. Results of this session indicated a positive response technically to the behaviorist approach, with an average score of 4.00 on a five-point evaluation scale. The second session, which was intended to gauge retention of knowledge learned in Session 1 by removing the tutorial learning aid, scored slightly higher with the participants averaging 4.12 on the same five-point evaluation scale.

In addition to the *Evaluation Accuracy* measure, the Behaviorist groups also scored well in the *Learned Valuable Skills* measure. Participants completed a survey at the end of each session in which aspects of the learning environment and experience were rated using the *Post-Session Survey*. While not as positive as the *Evaluation Accuracy* measure, the students showed a general agreement that valuable skills were learned during both sessions, averaging 3.06.

The behaviorist approach appeared to suffer in other areas, including *Completion Time* and *Total Stress*, *Perceived Confidence,* and *Design Embellishment*. The amount of time taken to complete each session was recorded for each participant. The Behaviorist group in Session 1 recorded the highest completion time of all four sessions, with an average of 57 minutes and 24 seconds. A positive note for this statistic is the greatly reduced completion time of the second session, where participants averaged only 35 minutes and 24 seconds. This 22-minute decrease, when coupled with the slight increase in *Evaluation Accuracy*, places a positive emphasis on the retention rate of students from the technical perspective in a behaviorist environment.

Other measures analyzed as part of the second research question (*Does the instructor's choice of a constructivist approach versus behavioral impact students' behavior during and attitude towards studio-based learning?)* were less positive. *Total Stress*, measured as indicators of learning stress recorded by trained observers during the learning sessions, was high at 12.76 during the first Behaviorist session(which means that on average, a Behaviorist participant exhibited almost 13 visual signs of learning stress during the first session). More impressive is the increase in this measure when compared with the Session 2 score of 18.29. This increase of 5.53, or 43.3%, from Session 1 to Session 2 is an indication that while accuracy increased, the cost of accuracy was increased learning stress.

Perceived Confidence was measured to determine how comfortable the participants felt during each of their sessions. The Behaviorist sessions were similar to one another in this measure, scoring a mediocre 2.65 and 2.82 (out of a possible 4.0) in Session 1 and Session 2 respectively. These results suggest that students felt only marginally confident in their learning achievement during each Behaviorist session. An interesting concept specifically relating to confidence is that even though the students were provided a step-by-step tutorial in Session 1 that was essentially a written walkthrough of the product to be designed, students did not express confidence in completing the session with accuracy.

Design Embellishment was a measure intended to determine the tendency for students to work beyond specified requirements as a result of the learning environment. In both sessions, few participants used any remaining time allotted for the session to add personal embellishments or creative elements to their drawings. This lack of creativity was expected for Session 1 where the tutorial was used, simply because once the participants reached the end of the tutorial, they would feel the project was complete. Additionally, without incentive to do additional work beyond the scope of the tutorial, participants were unlikely to elaborate on their drawings. The second session for the Behaviorist group contained aspects of constructivism, mainly in the learning goal phase of the session. Only general requirements were given for the end product to be created, which gave the students more opportunity to participate in the learning process by allowing freedom in determining the process by which they would design their drawings. Even with this inclusion of some freedom into the behaviorist construct, students showed a decrease in the amount of design embellishments and creative additions to drawings.

Constructivist Approach

The Constructivist group revealed high marks in most of the categories assessed, both in accuracy as well as behavior. *Evaluation Accuracy*, in particular, was extremely high in the Constructivist group, with participants in Session 1 averaging a 4.71 out of a five-point evaluation scale. While slightly lower, participants from Session 2 scored 4.59 out of a possible 5. The level of success was not expected in this category, particularly in Session 1 where the corresponding Behaviorist group was using a learning aid that walked participants through the development process. The Constructivist group was given a software introduction in lieu of the step-by-step tutorial, which supports a positive assessment of the constructivist environment as it pertains to accuracy in achievement.

Completion times for Sessions 1 and 2 for the Constructivist group were similar if the software introduction is factored into the analysis. While the average completion time for Session 1 was 49 minutes and 53 seconds, the actual working time for the participants was about 15 minutes less (the software introduction was 15 minutes long).

From the perspective of behavior, attitude, and creativity, the Constructivist groups submitted the same post-session survey and were observed in the same manner as the participants in the Behaviorist group.

The *Learned Valuable Skills* measure was comparable with the Behaviorist group in both sessions, indicating only a slightly higher response to whether or not skills learned during the sessions were valued.

Higher *Perceived Confidence* scores within both Constructivist groups were statistically significant as compared with the Behaviorist group. Sessions 1 and 2 of the Constructivist group scored 3.35 and 3.53 respectively, compared to 2.65 and 2.82 for the Behaviorist sessions.

The *Perceived Confidence* measure likely influences the amount of stress experienced by learners involved in the sessions. The trained observers recorded a significantly reduced number of stress indicators (found in Table 4, Chapter 4) when observing the Constructivist sessions (as compared to the Behaviorist sessions). Session 1 of the Constructivist group revealed a score of 9.76. More revealing is the score of 6.29 recorded in Session 2, which was less than 35% of the stress indicators recorded in Session 2 of the Behaviorist group. This is an important group of statistics when combined with *Evaluation Accuracy*, showing that participants in the Constructivist group were more accurate in achieving their learning goal and showed fewer signs of learning stress during the session, particularly in Session 2 of both groups.

Design Embellishment is an aspect of creative assessment essential to the study in comparing methodologies. Scores recorded in the Constructivist group were much higher than those participating in the Behaviorist sessions. While fewer than 25% of Behaviorist participants included design embellishments in their projects, over 50% of Constructivist participants went beyond the general requirements of the sessions. The level of observed embellishment was greater within the Constructivist group, as shown in the images at the end of chapter 4. The sample of images shown was indicative of the entire group's creative performance.

Integration of Methodologies

Both the behaviorist approach and the constructivist approach exhibited positive outcomes as well as negative. Both methodologies contributed to high accuracy scores, value in skill development, decreases in goal achievement time in the second sessions, and a degree of creative output.

The importance of utilizing aspects of both approaches as an integrated or hybrid methodology has strong implications as post-secondary studio-based education continues to evolve. The behaviorist methodology has historically been utilized to ensure accuracy in achievement, and this has been true throughout this study. Studio-based curricula continue to evolve in a way that requires a more global development of skills, including skills that go far beyond technical achievement.

Cognitive load theory is an essential element in designing instructional content at the course level as well as the lesson level. Chandler and Sweller (1991) explain that a poorly designed learning activity can drive learners to thinking and processing of information that is largely irrelevant, or at best inefficient, to presented learning goals. Learning stress, confidence, and lack of creative production have all been attributed to some degree to unmanaged cognitive load, particularly within inexperienced students or those that have little prior knowledge in a subject. By managing cognitive load and providing learning experiences that are designed to reduce learning stress, increase confidence, and promote creativity, the studio-based classroom can evolve in a way that better prepares students for transition into the professional world.

Creativity is often discussed as a sought skill, but execution of curriculum in the form of studio classes has frequently lacked the attributes within the learning environment that encourage such exploration. The value placed on college graduates that exhibit skill and ability to think and design creatively is great, but employers have consistently labeled creativity as an attribute most lacking in entry-level applicants (Reid and Petocz, 2004). Creativity is a difficult skill for faculty members to assess, let alone teach. The *Design Embellishment* measure performed in this study resulted in a strong relationship between unsolicited development of creative elements and the constructivist learning environment. Students in the Constructivist sessions were more than twice as likely to explore the assignment beyond the provided requirements, as verified by the increased scores in the *Design Embellishment* measure. This is an important statistic to note, since both the creativity level and accuracy were higher in the Constructivist group than in the Behaviorist. A higher accuracy score plus a lower *Total Stress* score leads to the assumption that the learning session was easier to complete for the Constructivist participants. Combine this with the shorter completion times, and it seems likely that a less stressful, less restrictive leaning environment can lead to higher creative output.

An important factor in the decision to perform this study was the researcher's faculty position at Indiana University of Pennsylvania. The difficulty in managing diminishing face-to-face time with students with an increase in industry requirements for recent graduates has been a point of frustration. Pressure from the Interior Design industry for gaining program accreditation is a monumental process that is becoming more important for recruitment of new students and retention of current students. The Council for Interior Design Accreditation (CIDA) presents rigorous requirements and rubrics for assessing learning environments and academic standards in their *Professional Standards 2011* document. Beyond the core components of the technical skills curriculum, CIDA requires that a university curriculum demonstrates the ability to engage students in a learning environment that supports and promotes (CIDA, II-7):

1. *Global Perspective for Design*
2. *Human Behavior*
3. *Design Process*
4. *Collaboration*
5. *Communication*
6. *Professionalism and Business Practice*

These are elements of a learning environment that traditional behaviorist practices generally have not fostered. Fifteen years ago, it was sufficient for many Interior Design programs to teach an emerging technology called Computer-Aided Drafting (CADD) as a singular course. The evolution of technology has provided many additional software packages that can be used in conjunction to develop plans, drawings, and recommendations to clients. In addition to CAD design, software is available for Building Information Modeling (BIM), and even experience with aesthetic and layout programs such as Adobe's Illustrator and InDesign are skills valued by employers in the industry. All of these new technologies go beyond the technical aspect of the software and so must be addressed to a certain degree to prepare a student for the work force. Creativity and critical thinking must be promoted to utilize the right tools for the right purposes and to foster higher-level decision-making. This study, providing much-needed rigorous support, was aimed at identifying aspects of sound practice that can foster collaboration, critical thinking, and creativity while improving retention rates between classes as well as academic semesters.

Recommendations

One way to integrate the behaviorist methodology is to provide tools and encourage research. This study has shown that both the behaviorist and the constructivist methodologies have the potential to deliver accuracy in learning goals, but the behaviorist approach is limited in its capacity to broaden students' knowledge within the learning environment. Pre-developed tools and supports (such as the tutorial used in this study) can be valuable as long as they do not define the entirety of the learning experience. As seen in the first Behaviorist session, while accuracy was high in the end product, learning stress was elevated and student confidence was low. If supports are provided, students should be encouraged to use them as a foundation and broaden their knowledge using any number of regulated information sources, from access to online resources to engaging in discussions with peers that may have a deeper knowledge in content areas. It was revealed through elements of this study that when students have opportunities to collaborate with one another, even if the end result is assessed individually, the learning process can be less stressful, elicit more creativity, and take less time. This combination of the behaviorist and constructivist imperative to developing lesson plans and new studio courses that need to teach more content than is traditionally taught in the same amount or less time.

While it is imperative to maintain rigorous accuracy standards, creativity shouldn't be lost in the process. Participants in the Behaviorist group, when provided with the all-encompassing tutorial, were satisfied to submit a standard drawing. While accuracy levels were high and creativity and embellishment were not requirements of the session, the inherent nature of the lesson structure did not encourage creative exploration. The Constructivist participants provided a wide array of drawings that exhibited many levels of creativity without sacrificing accuracy (see *Design Embellishment*, Figure 7 on page 72). This study has shown that students that are more involved in the learning process are more likely to feel ownership of their own learning and take initiative to shape the learning experience in a way that is beneficial to individual learning styles. This is evident in the increase in design embellishment and the tendency to go beyond requirements exhibited by the Constructivist group, particularly in Session 2.

If the content delivered in this experiment was to be used in a transitional classroom experience with a combination of methodologies, it might begin by providing a written support tool that teaches the software, which would then be supported by an introductory lecture and discussion. In order to manage cognitive load, this first "session" would focus only on the use of the software. A second session (or classroom period) would then provide an introduction of a project, perhaps like the one used in this experiment, where students can use the information learned in the first session to work towards a broader, more creative product. This second session would follow the constructivist methodology, allowing students to work together and to research beyond the standard written books and tools to enrich the learning experience and provide deeper interactions within a learning community. This approach, teaching software in a behaviorist-centered environment and the application of this knowledge in a broad, constructivist atmosphere, could greatly impact the learning outcomes of the students.

Areas for Future Research

This study has explored the effects of two teaching methodologies on a studio-based curriculum. After analyzing the learning sessions, some areas for improvement arose. If this study were performed again, a few changes would be proposed. First, a larger and more diverse (with age) sample would be used. This would allow for a stronger argument for effects on accuracy, with a group exhibiting a more varied background in regards to knowledge of software and experience in Interior Design. Also, as part of the *Post-Session Survey*, students would be asked the following question in addition to those already included in the survey: "Would you have liked more time at the beginning of the session to explore the software tools before beginning the project?" Perhaps more individual exploration time would have allowed accuracy scores between the sessions to increase.

While the data provided an enlightening view of how students perform within each of the methodologies, the scope of the experiment was fairly narrow, limiting the study to mostly Junior/Senior-level Interior Design students. This experiment will benefit not only Interior Design studio courses, but also other studio courses in other curriculum areas. For example, the goals of this study would be well-suited to be tested within Fine Arts and Communications Media. Fine Arts, specifically Graphic Design, is software-rich, with many avenues and options available to achieve different artistic goals. The Adobe Creative Suite alone contains 17 programs and extensions. The learning curve for younger Fine Arts students potentially could be greatly reduced with studies like this one applied to current classes. Further, Communications Media adds a studio core that includes many production and audio products, where software is the center of many classes. Both Fine Arts and Communications Media place value in creativity, which could be a focus of growth in future years. Results of this study could be valuable in targeting limited resources toward future growth.

As curricula grow across all academic areas, the need for further research into the conversion of current traditional course content into online and e-learning platforms will continue to be an area of expansion. This study could be the basis for a more generalized assessment of retention and creativity between traditional (face-to-face) and online (or electronic) learning environments. The need for institutions to continue demonstrating flexibility and adaptability will continue to grow.

While the behaviorist method of instruction is deeply rooted in many academic settings and certainly has merit in many situations, it is recommended that studio faculty begin (or continue) to include aspects of the constructivist model into the learning environment. Only through dedicated emphasis on the teaching behaviors that promote creativity, critical thinking, and ownership of the learning process will students be appropriately prepared for their design careers.

REFERENCES

Baddeley, A. D. (1986). *Working memory*. Oxford, England: Oxford University Press.

Baddeley, A. D. (1992). Working memory. *Science, 255,* 556-559.

Bandura, A. (1977). *Social learning theory*. Englewood Cliffs, NJ: Prentice-Hall.

Boghossian, P. (2006). *Fear of knowledge: Against relativism and constructivism*. New York, NY: Oxford University Press.

Boondee, V., Kidrakarn, P., & Sa-Ngiamvibool, W. (2011). A learning and teaching model using project-based learning (PBL) on the web to promote cooperative learning. *European Journal of Social Sciences, 21*(3), 498-506.

Buddenbaum, J. M., & Novak, K. B. (2001). *Applied communication research*. Ames, Iowa State University Press.

Chambers, J. A. (1973). College teachers: Their effect on creativity of students. *Journal of Educational Psychology, 65*(3), 326-334.

Chandler, P., & Sweller, J. (1991). Cognitive load theory and the format of instruction. *Cognition and Instruction*, *8*(4), 293-332.

Collins, A., Greeno, J., & Resnick, L. B. (1992). Cognition and learning. In B. Berliner, & R. Calfee (Eds.), *Handbook of educational psychology* (pp.15-46). New York, NY: Simon & Shuster MacMillan.

Craft, A. (1999). Creative development in the early years: Some implications of policy for practice. *The Curriculum Journal, 10*(1), 135-150.

Cunningham, D. J., Duffy, T. M., & Knuth, R. A. (1993). The textbook of the future. In C. McKnight, A. Dillon, & J. Richardson (Eds.), *Hypertext: A psychological perspective*, (pp. 19-50). Ellis Horwood Ltd.

Dede, C. (1996). The evolution of constructivist learning environments: Immersion in distributed, virtual worlds. *Constructivist Learning Environments: Case Studies in Instructional Design*, 165-175.

Durwin, C., & Sherman, W. M. (2008). Does choice of college textbook make a difference in students' comprehension?. *College Teaching*, *56*(1), 28-34.

Ediger, M. (2012). Recent leaders in American education. *College Student Journal*, *46*(1), 174-177.

Edwards, S. M. (2001). The technology paradox: Efficiency versus creativity. *Creativity Research Journal*, *13*(2), 221-228.

Fischer, G. (2001). Lifelong learning and its support with new media. *International Encyclopedia of Social and Behavioral Sciences*, 13, 8836-8840.

Garrison, D. R., Anderson, T., & Archer, W. (2001). Critical thinking and computer referencing: A model and tool to access cognitive presence. *American Journal of Distance Education, 15*(1), 7-23.

Goldberg, H. E. (2010). *Revit Architecture 2011: A comprehensive guide.* New York, NY: Prentice Hall.

Goldenburg, (1992). Instructional conversations. *Promoting Comprehension Through Discussion, 46*(4), 316-321.

Gourgey, A. F. (1998). Metacognition in basic skills instruction. *Instructional Science, 26*(1), 81-96.

Green, S. K., & Gredler, M. E. (2002). A review and analysis of constructivism for school-based practice. *School Psychology Review, 31*(1), 53-70.

Hannafin, M. J., Hannafin, K. M., Land, S. M., & Oliver, K. (1997). Grounded practice and the design of constructivist learning environments. *Educational Technology Research and Development, 45*(3), 101-117.

Haseeb, Q. S. (2011). Creativity in architecture definition and its affect on architectural thought. *European Journal of Scientific Research, 62*(2), 267-272.

Honebein, P. (1996). Seven goals for the design of constructivist learning environments. In B. Wilson (Ed.), *Constructivist learning environments,* (pp. 17–24). Englewood Cliffs, NJ: Educational Technology.

Johnson , D.W., & Johnson, R.T. (1994). An overview Cooperative Learning . In J. S. Thousand, R. A. Villa, & A. I. Nevin (Eds.), *Creativity and collaborative learning*. Baltimore , MD: Paul H. Brookes Publishing.

Johnson , D.W., & Johnson, R.T. (1999). *Learning together and alone: Cooperative, competitive, and individualistic learning* (5th ed.). Boston: Allyn & Bacon.

Johnson, B., & McClure, R. (2000, January). How are our graduates teaching? Looking at the learning environments of our graduates' classrooms. A paper presented at the annual meeting of the Association for the Education of Teachers in Science, Akron, OH.

Jonassen, D. H., & Rohrer-Murphy, L. (1999). Activity theory as a framework for designing constructivist learning environments. *Educational Technology Research and Development, 47*(1), 61-79.

Kalina, C., & Powell, K. (2010). Cognitive and social constructivism: Developing tools for an effective classroom. *Education*, *130*(2), 241-250.

Khogali, S., Laidlaw, J., & Harden, R. (2006). Study guides: A study of different formats. *Medical Teacher, 28*(4)*,* 375-377.

Kilmer, W. O., & Kilmer, R. (2009). *Construction drawings and details for interiors: Basic skills* (2nd ed.). Hoboken, NJ: John Wiley & Sons, Inc.

Kirschner, P. A. (2002). Cognitive load theory: Implications of cognitive load theory on the design of learning. *Learning and Instruction, 12*(1), 1-10.

Knuth, R. A., & Cunningham, D. J. (1993). Tools for constructivism. In T. M. Duffy, J. Lowyck, & D. Jonassen (Eds.), *Designing environments for constructive learning*. New York, NY: Springer.

Kreijns, K., Kirschner, P. A., & Jochems, W. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments: A review of the research. *Computers in Human Behavior, 19*, 335-353.

Lang, A. (2006). Using the limited capacity model of motivated mediated message processing to design effective cancer communication messages. *Journal of Communication*, *56,* S57-S80.

Lau, L. K. (2003). Institutional factors affecting retention. *Education*, *124*(1), 126-136.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. New York, NY: Cambridge University Press.

Lei, S. A., Rhinehart, P. J., Howard, H. A., & Cho, J. K. (2010). Strategies for improving reading comprehension among college students. *Reading Improvement*, *47*(1), 30-42.

McClure, R., & Gatlin, L. (2007). Assessment of online learning environments using the OCLES (20). *National Social Science Journal, 28*(2), 127-132.

Meneely, J., & Danko, S. (2007). Motive, mind, and media: Digital sketching in the creative culture of design. *Journal of Interior Design,* (32), 69-90.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 63*(2), 81.

Mousavi, S. Y., Low, R., & Sweller, J. (1995). Reducing cognitive load by mixing auditory and visual presentation modes. *Journal of Educational Psychology, 87*(2), 319.

Myers, S. A., & Rocca, K. A. (2001). Perceived instructor argumentativeness and verbal aggressiveness in the college classroom: Effects on student perceptions of climate, apprehension, and state motivation. *Western Journal of Communication, 65*(2), 113-137.

Nielsen, D., Fleming, M. J., Kumarasuriyar, A. C., & Gard, S. (2010). Digital design communication: Measuring learner technological prowess and self-efficacy in problem resolution. *Proceedings of the 2010 International Technology, Education and Development Conference,* Valencia, Spain.

Paas, F., Renkl, A., & Sweller, J. (2003). Cognitive load theory and instructional design: Recent developments. *Educational Psychologist, 38*(1), 1-4.

Paas, F., & Van Merrienboer, J. (1994). Variability of worked examples and transfer of geometric problem-solving skills: A cognitive-load approach. *Journal of Educational Psychology, 86*, 122-133.

Palincsar, A. S. (1998). Social constructivist perspectives on teaching and learning. *Annual Review of Psychology, 49*, 345-375.

Panasan, M., & Nuangchalerm, P. (2010). Learning outcomes of project-based and inquiry-based learning activities. *Journal of Social Sciences, 6*(2), 252-255.

Pektas, S. T., & Erkip, F. (2006). Attitudes of design students toward computer usage in design. *International Journal of Technology and Design Education, 16,* 79-95.

Pugsley, L. (2011). How to...Begin to get to grips with educational theory. *Education for Primary Care*, *22*(4), 266-268.

Rajendran, S., & Clarke, B. (2011). Building information modeling safety benefits & opportunities. *Professional Safety*, *56*(10), 44-51.

Reid, A., & Petocz, P. (2004). Learning domains and the process of creativity. *The Australian Educational Researcher, 31*(2), 45-62.

Reinard, J. C. (2006). *Communication research statistics*. Thousand Oaks, CA: Sage Publications, Inc.

Rutland, M., & Barlex, D. (2008). Perspectives on pupil creativity in design and technology in the lower secondary curriculum in England. *International Journal of Technology & Design Education, 18*, 139-165.

Sass, E. J. (1989). Motivation in the college classroom: What students tell us. *Teaching of Psychology, 16*(2), 86-88.

Savery, J. R., & Duffy, T. M. (1995). Problem based learning: An instructional model and its constructivist framework. *Educational Technology, 35*(5), 31-38.

Slavin, R. E. (1987). Ability grouping and student achievement in elementary schools: A best-evidence synthesis. *Review of Educational Research, 57*(3), 293-336.

Sharan, S., & Sharan, Y. (1976). *Small group teaching.* Englewood Cliffs, NJ: Educational Technology Publications.

Sharan, Y., & Sharan, S. (1992). *Expanding cooperative learning through group investigation.* New York: Columbia University.

Shaw, D. (2011). Promoting professional student learning through study groups: A case study. *College Teaching*, *59*(2), 85-92.

Shepard, L. A. (2000). The role of assessment in a learning culture. *Educational Researcher*, *29*(7), 4-14.

Sherfield, R. M., Montgomery, R. J., & Moody, P. G. (2005). *Cornerstone: Building on your best.* Upper Saddle River, NJ: Pearson Prentice Hall.

Sullivan, E. J. (1987). Critical thinking, creativity, clinical performance, and achievement in RN students. *Nurse Educator, 12*(2), 12-16.

Sultan, W. H., Woods, P. C., & Koo, A. C. (2011). A constructivist approach for digital learning: Malaysian schools case study. *Educational Technology & Society, 14* (4), 149–163.

Taraban, R., Rynearson. K., & Kerr, M. (2000). College student academic performance and self-reports of comprehension strategy use. *Reading Psychology, 21,* 283-308.

Taylor, P. C., & Fraser, B. J. (1991, April). Development of an instrument for assessing constructivist learning environments. In annual meeting of the American Educational Research association, New Orleans, LA.

Trytten, D. A., 2001. Progressing from small group work to cooperative learning: A case study from computer science. *Journal of Engineering Education,* 90(1), 85-91.

Tucker, R., & Morris, G. (2012). By design: Negotiating flexible learning in the built environment discipline. *Research in Learning Technology*, *20,* 1-16.

Van Merriënboer, J. J., & Sweller, J. (2005). Cognitive load theory and complex learning: Recent developments and future directions. *Educational Psychology Review, 17*(2), 147-177.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Vygotsky, L. S. (1986). *Thought and language.* Cambridge, MA: MIT Press.

Wallick, K. & Zaretsky, M. (2010). Fragmentation and interrogation as an approach to integration. *International Journal of Art & Design Education, 29*(3), 303-312.

Wenger, E. (1998). Communities of practice: Learning as a social system. *Systems Thinker*, *9*(5), 2-3.

Williams, R., Ari, O., & Santamaria, C. (2011). Measuring college students' reading comprehension ability using cloze tests. *Journal of Research in Reading*, *34*(2), 215-231.

Zemke R., Zemke, S. (1988). 30 things we know for sure about adult learning. *Training*. 57–61.

Appendix A – In-Class Announcement

"As a part of the research for my dissertation, I am conducting a teaching study. Volunteers will be separated into two groups who will meet twice for about 2 hours each session and will be provided dinner. You all will be drafting the same model in Revit, but each group will learn to use Revit in a different manner. There are five sets of dates available, so if you are interested, you will be able to request certain days to participate that will be convenient for you. The models you draw and the data will be anonymous, so you don't have to worry about your names being attached to any published information."

[Sign-up sheets were distributed to all students]

"If you are not interested in participating, simply hand your blank form back to me. If you aren't sure and have questions, please email me or talk to me in person – I'll be happy to answer any questions."

Appendix B - Informed Consent Form

Title of Study: Impact of Learning Theory Methods on Undergraduate's Retention and Application of Software in a Studio Setting

Principal investigator: Julie L. Gomboc-Turyan, M.A.

You have been invited to participate in a research study that will compare two different methods of teaching the same material. Two groups will be formed from the pool of students volunteering for this study. Each group will meet for two separate learning sessions, and dinner will be provided to all students after every session.

You will first complete a short demographic survey containing information about your age, GPA, prior experience with software, and academic history. Once you arrive to the learning site for the first session, the first step will be to draw an electronic model using Autodesk Revit. You will have help completing this drawing in the form of either a step-by-step tutorial or a beginning demonstration of the software, depending on the group you have been assigned to. After you have drawn the model, I will give you a short survey to complete where you will tell me about your learning experience. This first meeting will last no more than two hours.

Two weeks later, you will return and draw the same model that you completed in the first meeting, only this time you will not be given the step-by-step tutorial or the beginning demonstration. After you have drawn the second model, I will give you a short survey to complete where you will tell me about your learning experience. The second meeting will last no more than two hours.

In conducting this research I am very careful to safeguard your personal information. As soon as you volunteer, a number is assigned to your name, and the original demographic survey is destroyed. Your name is only kept on record in a single electronic file until the learning sessions are complete, and then will be removed completely from the study, even before the post-session survey results are reviewed. Your participation in this study is voluntary. You can withdraw your consent and discontinue your participation in the project at any time by calling or emailing me (the principal investigator) using the contact information below. If you wish to discontinue participation during one of the sessions, you can do so by simply telling the principal investigator in person, and you will be free to leave at your discretion. If you have any questions or concerns, contact either myself or my faculty sponsor:

Principal Investigator:

Julie L. Gomboc-Turyan, M.A.

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Dr. Mark Piwinsky

Chairperson, Department of Communications Media
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PHONE (724) 357-7730

Appendix C – Volunteer Sign-Up Sheet

Name	
Imail Address	
Preferred Dates **(Check all that you are available for)**	☐ Sunday, April 15 & Sunday, April 29 from 5-7pm ☐ Tuesday, April 17 & Tuesday, May 1 from 5-7pm ☐ Thursday, April 19 & Thursday, May 3 from 6-8pm ☐ Friday, April 20 & Friday, May 4 from 5-7pm ☐ Saturday, April 21 & Saturday, May 5 from 4-6pm

Appendix D – Voluntary Consent Form

I have read and understand the information on the Informed Consent form and I consent to volunteer to be a subject in this study. I understand that my personal information is completely confidential and that I have the right to withdraw at any time. I have received a copy of the Informed Consent form to keep in my possession. I understand and agree to the conditions of this study as described.

Name: **(PLEASE PRINT)** ____

Signature ____

Date ____

Phone Number _____________________________

Email Address ____

I certify that I have explained to the above individual the nature and purpose, the potential benefits, and possible risks associated with participating in this research study, have answered any questions that have been raised, and have witnessed the above signature.

_______________ ____

Date Investigator's Signature

THIS PROJECT HAS BEEN APPROVED BY THE INDIANA UNIVERSITY OF PENNSYLVANIA INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS.
PHONE (724) 357-7730

Appendix E – Pre-Session Demographic Survey

1. **What is your age?** _____________

2. **What is your gender? Please circle one.** Male Female

3. **What is your current GPA? Please circle one.**
   a. 0.0 – 0.49
   b. 0.5 – 0.99
   c. 1.0-1.49
   d. 1.5 - 1.99
   e. 2.0 – 2.49
   f. 2.5 – 2.99
   g. 3.0 – 3.49
   h. 3.5 – 4.0
   i. I don't know

4. **What year of school are you currently in?**
   a. Freshman – Year One
   b. Sophomore – Year Two
   c. Junior – Year Three
   d. Senior – Year Four

5. **How many INDS have you taken prior to this study?**

   Please check all that you have completed and are currently enrolled in:

   - ☐ INDS 105 – Intro to Interior Design
   - ☐ INDS 118 – Drafting for Construction I
   - ☐ INDS 205 – Color Theory and Application
   - ☐ INDS 218 – Drafting for Construction II
   - ☐ INDS 230 – Presentation for Interior Design
   - ☐ INDS 240 – 3-D Design for Interior Design
   - ☐ INDS 305 – Interior Lighting
   - ☐ INDS 310 – Human Factors in Interior Design
   - ☐ INDS 313 – Materials & Finishes
   - ☐ INDS 315 – Residential Design I
   - ☐ INDS 319 – Residential Design II: Kitchen & Bath
   - ☐ INDS 370 – Development of Design I

☐ INDS 380 – Development of Design II

☐ INDS 405 – Professional Practice

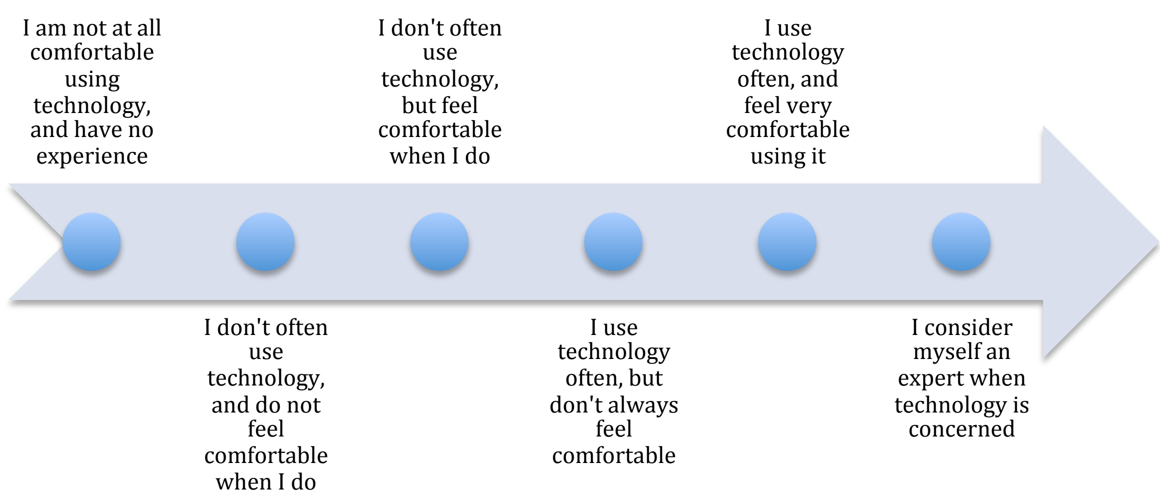
☐ INDS 464 – Contract Design I

☐ INDS 465 – Contract Design II

6. **Please describe your academic history by circling the letter of one of the following options that best describes you.**
    a. I have been an Interior Design major since I began taking classes at IUP.
    b. I changed my major to Interior Design from another major at IUP.
    c. I transferred to IUP from another school where I was an Interior Design major.
    d. I transferred to IUP from another school where I was not an Interior Design major.
    e. Other (please describe)

    ____

7. **Please describe your comfort level with technology using the following scale. Place a checkmark in the corresponding circle or circle the appropriate description.**



8. How many courses have you taken that involved learning new software as part of the curriculum?

a. 0 – 2
b. 3 – 5
c. 6 – 10
d. 11 or more
e. I'm not sure.

9. How many courses have you completed that involved a studio-based classroom environment (including ART, COMM, THTR courses)?

a. 0 – 2
b. 3 – 5
c. 6 – 10
d. 11 or more
e. I'm not sure.

Appendix F – Step-by-Step Tutorial

Autodesk Revit Architecture – Beginner's Tutorial

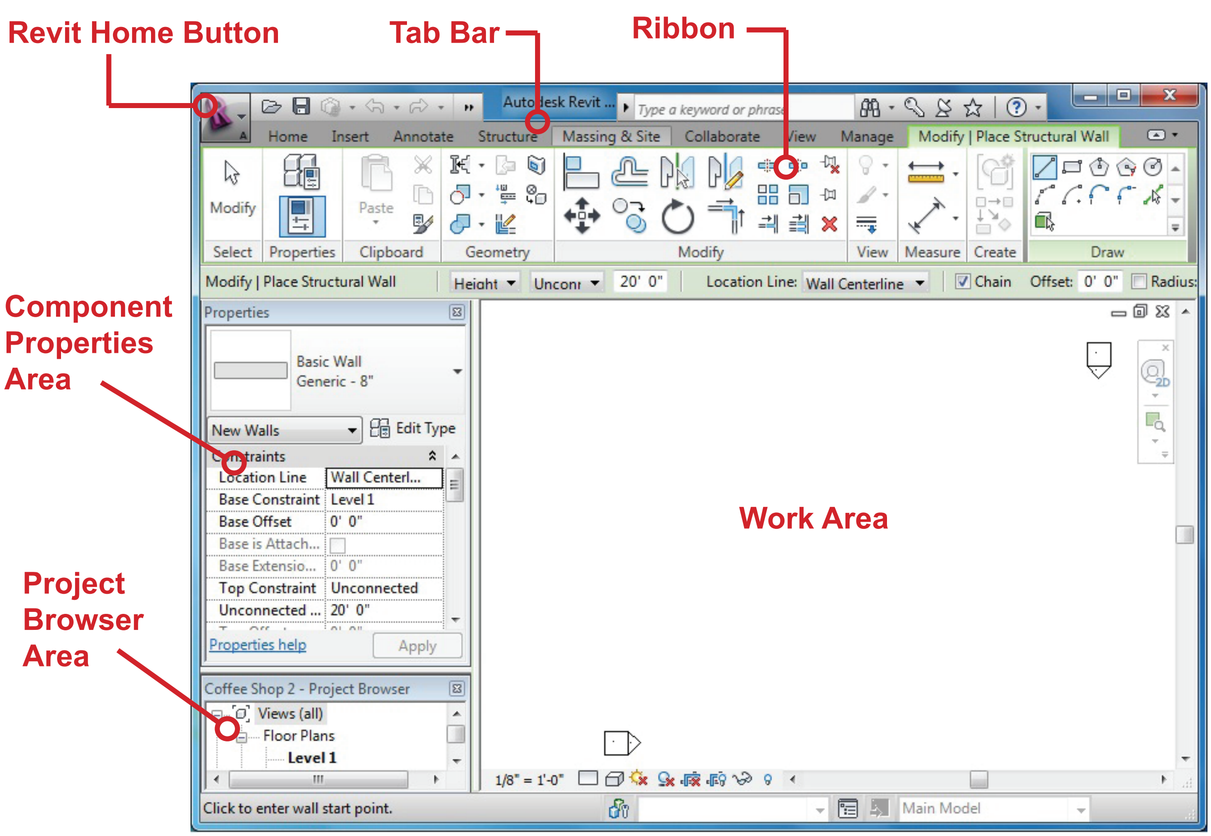
Creating a Basic Layout for a Coffee Shop or Cafe

Create A New Project

1. **Open** AutoDesk Revit Architecture from the program menu on your computer.

Introduction to the User Interface

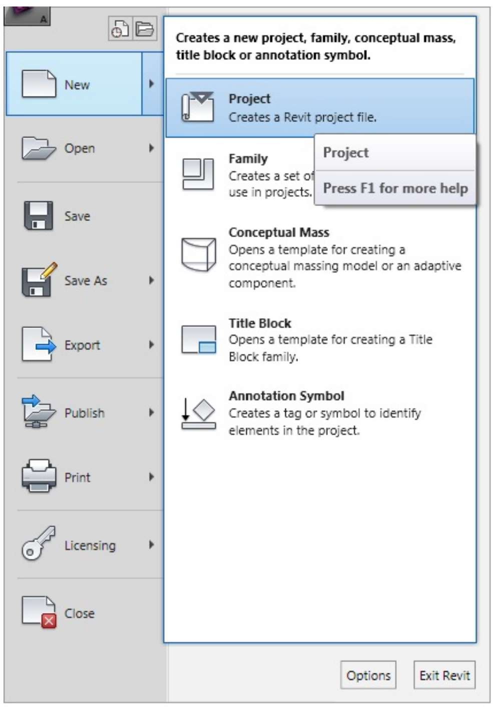
Below is a picture of the standard Revit Architecture user interface. Refer to this image when you need to review the areas of the workspace.



Note: Throughout this project you will need to zoom in and out of your drawing. Since everyone will want to use this tool in a different way, simply use the scrolling wheel on your mouse when you wish to zoom in or out. Scrolling the wheel north will zoom into your drawing area, and scrolling south will zoom out of your drawing area.**

Create A New Project

1. To create a new project, **click on the Revit Home button** at the top left of the toolbar, hover over the New button, and click Project on the extended menu.



2. In the *New Project* dialog box that appears, ensure that the *default template* is selected, and that the radio button beside *"Project"* is also selected.

3. **Click OK**.

Save Your Project

1. Save your new project immediately by **clicking on the Revit Home button** at the top left of the toolbar, **hovering over Save As**, and then **clicking on Project**.

2. In the *Save As dialog box* that appears, select Desktop as your destination, select your corresponding project folder, and name your project in the following fashion: *StudentID_Session#.*

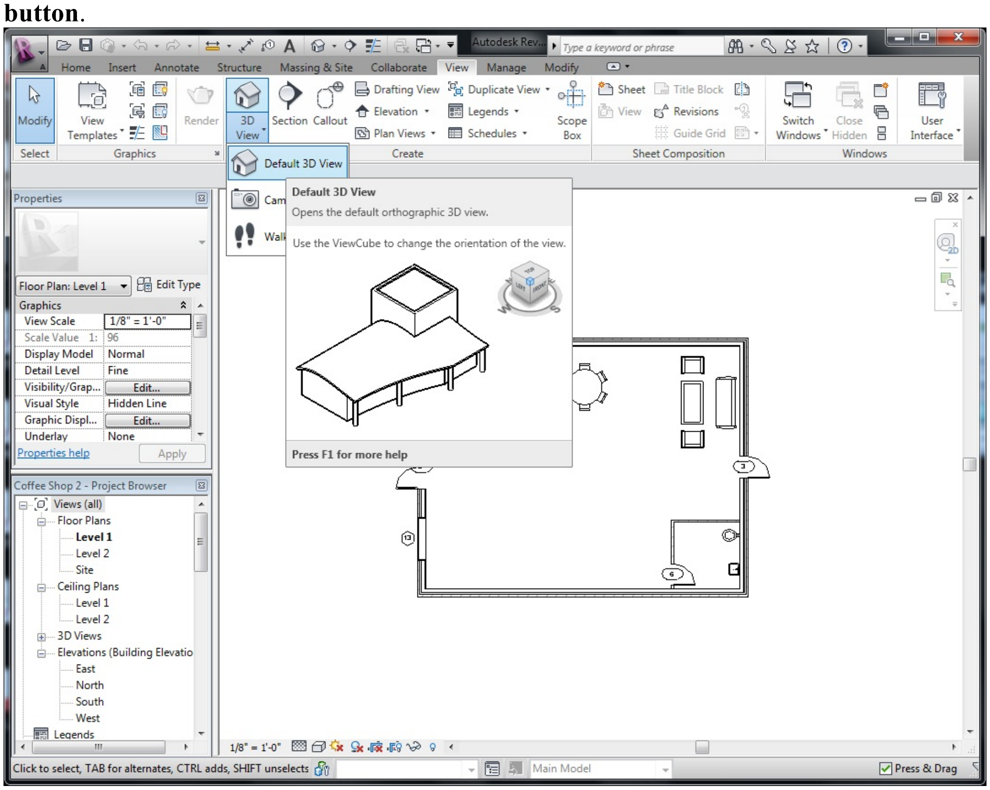
   So, if your student ID is *Crimson05*, and you are in the first of two sessions, you would name your project *Crimson05_Session1*.

3. **Click OK**.

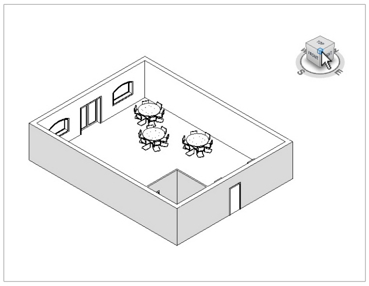
Using the View Cube in 3D Mode

Throughout the project, you can utilize the View Cube for 3D viewing of your model. This is not a required step of the tutorial, but can be valuable in reviewing the placement of objects and the progress of your drawing.

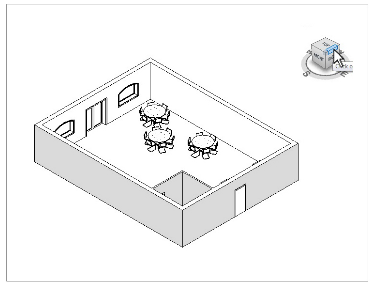
1. To view your project in 3D Mode, **click the View Tab**, and then **click the Default 3D View button**.



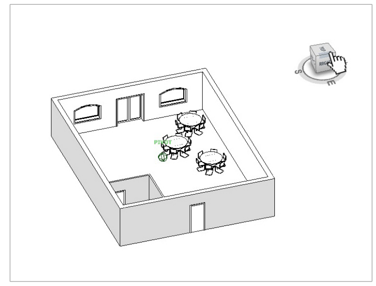
2. Your model will change to show a 3D view. The View Cube will appear at the top right of the screen, and you can click the corners, sides, top and bottom, and directional elements (North, South, East, West) to change the angle at which you are viewing the model. You can also grab the View Cube with your mouse pointer and turn or pivot the model in any direction. See below for examples of the View Cube selection areas.



View Top/Front Angle



View Top/Front Side



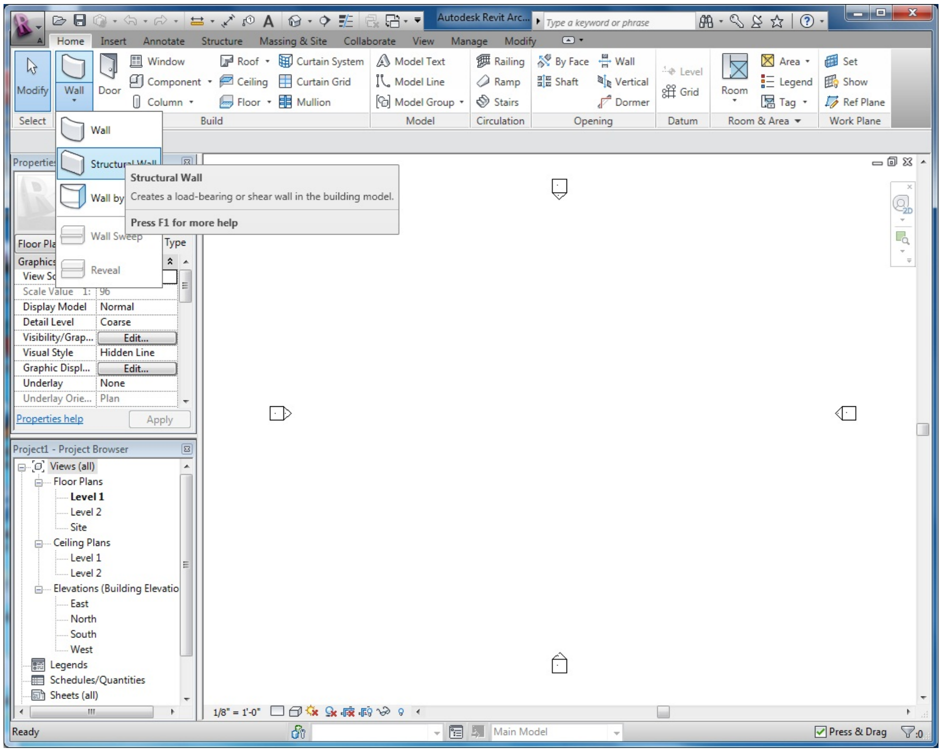
Grab and Pivot Model

3. Click on the *Floor Plan: Level 1* link in the Project Browser to return to standard Floor Plan editing mode.

Draw the Exterior Walls

Draw the exterior walls by following these steps:

1. **Select** the *Home tab*.
2. Click the arrow under the *Wall button* on the *Ribbon* (this will populate a drop-down menu).
3. Select *Structural Wall* from the drop-down menu.



4. In the *properties box*, **change the wall type** to ***Exterior – Brick and CMU on MTL. Stud***.

5. With the intent to draw the walls in a clockwise motion, click the cross-haired cursor in the lower right quadrant of the screen (see example below).

6. After you have clicked, a temporary wall will extend from your cursor and move wherever you move the mouse. From the spot where you clicked, move the mouse to the left, ensuring the wall is straight.

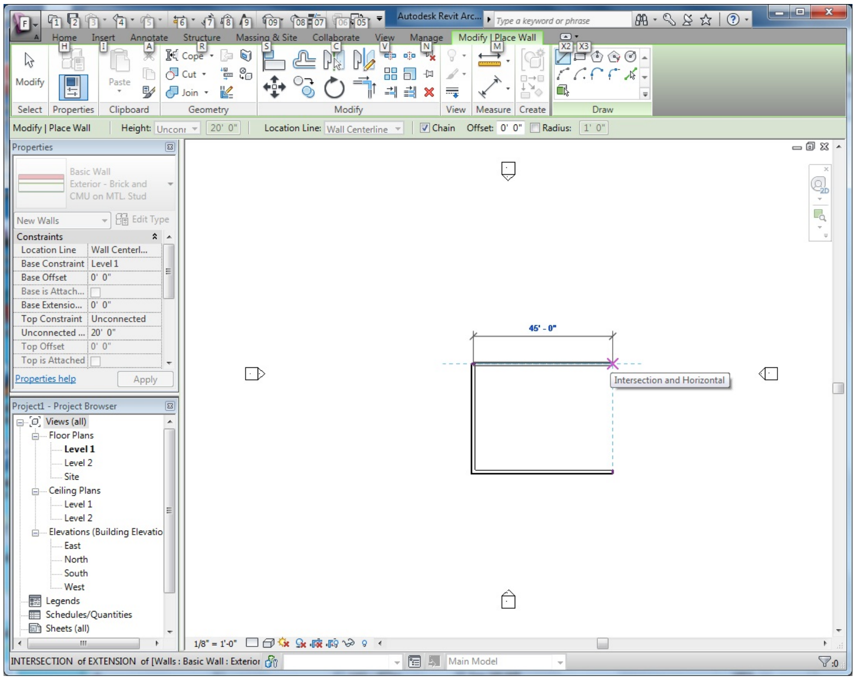
7. While the wall is still attached to your crosshairs, **type 45'** (the length entry field will automatically appear).

8. **Click Enter**.

9. From this point, move your cross-haired cursor north to begin a straight wall perpendicular to the last wall you created. In the same manner as in the last step, **type 35'**.

10. **Click Enter**.

11. Drag your cross-haired cursor to the right until it reaches the original point of the first wall and a blue line appears connecting the current wall and the original.



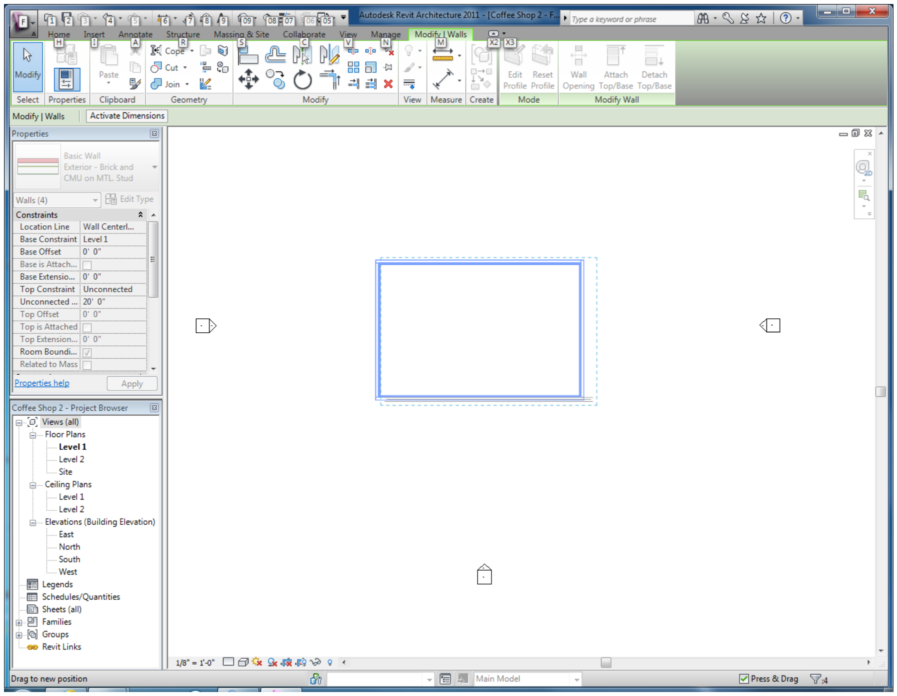
12. Click the mouse once to set the ending point for the third wall.

13. Drag your cross-haired cursor south until it touches the original wall and a purple box appears. Click the mouse one last time to connect the fourth wall to the first.

14. **Click the Esc button** on your keyboard **twice** (clicking it once will remove the drawing command from your crosshairs, however you will still be in drawing mode. Clicking a second time will remove you from drawing mode altogether).

Centering the Drawing

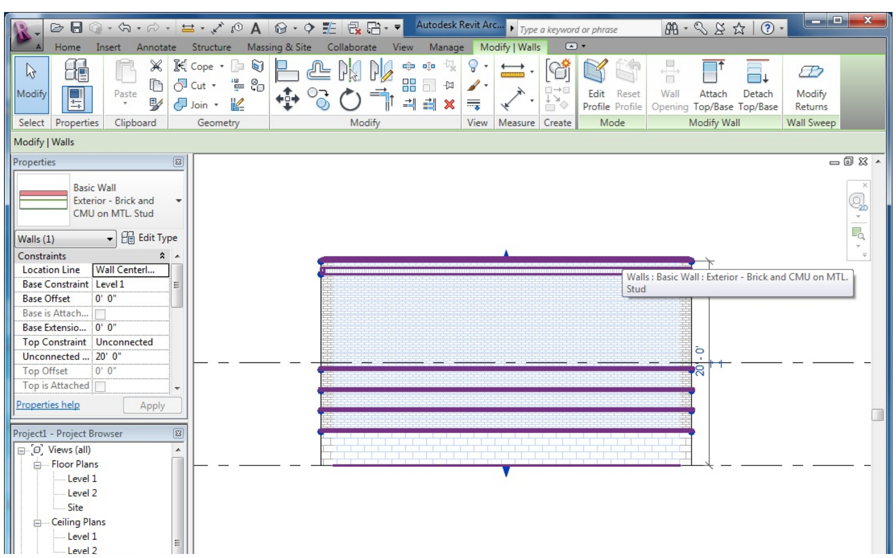
1. Drag room to middle of the work area by clicking and holding your mouse outside of the top left of your exterior walls and dragging to the right and down over the entire building. Release the mouse button and click one of the walls. Holding the mouse button, drag the building so that it is relatively centered between the elevation markers. (See example below - it does not have to be perfectly centered).



Change the Height of the Exterior Walls

1. In the project browser, **double-click the EAST elevation** found beneath the Elevations heading (this will change your work area from the top view of the layout to a view of the building as it would be seen from the east side of the site).

2. Drag the cursor to either of the top right side or bottom of the wall and **click once**, selecting the eastern-facing wall (see below).



3. Under the properties area for the wall (on the left-hand side of the page, above the project browser window, you will find a property item labeled *Top Constraint*. **Click in the area to the right of this property**, and when the drop-down menu appears, select *Up to level: Level 2*.

4. **Repeat steps 1-3** of this section for the remaining three elevation views – North, South, and West.

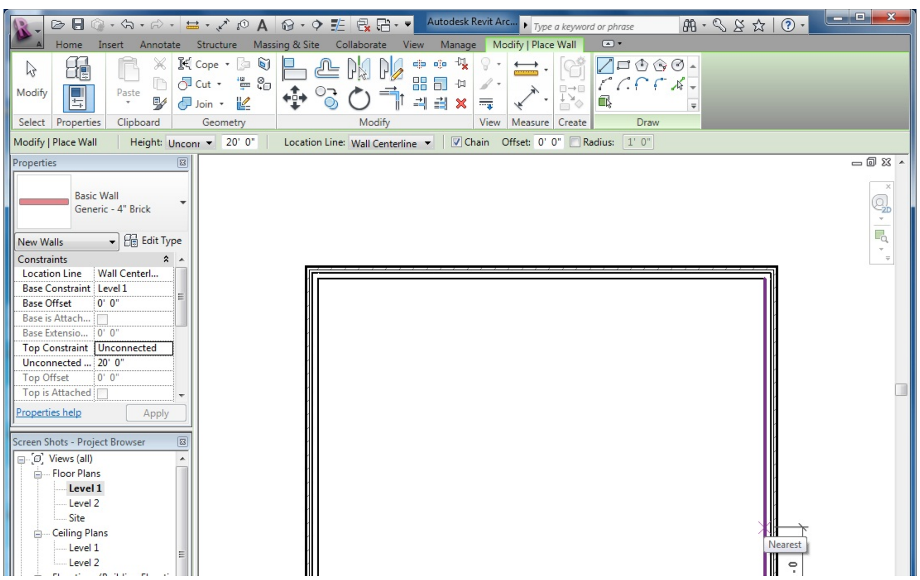
5. When all four walls have been adjusted for height, **double-click on Floor Plan Level 1** in the *Project Browser*.

Draw Interior Walls – Bathroom

1. On the top left of the ribbon, in the *Home tab*, **click the Wall button**.

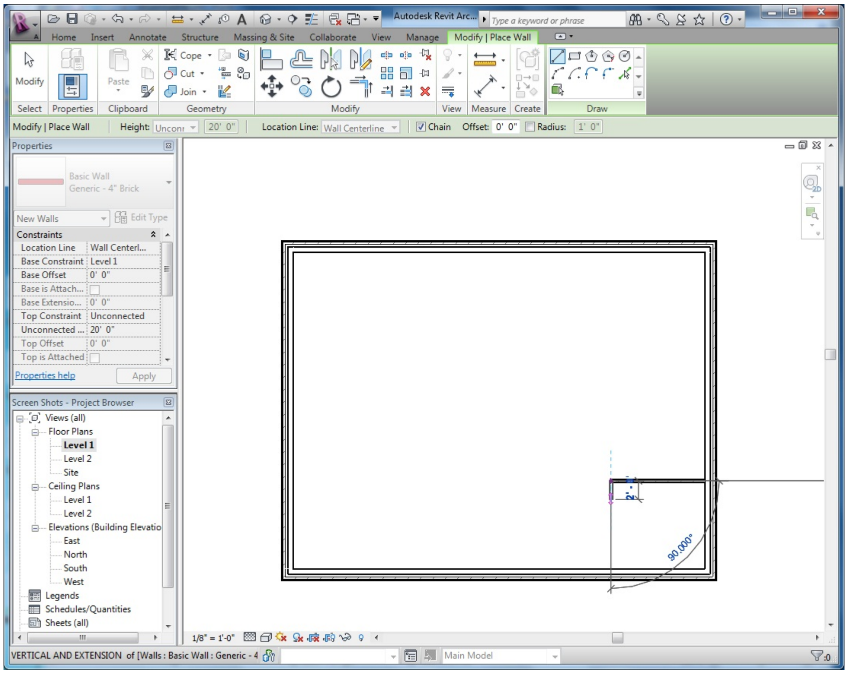
2. Under properties, **change the selection to Generic 4" Brick**.

3. With the crosshairs activated, move your cursor to the lower side of the right-hand wall, as seen below. **Click your mouse once** to attach the interior wall to the exterior.



4. Drag your cursor to left in a straight line and **type 10'**.

5. Drag cursor down until it meets the bottom wall and click the mouse. Your walls should be attached on both sides to the exterior of the building.



6. **Hit the Esc key twice**, as you did after you had finished drawing the exterior walls.

7. To insure that the bathroom is square, click on the north wall of the bathroom. You will see a measurement field appear on the left-hand wall, which designates the length of the wall. If it is not 10' in length, click in the measurement field and type 10' and hit the Enter key.

8. Double-check you work by clicking on the left-hand wall of the bathroom and insuring the width is also 10'. If it is not, repeat step 7 with the adjoining wall.

9. As you did for the exterior walls, you need to change the *Top Constraint* of the interior walls. Click one of the bathroom walls.

10. Under the properties area for the wall (on the left-hand side of the page, above the project browser window, you will find a property item labeled Top Constraint. **Click in the area to the right of this property**, and when the drop-down menu appears, select *Up to level: Level 2*.

11. Repeat steps 9 and 10 for the second bathroom wall.

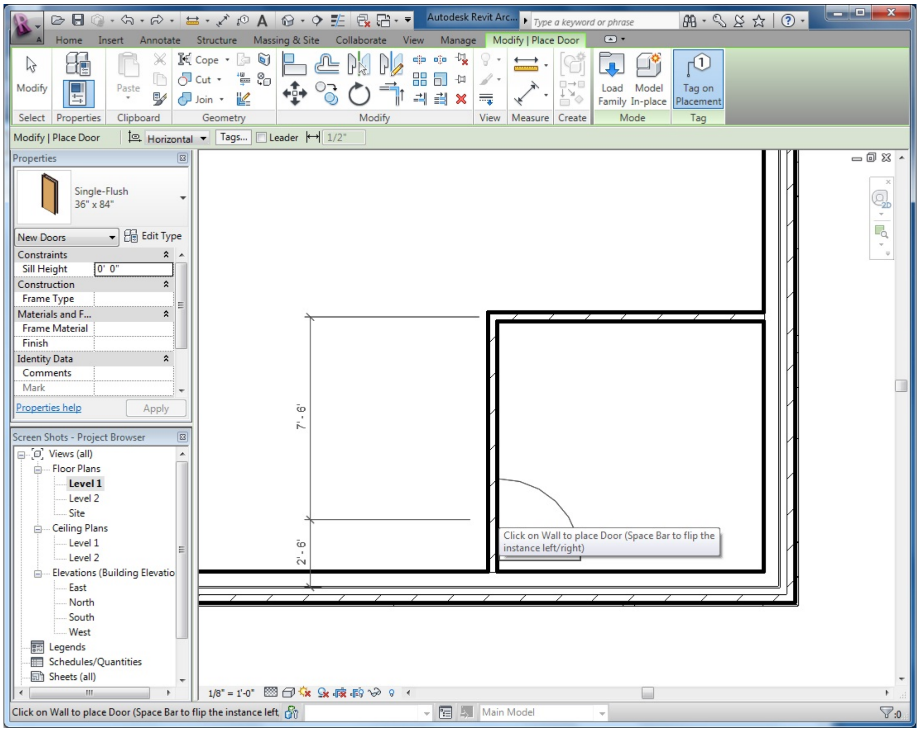
Creating the Bathroom Door

1. **Click the Home tab**.

2. **Click the Door button**.

3. Under the properties tab for the door**, select the correct door type** by clicking the type drop-down menu and selecting Single-Flush 36" x 84".

4. Move cursor so that the centerline of the door is 7'- 6" from the north wall of the bathroom. Ensure the door is opening to the inside of the bathroom.



5. **Click your mouse once**.

6. **Hit the Esc key**.

Inserting a Commode Fixture

1. **Click the Insert tab**.

2. **Click on Load Family** on the ribbon.

3. In the dialog box that appears, **double-click the Plumbing Fixtures folder**.

4. Select *Toilet-Commercial-Wall-3D*.

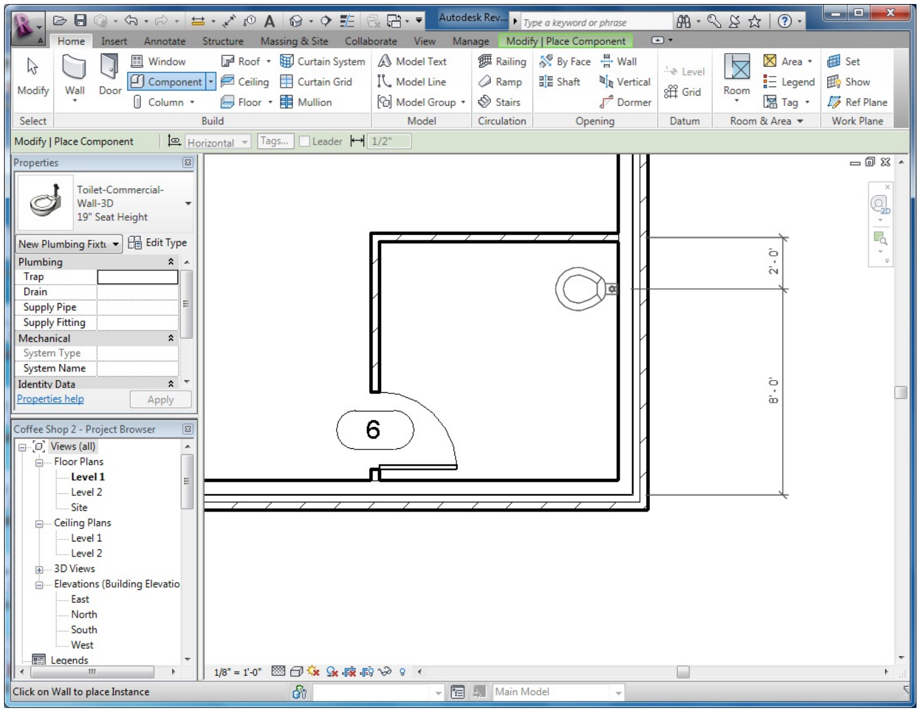
5. **Click Open**.

6. **Click the Home tab**.

7. **Click on the Component Button**.

8. In the Properties area, click the type drop-down and select the commode you have downloaded with a height of 19”.

9. Place your cursor on the left (East) wall of bathroom until the centerline is 2’ from the north wall of the bathroom.



10. **Click once** to place the commode.

11. **Hit the Esc key**.

Inserting a Sink Fixture

1. **Click the Insert tab**.

2. **Click on Load Family** on the ribbon.

3. In the dialog box that appears, **double-click the Plumbing Fixtures folder**.

4. Select *Vanity - Square*.

5. **Click Open**.

6. **Click the Home tab**.

7. **Click on the Component Button**.

8. In the Properties area, click the type drop-down and select the sink you downloaded.

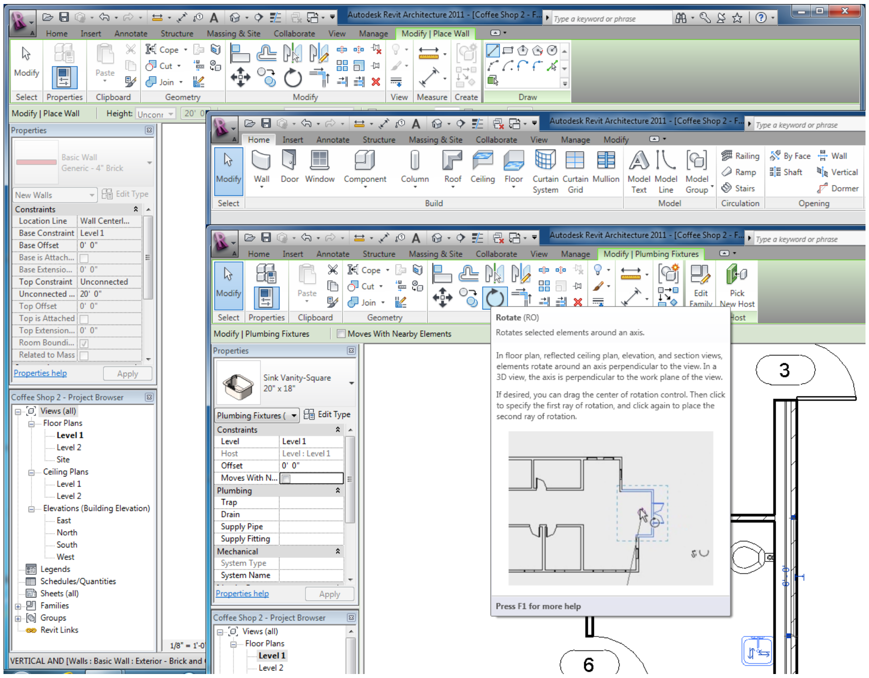
9. Place your cursor on the right (East) wall of bathroom until the centerline is 6' from the north wall of the bathroom.

10. **Click once** to place the sink.

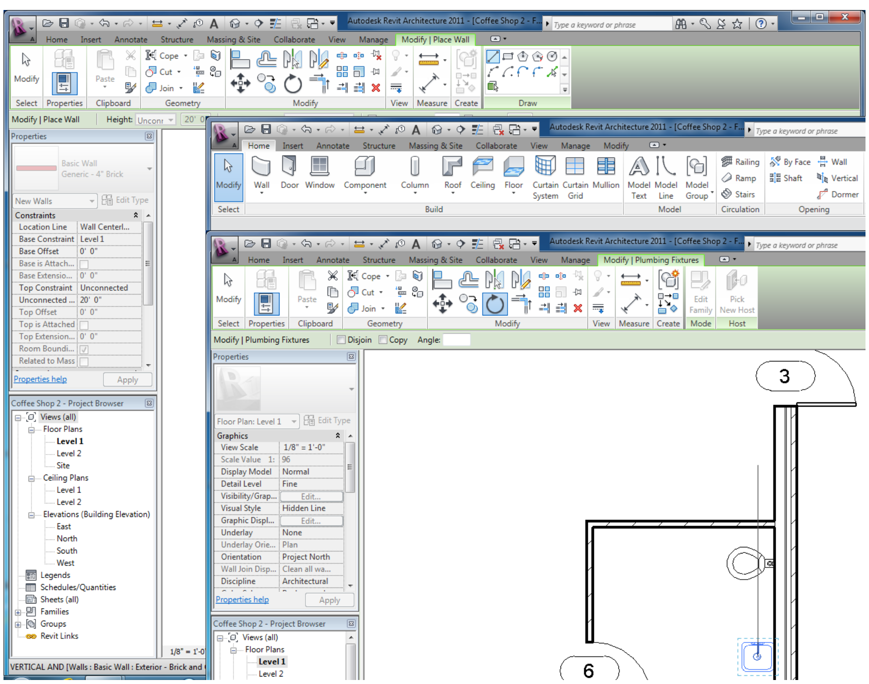
11. **Hit the Esc key twice**.

12. You will notice the sink is not facing the proper direction. You need to rotate the component. Click on the Modify button in the Ribbon so that you have a standard cursor. Click once on the sink.

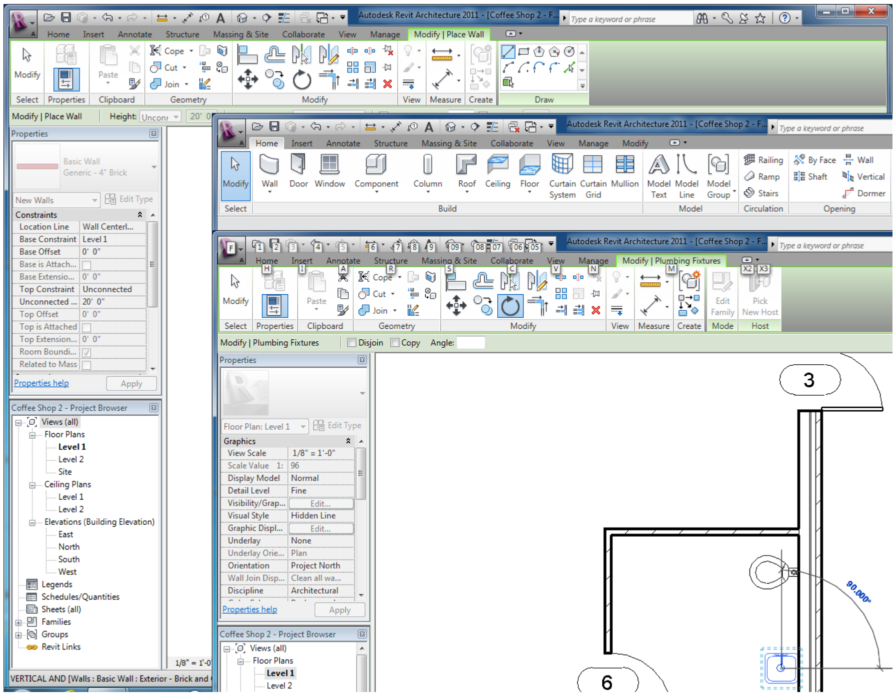
13. In the Ribbon, **click the Rotate Tool** (see below).



14. Place your cursor above the sink until a vertical line appears (see below).



15. Click the mouse button and drag your mouse in a clockwise circle to change the angle of the sink.



16. With the angle at 90 degrees, click again.

17. **Hit the Esc key twice**.

18. Select the sink, and move it so that it is flush with the back wall of the bathroom.

Creating the Main Entrance

1. **Click the Insert tab**.

2. **Click on Load Family** on the ribbon.

3. In the dialog box that appears, **double-click the Doors folder**.

4. Select the door labeled *Double-Glass 1*.

5. **Click Open**.

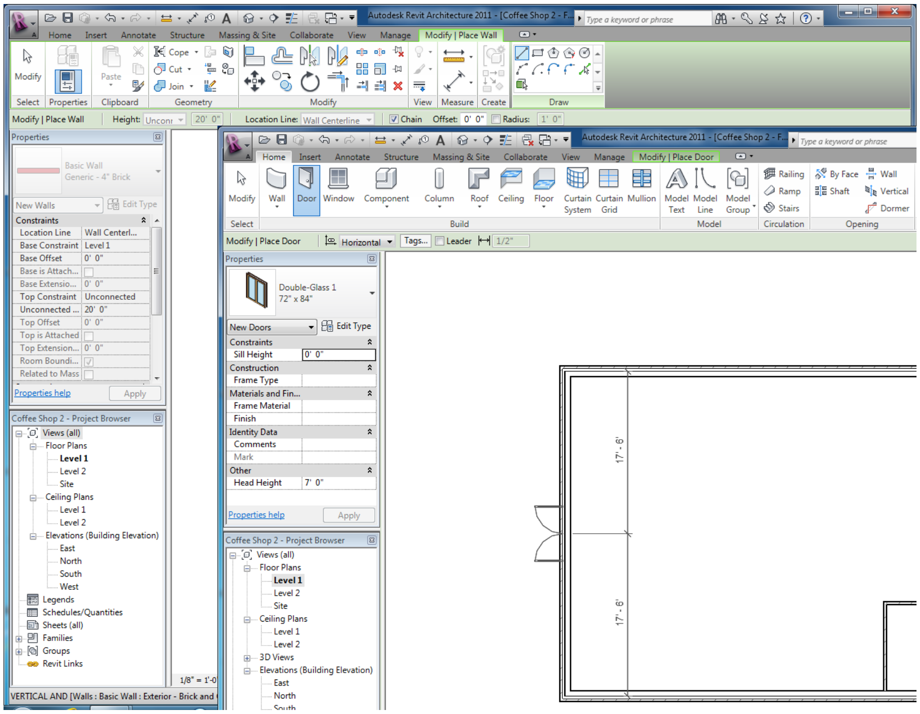
6. **Click on the Door Button** in the ribbon.

7. In the Properties area, click the type drop-down and select the door that you downloaded. Specifically, select the 72” x 84” version of the double door.

8. Place your cursor on the left (West) wall. A temporary sketch of the door should appear.

9. Position the cursor on the outside of the wall and in a position that has an even distance above and below the door’s centerline, as well as showing the doors opening outward. In this case,

you should see an even distance of 17’- 6” on both sides of the door.



10. When you have reached this point, and the door is in alignment, click your mouse to place the door.

11. **Hit the Esc key twice**.

Creating the Emergency Exit Door

1. **Click the Home tab**.

2. **Click the Door button**.

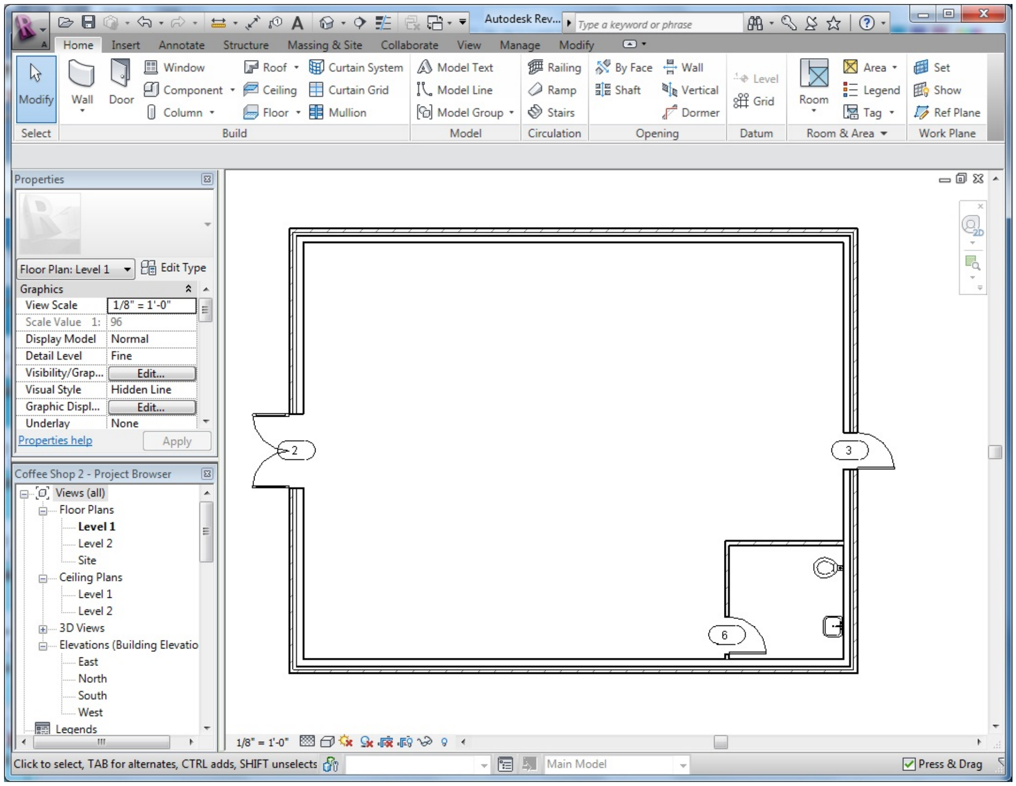
3. Under the properties tab for the door, select the correct door type by clicking the type drop-down menu and selecting Single-Flush 36” x 84”.

4. Move cursor to the back wall of the building, so that the centerline of the door is 17’- 6” from the north wall of the bathroom. Ensure the door is opening to the outside of the building.

5. **Click once** to place the door.

6. **Hit the Esc key twice**.

7. At this point, your drawing should closely resemble the one below.



Creating the Front Exterior Windows

1. **Click the Insert tab**.

2. **Click on Load Family** on the ribbon.

3. In the dialog box that appears, **double-click the Windows folder**.

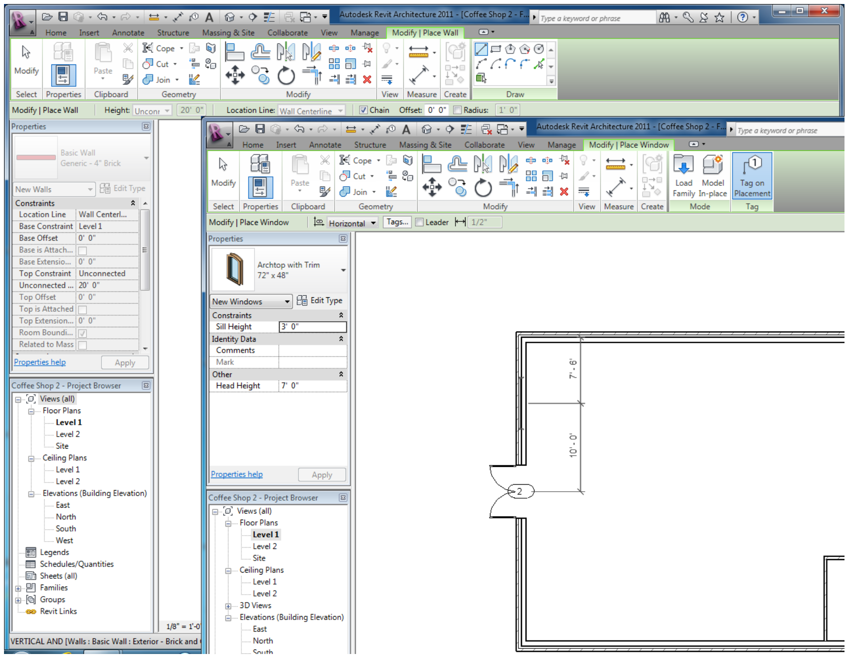
4. Select the window labeled *Archtop with Trim*.

5. **Click Open**.

6. **Click on the Window button in the ribbon**.

7. In the Properties area, click the type drop-down and select the window that you downloaded. Specifically, select the 72” x 48” version of the Archtop with Trim window.

8. Position your cursor on the front wall of the building so that it is between the main entrance door and the north wall of building.



9. When you have the window positioned 7' - 6" from the top of the building, click once to place the window. DO NOT HIT THE ESC KEY.

10. With the Window tool still selected, place a second window 7' - 6" from the south wall of the building.

11. **Hit the Esc key twice**.

Placing Tables

1. **Click the Insert tab**.

2. **Click on Load Family** on the ribbon.

3. In the dialog box that appears, **double-click the Furniture folder**.

4. Select *Table-Dining Round w Chairs*.

5. **Click Open**.

6. **Click the Home tab**.

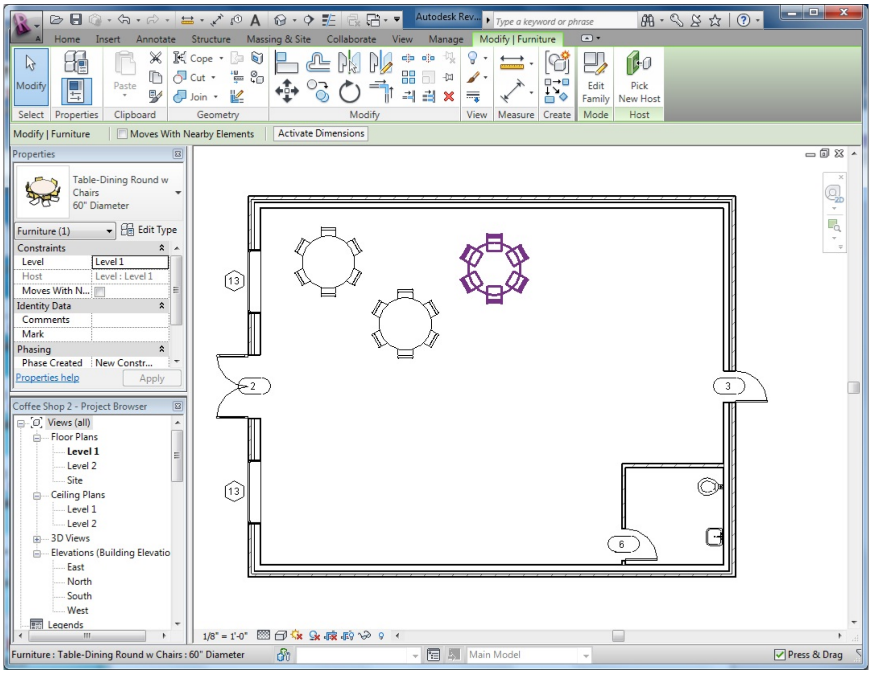
7. **Click on the Component Button**.

8. In the Properties area, click the type drop-down and select the table you downloaded – you will have three size options – choose 60".

9. Place your cursor in the upper left area of the open space within the building, and place three tables. You can simply click once, move your mouse, and click again. After you have placed

the tables, **hit the Esc key twice**.

10. Click the Modify button in the Ribbon, and move the tables around to resemble the image below.



Placing the Sofa

1. **Click the Insert tab**.

2. **Click on Load Family** on the ribbon.

3. In the dialog box that appears, **double-click the Furniture folder**.

4. Select *Sofa-Pensi*.

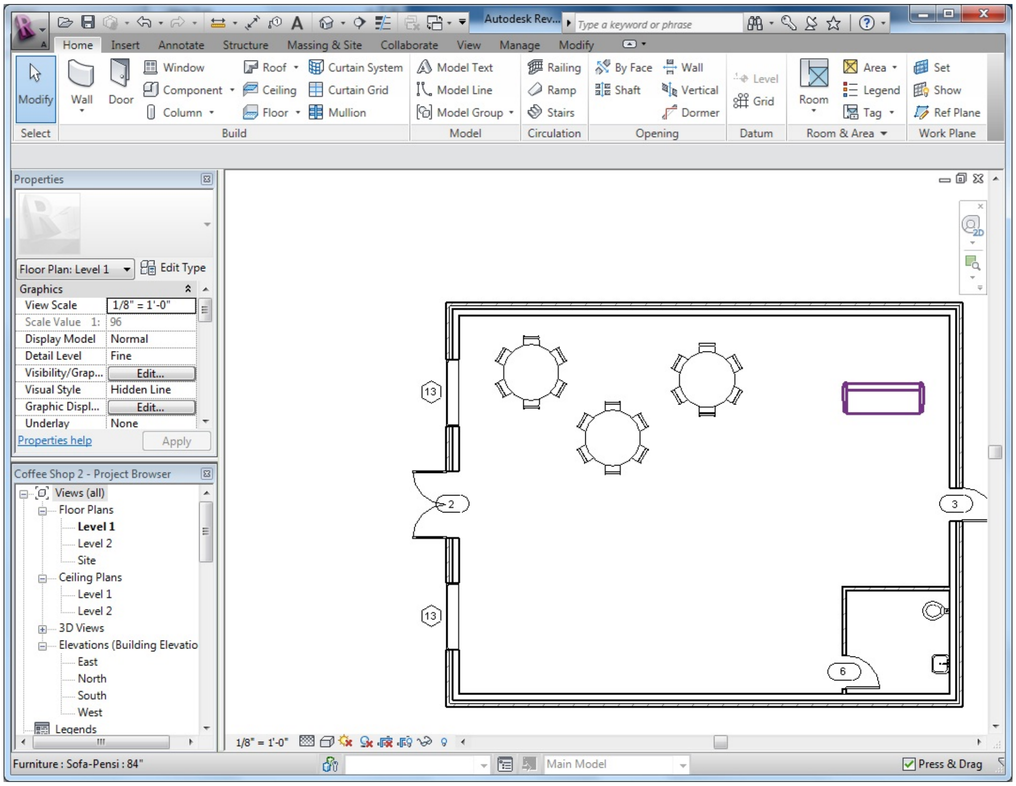
5. **Click Open**.

6. **Click the Home tab**.

7. **Click on the Component Button**.

8. In the Properties area, click the type drop-down and select the sofa you downloaded – you will have two size options – choose 84".

9. Place your cursor in the upper right area of the open space within the building, and place a sofa by clicking once (see below).



10. **Click Esc twice**.

11. You will need to rotate the sofa 90 degrees much like you did with the vanity sink in the bathroom.

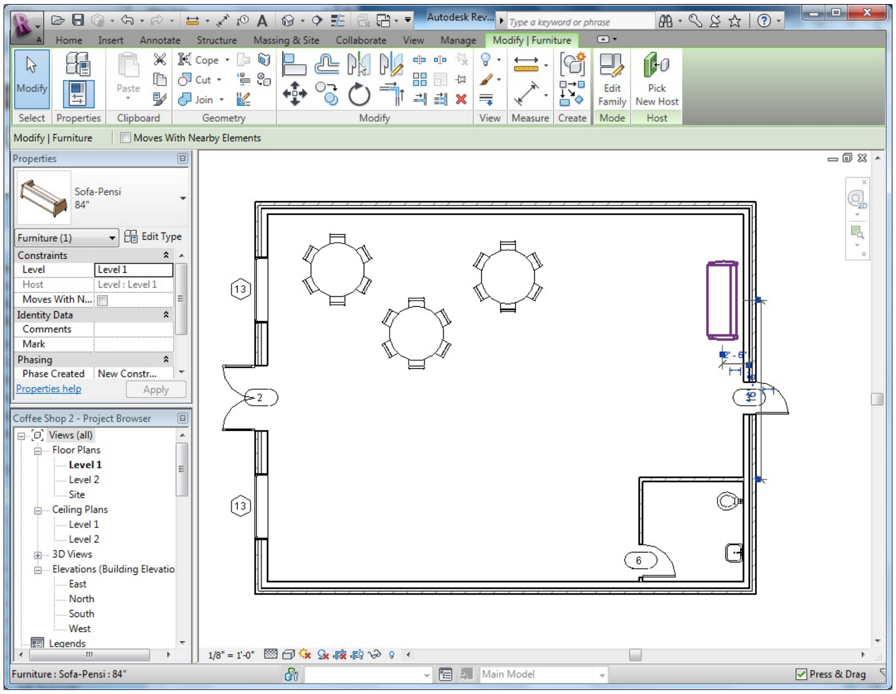
12. Place your cursor above the sofa until a vertical line appears.

13. Click the mouse button and drag your mouse in a clockwise circle to change the angle of the sofa.

14. With the angle at 90 degrees, click again.

15. **Hit the Esc key twice**.

16. Select the sofa, and move it so that it is close to the east wall (see image below).



Placing the Coffee Table

1. **Click the Insert tab**.

2. **Click on Load Family** on the ribbon.

3. In the dialog box that appears, **double-click the Furniture folder**.

4. Select *Table-Coffee*.

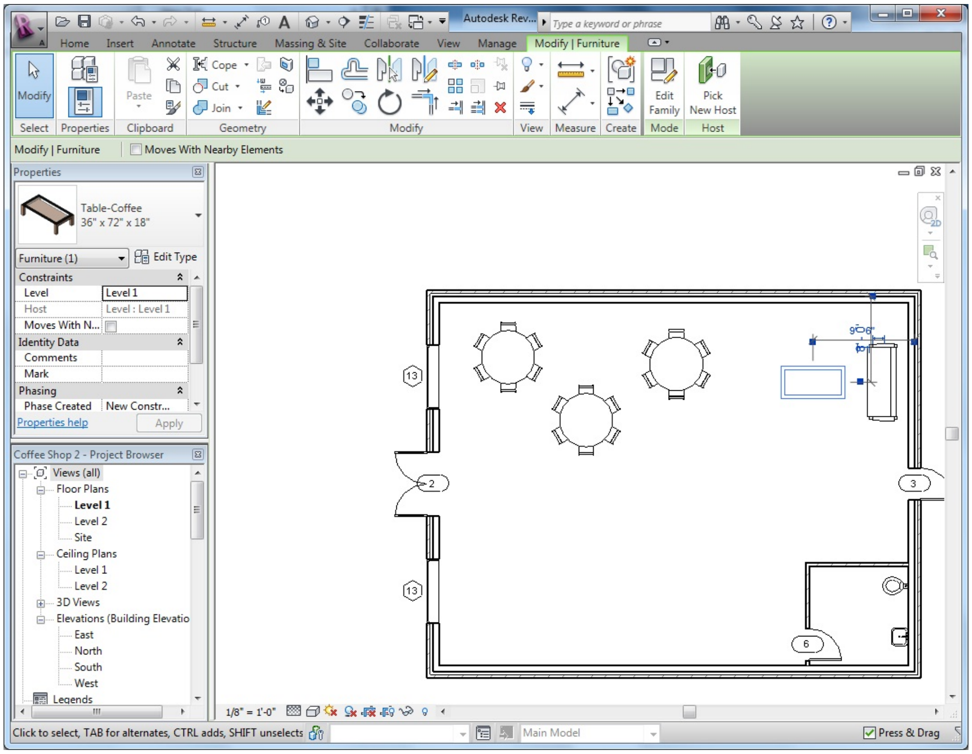
5. **Click Open**.

6. **Click the Home tab**.

7. **Click on the Component Button**.

8. In the Properties area, click the type drop-down and select the table you downloaded – you will have three size options – choose 36” x 72” x 18”.

9. Place your cursor in the upper right area of the open space within the building, and place a table by clicking once.



10. **Hit the Esc key twice**.

11. You will need to rotate the table 90 degrees.

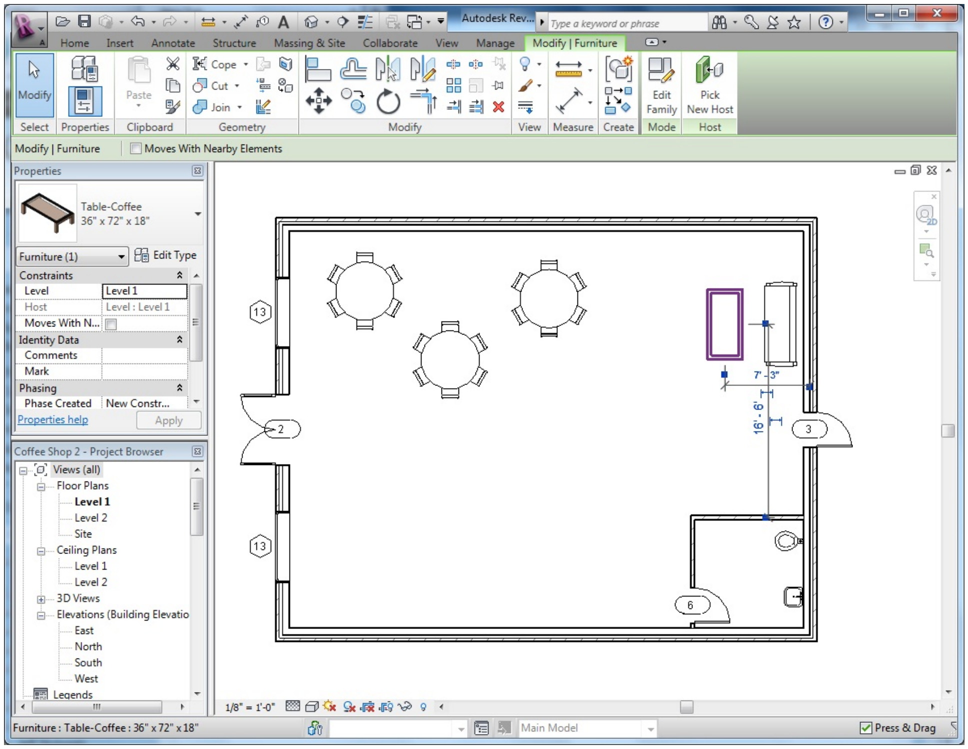
12. Place your cursor above the table until a vertical line appears.

13. Click the mouse button and drag your mouse in a clockwise circle to change the angle of the table.

14. With the angle at 90 degrees, click again.

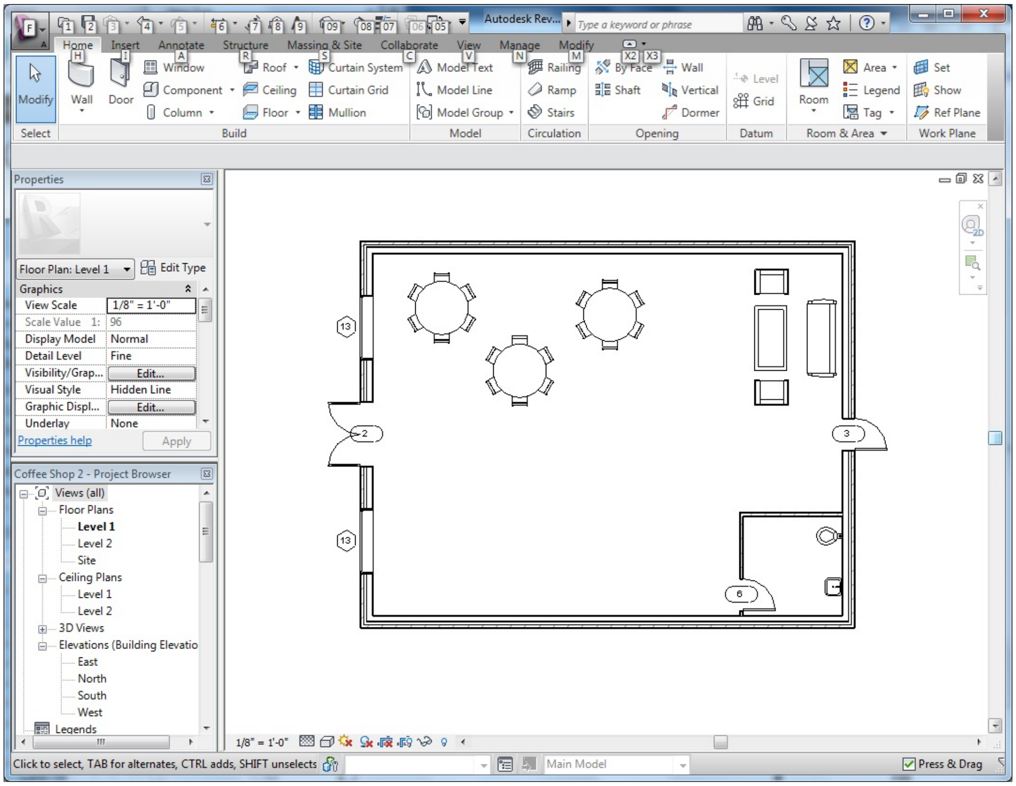
15. **Hit the Esc key twice**.

16. Click the Modify button in the Ribbon, select the table, and move it to the front of the sofa (see image below).



Placing the Lounge Chairs

1. **Click the Insert tab**.
2. **Click on Load Family** on the ribbon.
3. In the dialog box that appears, **double-click the Furniture folder**.
4. Select *Chair-Corbu*.
5. **Click Open**.
6. **Click the Home tab**.
7. **Click on the Component Button**.
8. In the Properties area, click the type drop-down and select the chair you downloaded.
9. Place your cursor in the upper right area of the open space within the building, and place two chairs.
10. **Hit the Esc key twice**.
11. Review the image below – this is the desired chair placement. You will have to move one of the chairs, and then rotate and move the other.



12. Click the Modify button in the ribbon, and select one chair. Move it above the coffee table.

13. Select the other chair.

14. Click on the Rotate tool in the ribbon.

15. Place your cursor above the other chair until a vertical line appears.

16. Click the mouse button and drag your mouse in a clockwise circle to change the angle of the chair.

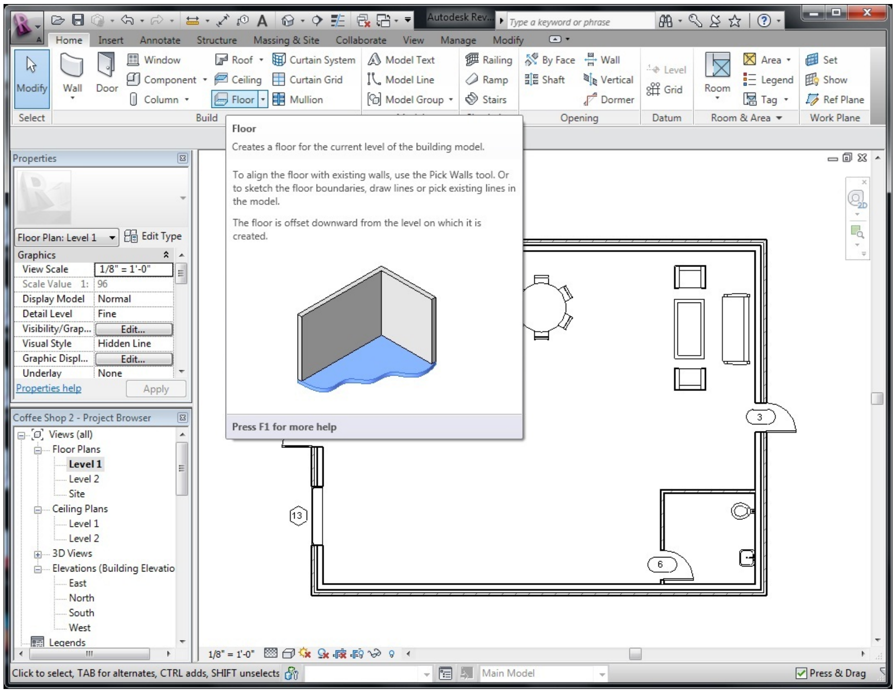
17. With the angle at 180 degrees, click again.

18. **Hit the Esc key twice**.

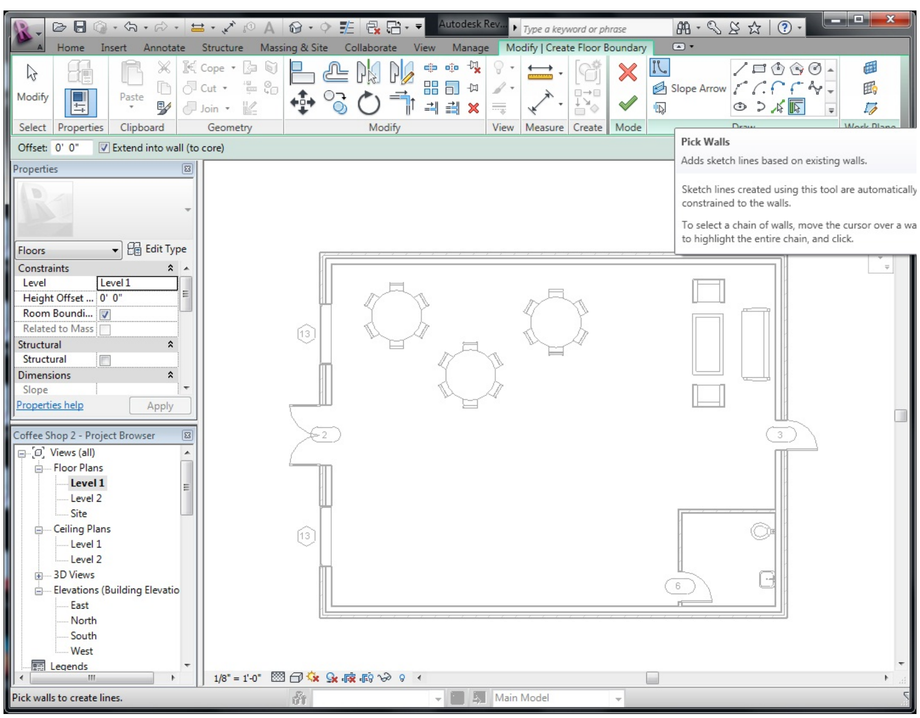
19. **Click the Modify button**, select the chair, and move it below the coffee table.

Creating the Hardwood Floor

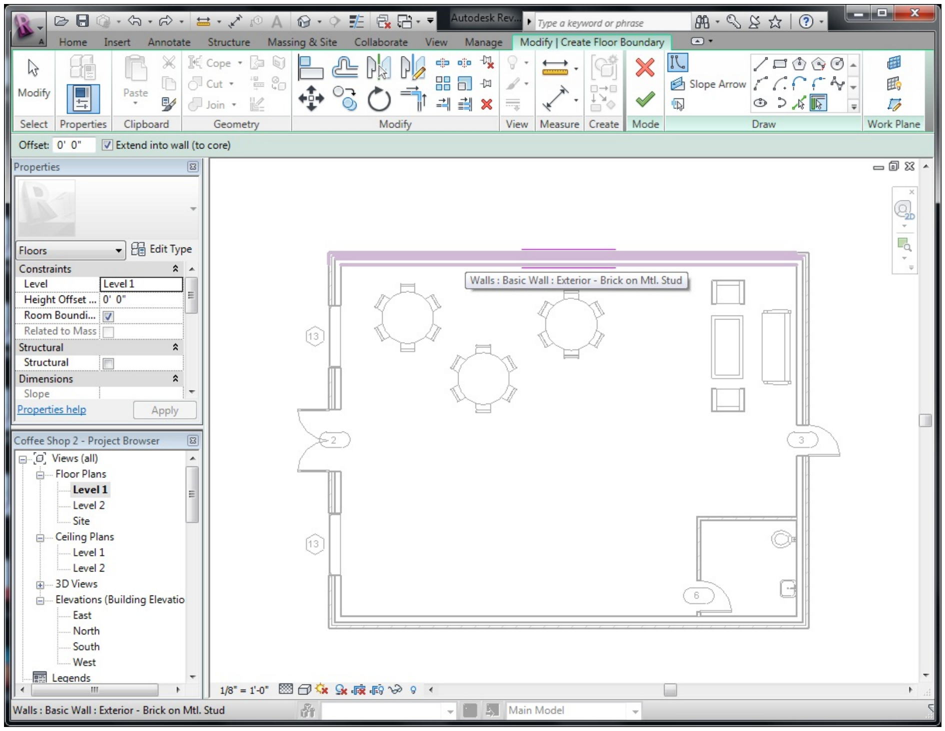
1. **Click the Floor button on the Home tab.**



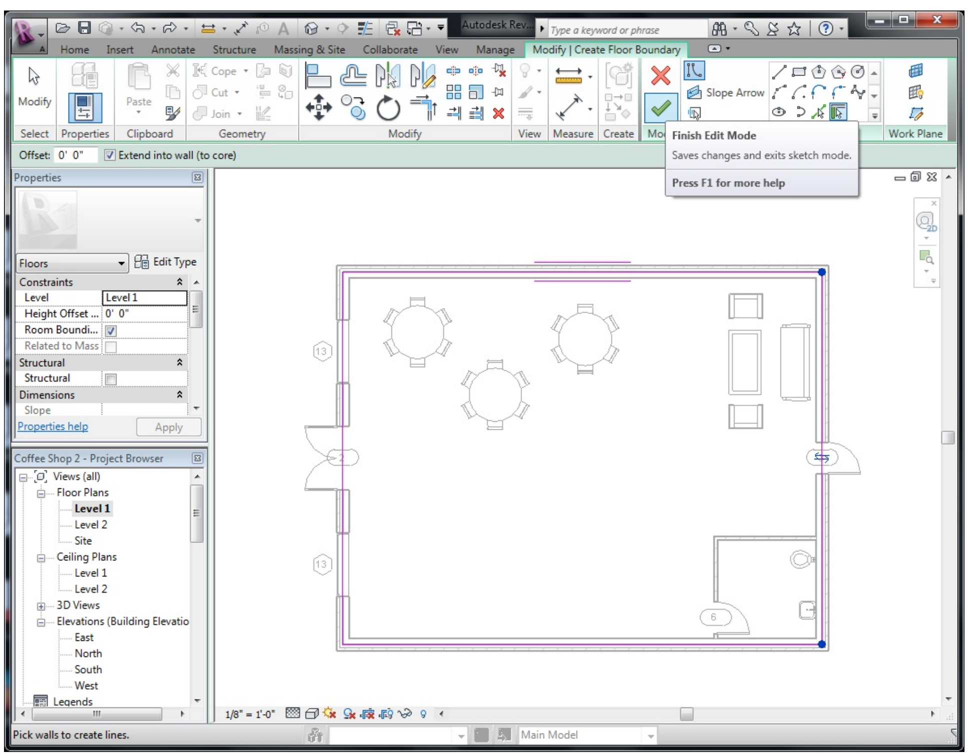
2. In the Draw Panel of the *Modify|Create Floor Boundary Tab*, **select the Pick Walls button**.



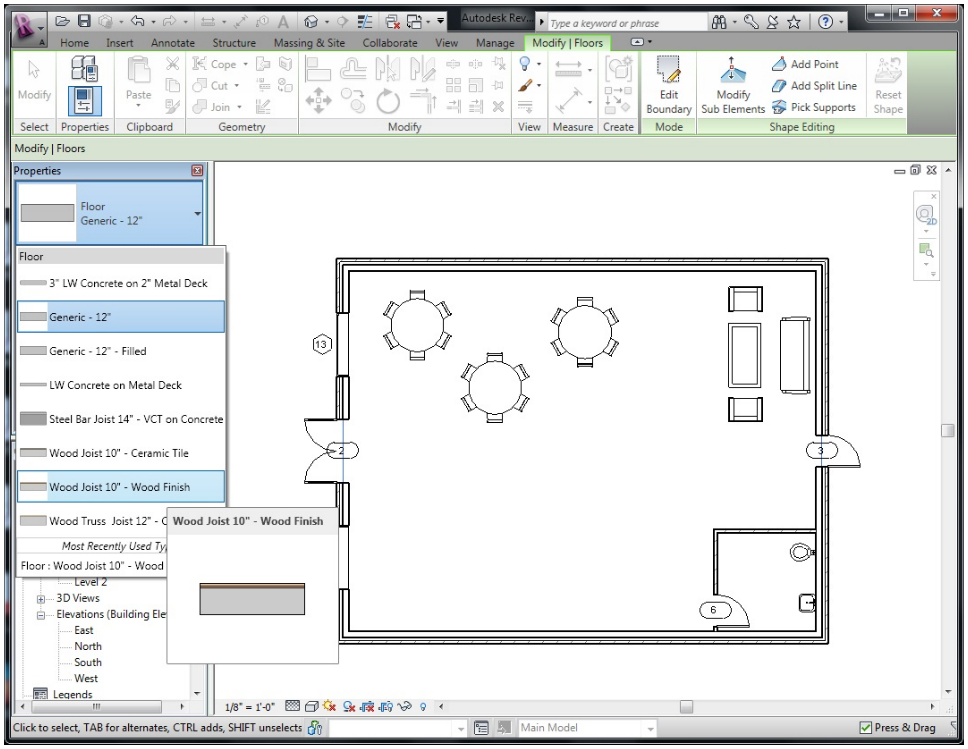
3. You will notice the drawing has turned a lighter shade of gray – this is ok. **Single-click each exterior wall.**



4. On the *Modify|Create Floor Boundary Tab*, you will see a large green checkmark, called the Finish Edit Mode button, seen below. **Click this button** to set the floor.



5. Finally, you will determine the floor type by selecting the Floor Type dropdown tab in the Properties box, and choose *Wood Joist 10" – Wood Finish*.



Save and Close the Project

1. On the main toolbar, **click the Revit home button.**
2. **Click Save**.
3. **Click the Revit home button** once more.

Click Close.

Appendix G – Building Guidelines

The following list was given to the constructivist groups as well as the second session of the behaviorist group as guidelines for the café drawing.

1. East/West measuring 35'- 0"
2. North/South measuring 45'- 0"
3. Ceiling height – 10'- 0"
4. Floor covering of your choice
5. Interior bathroom – 10'- 0" x 10'- 0"
    a. 4" Brick interior walls
    b. Include sink
    c. Include commode
6. Double doors on west (front) wall
7. Single-door exit on side or rear of building
8. Windows (2 or more) on exterior walls
9. Seating for at least 24 patrons

Appendix H – Learning Stress Observation Record

Observer ____ **Date** ____________________

☐ Group Crimson ☐ Group Slate

☐ **Student** ______________________________________ **A:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **B:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **C:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **D:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ **Student** ______________________________________ **A:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **B:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **C:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **D:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
☐ **Student** ______________________________________ **A:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **B:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **C:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **D:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ **Student** ______________________________________ **A:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **B:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **C:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **D:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
☐ **Student** ______________________________________ **A:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **B:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **C:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **D:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ **Student** ______________________________________ **A:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **B:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **C:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **D:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

☐ **Student** ______________________________	☐ **Student** ______________________________
A: ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	**A:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
B: ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	**B:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
C: ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	**C:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
D: ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	**D:** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Stress Indicator Key *(developed by the researcher and Committee Chair)*

A = Staring at computer screen – seemingly confused

B = Disruptive behavior – does not have to be negative

C = Nervous behavior (e.g. biting nails, sighing, fidgeting)

D = Moving around, standing and sitting, clock watching

Appendix I – Post-Session Survey

Name____ **ID#** ______________ **Date**____________

Please use the scale below to answer the following 10 questions about your experience today.

1. The project was difficult.

☐ **1**	☐ **2**	☐ **3**	☐ **4**
Completely Disagree	Moderately Disagree	Moderately Agree	Completely Agree

2. I feel confident using the software after the session today.

☐ **1**	☐ **2**	☐ **3**	☐ **4**
Completely Disagree	Moderately Disagree	Moderately Agree	Completely Agree

3. I feel I learned a great deal as a result of the session today.

☐ **1**	☐ **2**	☐ **3**	☐ **4**
Completely Disagree	Moderately Disagree	Moderately Agree	Completely Agree

4. I feel I could use the skills I learned today to complete a similar project in the future.

☐ 1	☐ 2	☐ 3	☐ 4
Completely Disagree	Moderately Disagree	Moderately Agree	Completely Agree

5. I feel the skills learned today would be applicable in another class.

☐ 1	☐ 2	☐ 3	☐ 4
Completely Disagree	Moderately Disagree	Moderately Agree	Completely Agree

6. I feel the skills learned today would be applicable in a future or current job.

☐ 1	☐ 2	☐ 3	☐ 4
Completely Disagree	Moderately Disagree	Moderately Agree	Completely Agree

Appendix J – Evaluation Protocol Student Team______________ ID #__________

1. Did the student complete the project within the allotted time?

☐ Yes	☐ No

2. On a scale from 1 to 5, rate the student's level of technical accuracy as compared with the original model.

☐ **1**	☐ **2**	☐ **3**	☐ **4**	☐ **5**
Not at all Accurate	Somewhat Accurate	Accurate	Very Accurate	Perfectly Accurate

3. On a scale from 1 to 5, rate the student's application of furniture and accessories as compared to the original model.

☐ **1**	☐ **2**	☐ **3**	☐ **4**	☐ **5**
Not at all Accurate	Somewhat Accurate	Accurate	Very Accurate	Perfectly Accurate

4. Did the student embellish or add extra elements or accessories?

☐ Yes	☐ No