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Effect Of Expert Modeling On Ill-Structured Problem Solving In An Undergraduate General Education Honors Course

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EFFECT OF EXPERT MODELING ON ILL-STRUCTURED PROBLEM SOLVING IN AN UNDERGRADUATE GENERAL EDUCATION HONORS COURSE

by

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DISSERTATION

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of Wayne State University,

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Approved By:

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Advisor   Date

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DEDICATION

To my parents Nandalal Chakraborty and Meera Chakraborty, for providing me with the foundations of best possible education, for instilling in me humane, ethical and moral values, and love of learning from my childhood years. I am grateful for your love and support throughout my life until very recently, when I delivered my baby girl while working on my PhD. Words are inadequate to express my appreciation for the sacrifices that you have made towards providing me and my sister with world class education.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1   INTRODUCTION

A constructivist approach to instruction requires a changed role of the instructor from primarily being a content expert to acting as a facilitator of learning (Murphy, Mahoney, Chen, Mendoza-Diaz, & Yang, 2005; Ornstein and Hunkins, 1998; Markel, 1999; Westera, 1999; Jonassen, Davidson, Collins, Campbell & Haag, 1995)). Loyens, Rikers & Schmidt (2007) conducted two studies and identified four important constructivist elements in facilitating student learning, which are which are knowledge construction, collaborative learning, self-regulation and use of authentic problems. Constructivist elements, such as high levels of learner collaboration and authentic learning tasks were identified as significant factors to promote student learning in online environments (Leh, 2005; Murphy et. al., 2005). Huang (2002) advocated certain constructivist principles that instructors could use to design effective online courses for adult learners, such as interactive learning, collaborative learning, authentic learning and learner centered learning. Murphy, Mahoney, Chen, Mendoza-Diaz & Yang (2005) advocated that a collaborative, interactive, constructivist online learning environment, in contrast to passive traditional learning environment, help students learn more actively and effectively.

Problem-based learning (PBL) is a constructivist instructional approach that is student centered and helps to prepare students as problem solvers (Richey, Klein & Tracey, 2011). In the PBL approach to instruction, an authentic, real life problem is used to situate learning rather than exposing learners to disciplinary knowledge before they solve problems as is done in traditional instructional approach. PBL approach emphasizes understanding of the causes of the problem by the learners, critical thinking and active construction of knowledge that transfers to other similar problems or opportunities (Hmelo & Evensen, 2000). Hence in PBL approach, the learners gain content knowledge as they are actively engaged in an authentic problem solving task.

Why is PBL so relevant in the current context? Businesses and employers of the 21st Century are increasingly interested in employing graduates who are innovative, highly skilled problem solvers, critical thinkers, committed as lifelong learners and team players (Reigeluth, 2009; Savery, 2009; Marx, 2006; Bonk, Wisher & Lee, 2004). This demand for workforce-ready quality graduates has forced educators and educational institutions to redefine learning objectives and re-design instruction and courses so that knowledge and skills gained by the learners can be applied to the real world setting and learning can be transferred to any authentic work situation. This has set the trend for more and more higher education courses adopting learner centered instructional methods. Courses are designed so that students experience authentic real life problem solving which help them gain the essential skills of being real world problem solvers and team players.

Problem Statement

For successful learning in a PBL setting, learners need to be able to adapt internally to the process of problem solving, acquire problem solving and critical thinking skills, as well as gain knowledge of the body of existing literature of the discipline in which the problem is presented. Additionally, learners also need to retain the skills so that they are able to transfer and apply the gained knowledge and skills to solve authentic problems in real life work environments. Novice PBL learners also struggle to develop learning strategies in a PBL setting, which is in most situations, out of comfort zone for many first time PBL students who are familiar with the traditional lecture format instructional settings. Learners might feel overwhelmed at the flexibility and possibilities of "correct" responses to an ill-structured problem (Henry, Tawfik, Jonassen, Winholtz, & Khanna, 2012) and in understanding, restructuring the problem as well as the "sudden-ness of the solution" (Sandkuhler & Bhattacharya, 2008, as cited in Spector, Merril,

Elen & Bishop, 2014, p. 58). There are several adjustments that students need to make regarding study habits in a PBL situation (Hmelo-Siver, 2004; Savery, 2006) and regarding participation in group processes (Chiriac, 2008; Dolmans & Schmidt, 2006). Research on PBL implementations have identified several challenges, including no universal solution (Nasr & Ramadan, 2008), added workload (Johnson, 1999), problems with group grading that it did not account for individual contribution (Mitchell & Smith, 2008), and challenges in group dynamics (Chiriac, 2008; Dolmans & Schmidt, 2006) that students experience in a PBL course.

While there are several factors, both internal and external, that affect learning with the problem solving process (Jonassen, 2011), instructional designers and instructors can explore selection of media in combination with scaffolding strategies that help in adjusting external conditions of learning and in designing effective learner centered environments for problem based learning. Facilitators of PBL use scaffolding to support students in PBL environments to help students develop real life problem solving skills that they can transfer to authentic situations. Scaffolding involves learning support from instructor, facilitator, tutor or peer learners in the form of cognitive, emotional or social exchange that fosters student learning (Vygotsky, 1978). Scaffolding in PBL help students gain essential problem solving skills along with in depth understanding of content that helps in transfer of knowledge to real life situations (Kim & Hannafin, 2011; Barnett & Ceci, 2002). Savery (2006) and Henry, et. al. (2012) in their studies with undergraduate students, concluded that higher levels of structure and significant scaffolding was critical and imperative to any PBL design. Effective design of PBL environments, with scaffolds to facilitate learning, can help students overcome the initial challenges and be successful in PBL learning and be workforce ready at graduation. While PBL environments have been greatly advocated by educational policy makers in the recent years, there is limited research

on effective PBL implementation across disciplines (Jonassen, 2011; Savery, 2006). More research for effective design of PBL environment with support in the form of scaffolding of various kinds, to facilitate student success in PBL across varied disciplines like engineering, history, social sciences and in K-12 - has been suggested by practitioners and researchers (Savery, 2006; Strobel & van Barneveld, 2009; Henry, Tawfik, Jonassen, Winholtz, & Khanna, 2012; Jonassen, 2011). Research results from Choi & Lee (2009), Ge, Planas & Er (2010) and Ge & Land (2003) have shown positive impact of using scaffolding strategies to facilitate ill structured problem solving. More research on designing various scaffolding strategies, in different PBL environments, across disciplines, with use of technology was recommended by Ge, Planas & Er (2010), Choi & Lee (2009), and Ge & Land (2003).

According to Jonassen (2011), more instructional design research is needed for PBL environments, as, in everyday life and work, problem solving is a ubiquitous activity. Instructional designers, researchers and facilitators implementing PBL are intrigued about what the best approach is to provide support and guidance for the different kinds of ill structured problems, so that students are not frustrated and demotivated with the initial learning challenges of PBL and effectively learn skills that they can transfer in work life. The growing impetus of implementing problem based learning (for in depth learning and transfer to authentic situations), and the potential and importance for designing effective PBL environments across disciplines (Jonassen, 2011) with various scaffolding strategies to impact student learning establish the purpose of this research study.

Purpose of the Study

Scaffolding is an instructional strategy that helps learners to solve problems and achieve goals with support that otherwise they are unable to accomplish by themselves. Scaffolding helps

the learner to gain problem solving skills initially with support from the facilitator and then slowly develop as independent problem solvers with gradual fading or withdrawal of scaffolds.

The purpose of this research study was to investigate the effect of using expert modeling of ill-structured problem solving as a scaffolding strategy on undergraduate students' problem solving outcomes. A document containing expert's analytical guideline to approach and solve the ill structured problem and an example of the expert's problem solving report was used as a scaffold for the problem solving task. The problem solving performance of the undergraduate students were measured on the three major problem solving learning outcomes:

i.   Ability to define problem

ii.   Ability to analyze issues critically and comprehensively

iii.   Ability to evaluate proposed solutions/hypotheses to problems

The above mentioned problem solving outcomes and performance scales and categories are defined by a rubric (included in Chapter III) that was developed by an expert educator and a subject matter expert, with several years of experience of teaching and research in higher education setting, following the guidelines from the Association for American Colleges and Universities (AACU) problem solving Valid Assessment of Learning in Undergraduate Education (VALUE) rubric. The rubric was reviewed by the Assessment and Curriculum Committee, composed of administrators and faculty, at the IDR Honors College, the site of this study. The suggestions from the Assessment Committee were incorporated in the rubric to enhance validity of the measurement tool. The rubric was used to score the PBL activity and quantitative methods were applied to determine the effect of expert modeling on ill structured problem solving. In this study, a document containing expert's analytical guideline to approach and solve the ill structured problem and an example of the expert's problem solving report was

used for expert modeling as a scaffolding strategy. Qualitative data analysis of students' reflection essays for the treatment group was used to understand what the students learned from the experts' responses and whether they found the scaffolding strategy helpful.

Expert modeling, formed the independent variable in this proposed study and students' problem solving outcomes as measured by the scores of students' problem solving reports on their ability to (a) Define problem, (b) Analyze issues critically and comprehensively and (c) Evaluate Proposed Solutions/Hypotheses; were the dependent variable in this study. In conjunction to the quantitative data, self-reflection reports of the problem solving assignment from treatment group students with guided questions, provided data for a qualitative analysis of the effect of expert's modeling on student learning.

Blackboard, a web based course management system, was used to design the platform for scaffolding, documentation, communication and collaboration of the problem solving learning process, and hence this study could be applied to an online environment using a Learning Management System or a Course Management System as well as in a traditional face to face or on-campus setting.

Research Questions

The study addressed the following research questions:

1. What is the effect of using expert modeling as a scaffolding strategy on students' problem solving outcome?

   1a. What is the effect of using expert modeling as a scaffolding strategy on students' ability to define a problem?

   1b. What is the effect of using expert modeling as a scaffolding strategy on students' ability to analyze issues within a given problem?

1c. What is the effect of using expert modeling as a scaffolding strategy on students' ability to evaluate proposed solution?

2. How do the students experience problem solving when expert modeling is used as a scaffolding strategy?

2a. What did the students perceive they learned from the expert's modeling of problem solving?

2b. What did the students see as benefits when expert modeling is used as a scaffolding strategy?

This quasi experimental, mixed methods study investigated the effect of expert modelling on the students' problem solving performance as measured by the students' problem solving reports on the three stages of problem solving. In conjunction to the quantitative data, self-reflection reports of the problem solving assignment from treatment group students with guided questions provided data for a qualitative analysis of the effect of expert's modeling on student learning.

Significance of the Study

- With the increased emphasis on transfer of learning and learning to solve real world problems, educators are adopting a curriculum that reinforces problem solving skills, and prepares learners as problem solvers. This study adds to the body of literature on designing effective problem based learning environments with scaffolding strategies for successful learning, retention and transfer of skills/knowledge to real life situations.

- The results of this study will benefit stakeholders including learners, higher education institutions, educators, facilitators, instructional designers, researchers and practitioners

who are experiencing, implementing or have intentions to implement PBL in their practices.

- The PBL environment in this study was designed using tools within a web based course management system, and hence this study could be applied to an online environment as well as in a traditional face to face setting.

- While much of the research on problem based learning have been conducted in the field of medical learning, there is a need for more research that investigate effectiveness of PBL in other disciplines and contexts (Strobel & van Barneveld, 2009), and hence this study and its findings contributes greatly to the knowledge base of problem based learning in undergraduate general education curriculum.

- Strobel & van Barneveld (2009) in their meta-synthesis also called for further research on studying the differences in effectiveness of different strategies, like optimal scaffolding, coaching or modeling strategies for facilitation of successful PBL. This study is significant from this perspective, as it addressed and investigated the use and effect of expert modeling as scaffolds in PBL for student learning.

- The modeling strategy used in this study is inexpensive and it does not require any additional budget or grant for technology or tools to be purchased. This makes it an affordable and effective method of scaffolding problem based learning.

Definition of Key Terms

This study used the definition of the terms as follows as a basis for discussion.

Constructivism. A theory according to which learning is constructed by the learner during authentic learning experiences considering multiple perspectives (Richey, Klein, & Tracey, 2011).

Course Management System. Course Management Systems are used for delivery of course materials electronically (usually in online or blended courses), tracking student performances within the courses, for submission and storage of student assignments, and for communication purposes with students and instructors (Watson & Watson, 2007). Examples of CMS are Blackboard, Angel, Sakai etc.

Expert Modeling: The instructor in PBL is a facilitator of learning who is an expert in the content as well as an expert in modeling effective strategies for learning and thinking through the problem solving task and solving the problem. According to Hmelo-Silver and Barrows (2003), a PBL instructor facilitates problem solving learning by coaching and modeling the problem solving tasks across various stages of PBL. This is usually achieved by experts "thinking aloud" on the problem task, and encouraging development of higher order thinking skills, by students as they engage in problem tasks and helping students learn to make connections with prior knowledge and experience (Hmelo-Silver, 2004).

Facilitator. In a constructivist Problem Based Learning environment, students learn by solving problems, reflecting on their experience, guided by a *facilitator*. The *facilitator* guides the learners through their learning process, helping them to think deeply and critically, and modeling the kind of questions that students need to be asking themselves (Hmelo-Silver, 2003).

Learning Management System. A Learning Management System is a software application that can be used to deliver and manage course content, for administration of course, tracking, supervising and reporting on the learning process of an organization; a learning management system is also used for course registration and administration (Szabo & Flesher, 2002; Gilhooly, 2001). The scope of functionalities of a LMS encompasses the entire organization.

Problem. A problem is an opportunity that may differ in difficulty based on complexity and structured-ness (Jonassen, 2008). Complexity in defining a problem includes factors like attainment level, breadth of knowledge while problem structured-ness can depend on factors like inter-disciplinarity, dynamicity, heterogeneity of interpretations, intransparency, etc. (Jonassen, 2008). Based on these characteristics, Jonassen (2008) defines three kinds of problems: decision making, diagnosis-solution, and policy problems.

Problem Based Learning (PBL). Learning that is acquired by solving real life authentic problems through self-directed learning (Slavin, 1995). PBL is an instructional model that places problems at the center of learning (Jonassen, 2008).

Problem Based Learning Environments (PBLEs). PBLE is a generic term that is used to describe the teaching learning components necessary for supporting students learning to solve different kinds of problems in a PBL setting (Jonassen, 2011).

Scaffolds. Scaffolds are instructional supports that enable learners to achieve a higher level in learning than would be possible independently (without any support) (Vygotsky, 1978).

CHAPTER 2   REVIEW OF LITERATURE

Constructivism

According to constructivists, individuals "construct" knowledge by filtering new information through their personal experiences to understand the world (Jonassen, 1991). Individuals actively acquire and create meanings of new knowledge based on their own personal experiences (Jonassen, 1991). The origins of constructivist ideas can be traced back to the works of Immanuel Kant (1724 - 1804), where he proposed that our experiences in the world are regulated by our ideas and our individual patterns of thinking (Bruner, 1986). Hans Vaihinger (1852 - 1933) based his construct of "functional fictions" on Kant's work, and postulated that humans use their mental processes to help them navigate through the world in which they live. Long before the term "constructivism" was coined, John Dewey (1897) said "Education must be considered as a continuing reconstruction of experience; that the process and the goal of education are one and the same thing" (p. 13).

Increasingly, contemporary constructivists view the learning environment as not only the immediate surroundings of the learners and their individual knowledge construction but include a broader social environment in which the learner lives and interacts with people and the community in general. This theory of social constructivism originates from the work of Lev Vygotsky (1930 – 1934/1978) and postulates that knowledge is constructed within a contextual framework that is grounded in the learners' social environment. Social constructivists view learning as a social process that happens through constant and dynamic interaction in which there is a continuous process of knowledge creation, negotiation and meaning making that occurs as the active members of the community negotiate meaning together (Kim, 2001). The continuous interaction between the learner and the learning stimulus both within the immediate learning

environment as well as the broader social environment help in the construction of new knowledge by altering the mental structure of the pre-existing knowledge. Social constructivists believe that meaning making is a process of social exchange and negotiation among the participants involved in any activity. From this perspective, learning is an internal as well as a social process. Savery and Duffy (1995) define learning as inherently a social-dialogical process. Smith and Ragan (2005), summarized the key assumptions that characterize both of these constructivist orientations as follows:

- Knowledge is constructed from experience

- Learning results from a personal interpretation of knowledge

- Learning is an active process in which meaning is developed on the basis of experience. (p. 19)

According to Jonassen (2006), constructivism is neither a theory of learning nor it is a model for designing instruction. He mentions that constructivism has influenced how psychologists and educators view learning. Thus researchers and educators are unable to empirically assess effects of constructivism on learning. However he proposes that educators and researchers can assess the impact of instructional methodologies like authentic learning, problem solving, situated learning and collaborative learning which are derived from constructivist ideas and principles.
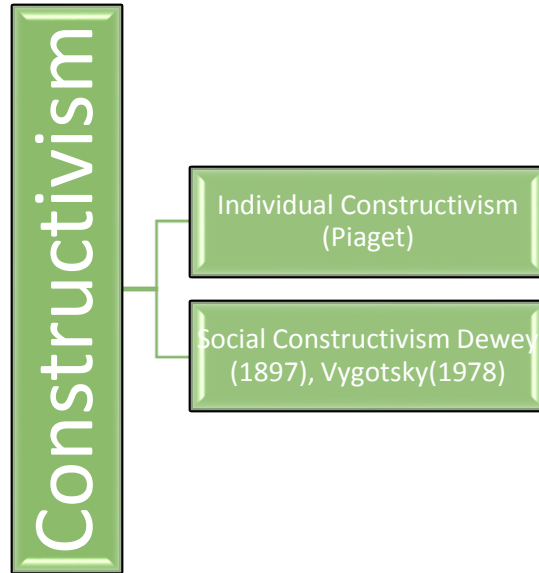
Figure 2.1: Constructivist perspectives – Individual and Social Constructivism

Problem Based Learning (PBL)

Savery (2006) defined PBL as a learner centered instructional approach that empowers the learners to be researchers, to integrate theory and practice, and to apply knowledge and skills to solve problems. According to Torp & Sage (2002), PBL is a focused and experiential learning experience to investigate solution of messy, real world problems. According to Barrows (2000), PBL is an active learning method with an ill structured problem as a stimulus for learning. PBL design involves use of a real world, ill structured problem in a student centered learning environment with support from the instructor as a facilitator (Hmelo-Silver & Eberbach, 2012). The goal of PBL is to integrate the practical and theoretical knowledge base, and helping learners acquire reasoning and collaborative skills, together with future learning skills. Students learn by solving a problem collaboratively, within a small group setting with guidance from a facilitator (Hmelo-Silver & Barrows, 2006). Savery (2006) summed up the characteristics of PBL as:

1. In a PBL environment, the instructor is the facilitator of learning;

2. The learners need to be self-directed and self-regulated in their learning

3. Ill structured instructional problems are the driving force of inquiry
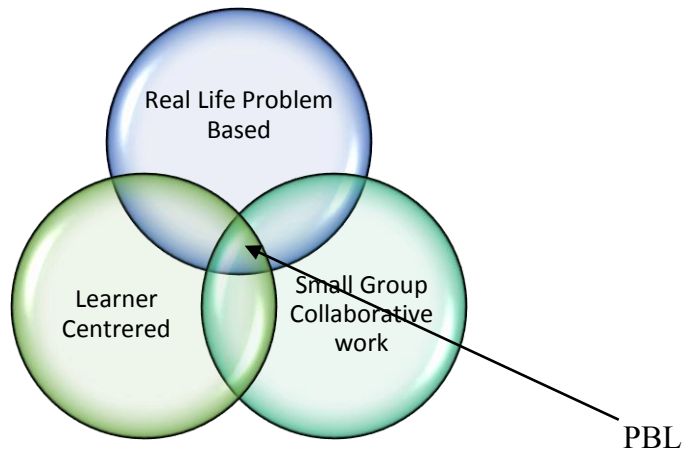
Figure 2.2: PBL instructional approach

A PBL approach to instruction usually involves learners working in small groups collaboratively to solve a problem.

Well Structured and Ill Structured Problems

According to Jonassen (1997), all problems vary in (i) structure or how the problem is posed or defined; (ii) complexity – whether the problem is simple to diagnose or complex and (iii) abstractness. He defined well-structured and ill-structured problems and developed an Instructional Design model for designing Problem Solving instructions (Jonassen, 1997).

Well Structured problems have known variables, definite solutions and require application of fixed and certain number of rules, procedures and concepts to arrive at the result or solution. Examples of well-structured problems are logic, mathematical, statistical problems. Jonassen (1997) proposed a model for well-structured problem solving instruction (Figure 2.3).

Figure 2.3: Jonassen's Model (1997) for Designing Well Structured Problem Solving Instruction:
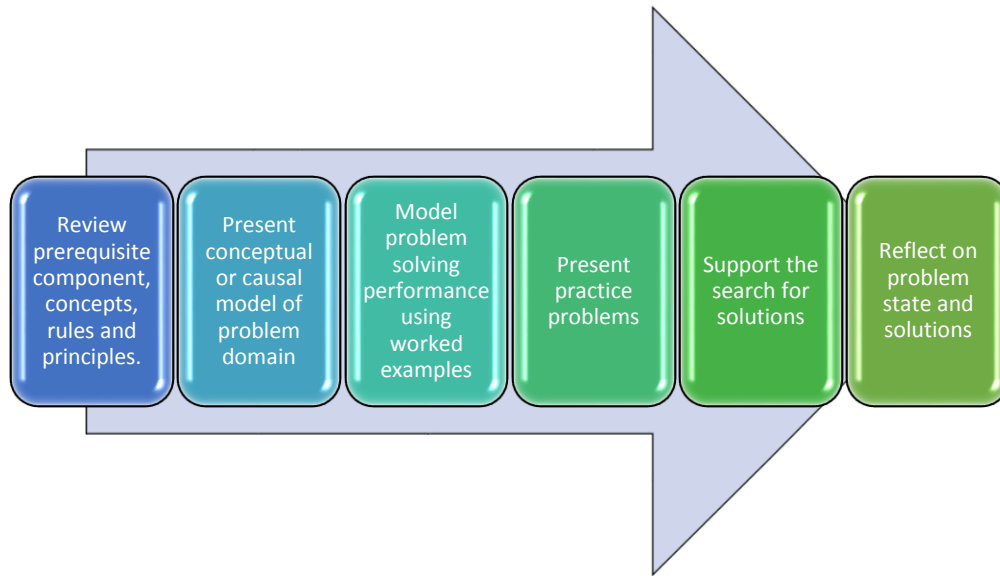
Ill structured problems are not well defined or loosely defined, can have multiple solutions, unknown variables, and inconsistent relationship among concept, rules and principles. Design problems, decision making problem situations, policy analysis, diagnosis, case studies etc. and almost all real life problem situations are ill structured problems. Solving ill structured problems is a cyclical and iterative process (Jonassen, 1997). Jonassen (1997) recommended that his prescribed model for problem solving instruction provide a general guideline and are not definitive answers or prescribed approaches; but that the models can be applied, mixed, matched depending on the nature of the problem that is under consideration. The goals are unclear in ill-structured problem solving and the learner needs to be able to evaluate alternative solutions as well as critically think about their problem-solving activities (Jonassen, 2011). Jonassen (1997) recommended an instructional design model for ill structured problem solving instruction (Figure. 2.4).

Figure 2.4: Jonassen's Model (1997) for Designing Ill Structured Problem Solving Instruction:

Articulate the problem context | Introduce the problem constraints | Locate, select and develop cases for learners | Support knowledge base construction | Support argument construction | Assess problem solution
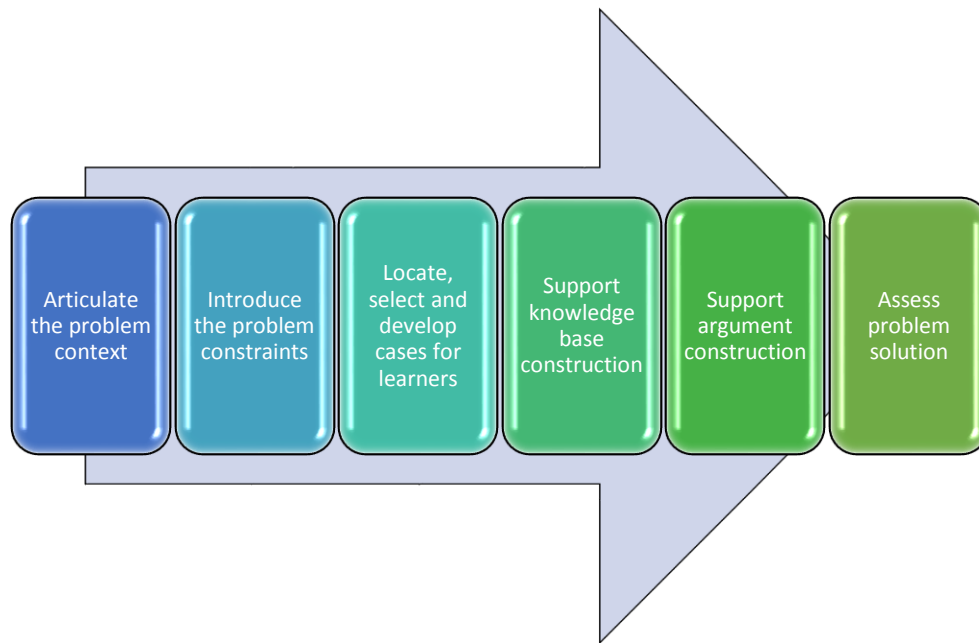
According to Jonassen (2000) individual differences within learners like general problem solving skills, familiarity with the problem type, domain knowledge, how concepts in the domain are interrelated, cognitive and meta cognitive processes, and affective, motivational and volitional factors affect problem solving. The ID models for problem solving by Jonassen (1997) provides a guiding sequence for instructional designers to follow, while developing instructions for Problem Solving.

Designing Effective PBLEs

PBL represents a significant shift in learning situation from the traditional methods of instructions, and hence students need to be supported by PBL facilitators to adapt to the learning methods of PBL (Jonassen, 2011). According to Jonassen (2011), implementation and design of PBL requires several considerations including the discipline/curricula, external factors (perspective, difficulty, dynamicity, structure and context); and internal factors which include

learner's level of prior knowledge, experience, reasoning ability, cognitive styles and epistemic beliefs (Jonassen, 2007). Jonassen (2011) described Problem Based Learning Environments (PBLEs) as a generic term that provides the description of instructional components necessary to support student learning in a PBL setting.

According to Jonassen (2011), in PBL, students must be actively engaged in solving problems, make mistakes, and present arguments for solution proposed. He proposed that in order to support problem solving learning, students can be presented with some combination of structural analogues, worked examples, case studies, alternative perspectives or simulations to help learners interpret and solve problems. He recommended cognitive scaffolds or strategies to help students construct mental schemas. Some of the strategies he listed includes, use of analogical coding, mapping causal relationship, argumentation, question prompts, problem modeling activities and metacognitive self-regulation. Since PBL assumes that students will master the content while engaging in solving a meaningful and real world problem, learning in PBL is usually designed with an authentic problem to be solved, which is normally the focus of a PBL (Hung, Jonassen & Liu, 2008). According to Jonassen (2011), study of case studies, structural analogues, prior experiences, alternative perspectives, and simulations similar to the problem to be solved, helps the learner by enhancing problem understanding. He suggested that cognitive scaffolds were vital to focus student attention on the relationships among the elements in the problem as well as between problems. He described analogical encoding, causal reasoning, using question prompts, argumentation, and modeling as scaffolding strategies to support students in ill structured PBL.

Jonassen (2011) provided a set of recommended components for different kinds of problems. Table 1 (adopted from Jonassen, 2011) provides a recommended set of case components and cognitive scaffolds for designing PBLEs.

Table 1. Case and scaffold requirements by problem type (Adopted from Jonassen(2011))

Problem Types	Case Components	Cognitive Scaffolds
Story	Problems, examples, analogues	Analogical, causal, questioning, argumentation, modeling
Rule using/Induction	Problems, examples, analogues	Analogical, causal, questioning
Decision Making	Problems, case studies, prior experiences, alternative perspectives	Causal, argumentation, modeling, (scenario construction)
Troubleshooting	Problems, prior experiences	Causal, argumentation, modeling
Policy Analysis	Problems, case studies, prior experiences, alternative perspectives	Analogical, questioning, argumentation, modeling
Design	Problems, prior experiences, alternative perspectives	Causal, argumentation, modeling
Dilemmas	Case studies, alternative perspectives	Argumentation

According to Jonassen (2011), his recommendations for instructional conditions to support different kind of problem solving learning, to be called validated, would require several empirical studies conducted over several curricular areas.

Use of Scaffolds in PBL

The concept of scaffolding can be traced back to Vygotsky (1978). According to Vygotsky, there is a cognitive distance between what learners know and can do independently; and what they can achieve with support from an expert. This cognitive distance is known as the Zone of Proximal Development (ZPD). Scaffolding helps learners cross ZPD and provide them with just enough learning support (Arts, Gijselaers, & Segers, 2002). Research recommends that

learners new to PBL require scaffolding in various forms and extent to solve problems, work with others and to be able to articulate their learning (Savery, 2006; Henry et. al. , 2012). Scaffolding enables the learner to solve a task that the learner would have struggled or would not have been able to do independently (Bruning, Schraw, & Ronning, 1999; Schunk, 2000; Woolfolk, 2004). Scaffolds are used by facilitators in PBL to add a support structure to problem solving learning process (Reiser, 2004; Schmidt, Loyens, VanGog & Paas, 2007; Simons & Klein, 2007; Saye & Brush, 2002). Scaffolds when used appropriately, reduces the amount of cognitive effort that students exert to learn any material (Schmidt et al., 2007).

There are several ways that facilitators of PBL have used scaffolding strategies to foster learning, like encouraging, explaining, modeling, questioning (Hogan & Pressley, 1997). Scaffolds can be a lab handout, a worksheet, question prompts (Ge & Land, 2003; Jonassen, 2011), or job aid; or it can be the presence of a human, like a tutor or the facilitator to provide support as and when needed (Simons & Klein, 2007; Saye & Brush, 2002). Scaffolds can be used to support learning content of the subject matter. Reid, Zhang, & Chen, (2003) found positive results by using interpretative support to help learners to conduct meaningful discovery learning and understand the knowledge base. Pedaste & Sarapuu (2006) in their study found that using scaffolds to support student learning provided evidence of significant effectiveness to both general problem solving ability and analytical skills. A content scaffold can be used to direct attention of students to key terms and information as they approach a problem (Su, 2007). Scaffolding in the form of question prompts and alternative perspectives have been used to support learners effectively during the problem solving process in previous studies (Ge & Land, 2003; Choi & Lee, 2009; Ge, Planas & Er, 2010). In solving an ill structured problem, asking and answering questions is essential in identifying the problem space as well as in development

of justification for the chosen solutions (Jonassen, 2011). Question prompts can provide the cognitive tools for the learner during problem solving and with a goal that the learner will be apt at generating questions in future problem solving situations (Jonassen, 2011). Questions that provoke in depth comprehension like those that begin with "why", "why not", "how", etc. are needed to support ill structured problem solving. Ge & Land (2003) used procedural question prompts related to the domains: problem representation, solution generation, justification and monitoring and evaluation. Ge & Land (2003) showed in their study that learners who received question prompts as scaffolds performed better in all the four identified domains. Metacognitive scaffolds help learners reflect on their learning, evaluate their own learning, or monitor and plan their learning. (Su, 2007; Reid et. al., 2003; Pedaste & Sarapuu, 2006).

Saye & Brush (2002) grouped scaffolds that instructors generally used into two types, based on the flexibility of the scaffolds used. Soft scaffolds tend to be real time, dynamic and situational where the facilitator or the tutor takes on spot decision to provide learning support by continuously diagnosing the student's progress and situation. Hard scaffolds are static supports that are usually planned and prepared prior to the instruction based on assumptions of the typical difficulties that a student might face in any learning situation (Saye & Brush, 2002).

Researchers agree that as students become proficient in dealing with uncertainties in solving a problem and accustomed to the PBL process, scaffolds can be gradually reduced until finally students are responsible alone for learning (Schmidt, Rotgans, & Yew, 2011). While some researchers have argued that scaffolds in PBL are ineffective since PBL should be by design unstructured learning (Kirchner, Sweller & Clark, 2006; Choo, Rotgans & Yew, 2010); others have called this illogical citing that all instruction in order to be effective and efficient must have

some form of structure (Schmidt, et al., 2007; Simons & Klein, 2007; Hmelo-Silver, Duncan & Chinn, 2007).

Expert Modeling as a Scaffolding Strategy for Novice PBL Learners

According to Ge & Land (2004), ill structured problems have certain cognitive and metacognitive requirements on the problem solver, which varies in magnitude from the novice to the expert problem solvers. They explain that cognitive requirements for solving an ill structured problem involve domain or content specific knowledge and structured knowledge. Experts in any content area use their domain knowledge during problem solving that facilitates the process to arrive at a specific solution while novices with their limited domain knowledge arrive at inadequate solutions.

According to Voss & Post (1988) and Voss, Wolfe, Lawrence & Engle (1991), as cited in Ge & Land (2004), experts also have well organized mental knowledge structures, also called mental schemata in long term memory, in their domain of expertise. A schema helps the problem solver to interpret new situations and observations and helps in selecting and using the correct problem solving approach. A novice learner lacks domain specific well organized schemata, and applies general processes to solve a problem, which is often inadequate for arriving at the best possible solution for a problem. The schemata in long term memory helps the experts recognize, notice, organize and interpret information which helps in formulating reasoning while solving any problem. Metacognition, which includes knowledge and regulation of cognition, is also necessary for solving ill structured problems (Ge & Land, 2004). Ability to make connections to the problem with past experiences also facilitate the problem solving process in experts; while novice problem solvers learn to make these connections as they gain experience in problem solving.

Figure. 2.5. Ill structured problem solving process components

Experts and novices approach solving problems in very different ways, and that difference occurs due to the difference in the domain or content knowledge of an expert and a novice and also the prior knowledge and experience that exists as organized information in the experts' long term memory as mental schemata, which helps the expert to apply the knowledge and experience in approaching and solving any new problem. Bransford, Brown & Cocking (2000) summarized that experts notice patterns and features of problem solving that novices fail to recognize and they organize the domain knowledge in a way that reflect deep understanding of the content. Experts also display flexibility in their approach to new situations. The authors recommend that metacognitive approach can improve transfer of learning as it helps the students develop skills to monitor and regulate their own understanding (Bransford, Brown & Cocking, 2000, p. 78).

Expert modeling scaffolding strategies help novice learners experience and develop problem solving abilities by closely following the approach and strategies of an expert and by following how an expert tackles a problem situation and utilize the problem as an opportunity to think critically, relate to prior experiences and reflect deep understanding of the content.

Research with Expert Modeling as Scaffold for PBL

Expert modeling can be used as an effective scaffolding strategy for ill structured problem solving (Jonassen, 1994). According to Collins, Brown & Newman (1989), expert modeling provide learners with an opportunity to learn about the cognitive process of an expert while problem solving and encourage reflective thinking to compare expert's problem solving with their own process with gradual internalization of the problem solving process. Expert modeling facilitates enhanced comprehension and ability to visualize the different perspectives and approaches to solving an ill structured problem. Expert modeling have been used by researchers as a scaffolding strategy for PBL teaching learning environments (Pedersen & Liu (2002); Simons & Klein (2007); Chen & Ge (2006); Ertmer, et. al. (2009); Ge, Planas & Er (2010)). Some empirical research on expert modeling as scaffolding strategy have recommended or used approaches of tutors in problem solving, or instructors, or instructor created product or outcome as the "expert" scaffolding strategy (Rowland (1992); Ge, Chen & Davis (2005); Chen & Ge (2006); Ge, Planas & Er (2010)). Other contemporary research have relied on information technology and multimedia as a means to create the "expert" scaffolding strategy through creation of a virtual expert. Researchers have used technology to create a PBL environment, using hypermedia or multimedia programs, with scaffolds built within the program that student could access to guide them through the problem solving process. It was an interesting observation during the literature review process that information technology was used to create a

technology rich PBL environment with hypermedia program in studies that were conducted within K-12 educational settings (Pedersen & Liu (2002); Simons & Klein (2007)). The studies that were conducted within higher education settings used tutors, instructors and products created by instructors as "expert" models (Chen & Ge (2006); Ertmer, et. al. (2009); Ge, Planas & Er (2010)).

In their study, Pedersen & Liu (2002) examined the potential of scaffolding PBL for sixth graders using a hypermedia based expert tool. The tool provided students interactive video of an expert modeling the cognitive processes to complete the tasks relevant to the PBL task. The students could compare with their own problem solving approach with the expert's approach. Results of their study indicated that the expert tool influenced the learners approach to problem solving, enhanced their decision making abilities, when they encountered the problem task and the learners' quality of work in the form of rationales in their individual problem report showed improvement.

Self-reflection is usually coupled with expert modeling as a scaffolding strategy since self-reflection helps the learner realize the relevance and importance of observing the expert modeling (Lin, Hmelo, Kinzer & Secules, 1999). Self-reflection exercise forces the learner to critically think about the individual's approach to problem solving and appreciate the learning from observing the experts' approach, and comparing both, which promotes problem solving abilities.

Simons & Klein (2007) investigated scaffolds in a hypermedia based program and how it influenced student achievement and performance in the PBLE. The participants of their study were one hundred and eleven seventh graders from Science and Technology course. Students in their study used any one of the three PBL hypermedia programs for the problem assignment;

one, with no scaffold, one with optional scaffold and one in which students were required to use scaffolds. They found that students in scaffold optional and scaffold required programs outperformed students in no-scaffold group. The researchers also analyzed the participants' journals qualitatively, and found that the students with scaffold optional and scaffold required program demonstrated highly organized work in their journals. They inferred that use of scaffolds in PBL enhances student performance and improves quality of student work.

Chen & Ge (2006) designed a web based cognitive scaffolding system that utilized expert modeling as a scaffolding strategy for graduate students in instructional technology. The web based system contained a case library of real world cases in instructional design in various settings. Participants of the study were graduate students who studied the real world cases, performed analysis, and proposed solutions to the given cases. Chen & Ge (2006), in their qualitative study, with eight graduate students, all novice in ill structured problem solving, built different scaffolding strategies within the system like procedural prompts, reflective prompts, expert modeling and peer review to enhance problem solving skills. Expert's problem solving report was provided to the students to give the students an opportunity to see how an expert approaches the problem case as well as the procedures that an expert undertakes to propose solution to a problem. The researchers got positive outcomes from the use of the cognitive tool, particularly in activating the novice problem solvers' prior knowledge, helping them organize their thoughts and to help articulate their reasoning.

Ertmer, et. al.(2009) compared differences in problem representations by 8 expert and 24 novice instructional designers in an advanced educational technology course. They used expert analytical guidance as a scaffolding strategy with the treatment group of the novice designers. All participants, belonging to control and treatment group in this study, were provided with a case

study narrative that dealt with training issues in a manufacturing setting, and a basic set of directives for analysis of the case study. The participants were required to analyze the problem, make decisions and provide a case response. In addition to the problem and the directives, the treatment group also received guidelines for analysis from experts on problem representation based on Ertmer & Stepich (2005). Ertmer, et. al. (2009) found significant differences between the control and treatment groups on dimensions of problem representations and the total score on problem solving. The performance of the treatment group was better than the control group and treatment group and expert designers' performance did not differ significantly. The researchers concluded that use of expert analytical guidance as a scaffold in PBL guided a novice problem solver to use an expert approach to analyze and make decisions and propose solution to the problem situation.

Expert modeling as a scaffold for problem solving was also used by Ge, Planas & Er (2010) in their study. The participants of this study were from the College of Pharmacy, enrolled in graduate level Clinical Communications course. The researchers in this study used a real world case study in Clinical Communications and a five step directives for problem solving for both the treatment and the control groups. The five step outline for problem solving was adopted by the researchers from health professional's decision making work by Longest (1984). The scaffolding strategies used in this study included question prompts, peer review, expert modeling and prompted self-reflection. Expert modeling in this study was a report of the expert's response to the case problem for the five decision making problem solving steps. The expert report provided an opportunity to the novice problem solvers to observe an expert's reasoning in the five decision making stages of an ill structured problem in this context. The researchers provided reflection prompts following the review of expert's responses to the problem, for self-reflection.

The reflection prompts enabled guided and deeper level thinking about the observations that the students made in the experts' problem solving reasoning and approach. The reflection essay also provided the learners an opportunity to think critically about their own problem solving process as well as consider alternative perspectives of approaching the problem while reflecting on the learning experience. The research findings from this study indicated that the novice problem solvers looked up to the expert's report as a standard, and used the expert's logic to determine whether their approach was on the right track or not. Also some students indicated that the expert modeling report increased their confidence in solving similar problems themselves. The findings of this study suggested that the students found expert modeling strategy helpful. Some of the benefits of expert modeling scaffolding strategy identified in this study were: students learned ways in which experts approach to solve problems in a structured way, how experts used their domain knowledge, their clinical expertise, standards and guidelines to define problem, analyze pertinent issues, and support their solutions, and how experts organized the available case information to develop reasoning and solve the problem.

Summary of Chapter 2

Jonassen (2011) provided recommendations for matching components and scaffolds with learners' needs when solving different kinds of problems in a PBLE. Scaffolding in the form of question prompts, alternative perspectives, peer interaction, expert modeling have been used to support learners effectively during problem solving process in previous studies (Ge & Land, 2003; Choi & Lee, 2009; Ge, Planas & Er, 2010). With the changing context of technology, changing dynamics of learning environments - traditional or online or hybrid or blended courses, more research on scaffolding student learning in PBL across disciplines, in different environments, using emerging technologies with different scaffolding strategies or combination

of scaffolding strategies that help in facilitating and promoting problem solving learning has been advocated by several researchers and practitioners (Jonassen, 2011; Ge, Planas & Er, 2010; Henry et. al., 2012; Savery, 2006).

CHAPTER 3   METHODOLOGY

Chapter III describes the research methodology that will include discussion of research design, context, participants, instruments, data collection procedures and data analysis techniques. The purpose of this research study was to investigate the effect of using expert modeling of ill-structured problem solving as a scaffolding strategy on undergraduate students' ill structured problem solving outcome. The problem solving learning outcomes of the undergraduate students were measured on the three problem solving stages:

> i.   Ability to define problem
>
> ii.   Ability to analyze issues critically and comprehensively
>
> iii.   Ability to evaluate proposed solutions/hypotheses to problems

The above mentioned problem solving stages and performance categories are defined by a rubric (Appendix B). The rubric was developed by an expert in the subject matter of the course and an educator engaged in higher education for several years following guidelines from the Association for American Colleges and Universities (AACU) problem solving VALUE rubric. The rubric was used to score the PBL activity/assignment and quantitative methods were applied to determine if the use of expert modeling as a scaffolding strategy improved problem solving performance of the students in the categories (a) Define problem (b) Analyze issues critically and comprehensively and (c) Evaluate proposed solutions/hypotheses. Qualitative data analysis of students' reflection essays were used to understand what the students learned from the experts' responses and to what extent they found the scaffolding strategy helpful.

A web based course management system, Blackboard (http://www.blackboard.wayne.edu) was used to design the platform for scaffolding, documentation and communication of the problem solving learning process, and hence this study

could be applied to an online environment as well as in a traditional face to face or on-campus setting.

The study addressed the following research questions:

1. What is the effect of using expert modeling as a scaffolding strategy on students' problem solving performance?

   1a. What is the effect of using expert modeling as a scaffolding strategy on students' ability to define a problem?

   1b. What is the effect of using expert modeling as a scaffolding strategy on students' ability to analyze issues within a given problem?

   1c. What is the effect of using expert modeling as a scaffolding strategy on students' ability to evaluate proposed solution?

2. How do the students experience problem solving when expert modeling is used as a scaffolding strategy?

   2a. What did the students perceive they learned from the expert's modeling of problem solving?

   2b. What did the students see as benefits when expert modelling is used as a scaffolding strategy?

Both qualitative as well as quantitative measures were used in this mixed methods study. The use of mixed methods enabled data triangulation from different sources, ensuring increased trustworthiness of results. While the quantitative data analysis indicated if the intervention, scaffolding with expert modeling, improved the problem solving outcomes of the students; the qualitative data analysis provided rich and soft data on the students' perspectives; whether the learners found the scaffolding strategy helpful in problem solving and what they learned from the

expert's problem solving report. According to Cresswell (2009), any mixed methods research study should have mixed methods research questions, to shape the design and methods of the study. Mixed methods research may have (a) quantitative questions or hypotheses and qualitative questions, (b) both quantitative question or hypotheses and qualitative question followed by a mixed method question, also called a "hybrid" question (Tashakkori & Creswell, 2007), or (c) only a mixed methods question (Creswell, 2009). This mixed methods study used model (a) which is quantitative questions or hypotheses and qualitative questions, for research questions. A sequential explanatory mixed method design (Creswell, 2009) was used in this study to explain and interpret the quantitative and the qualitative data.

Figure 3.1 explains the steps involved in the mixed methods study (Creswell, 2009).

QUAN	$\longrightarrow$	qual

QUAN $\longrightarrow$ QUAN $\longrightarrow$ qual $\longrightarrow$ qual $\longrightarrow$

Data Collection   Data Analysis   Data Collection   Data Analysis

Analysis and interpretation of entire data
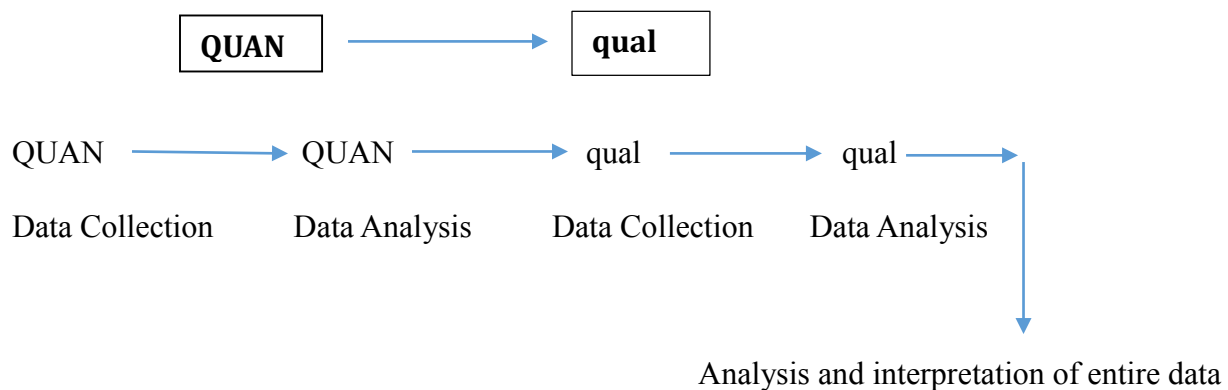
Context and Participants

The study was conducted in an Honors College at an urban public research university in the mid-west region of the United States. Study participants were undergraduate freshmen admitted to the university in Fall 2015, who qualified to be selected as members of the Honors College. Convenience sampling was used to select the participants of this study. The researcher approached the six Senior Lecturers at Honors College with the proposal to volunteer to

participate in the study. Each senior lecturer taught 3 discussion sections. The sample population

for the study were students from six Honors1000 freshmen sections.

Selection of instructors and the discussion section for the study

The researcher selected 2 senior lecturers from those who volunteered, on the basis of

seniority (determined by number of years of teaching experience). Though the ideal assignment

of the control and treatment conditions to the discussion sections would have been a random

assignment, due to limitations of the scope of this research, treatment and control group

assignment was done based on the senior lecturers. A coin toss was used to determine which

senior lecturer's sections would be assigned the treatment condition. Nonequivalent control

group design is suitable in such situations where randomization is difficult to achieve due to

practical reasons and a treatment is administered to an entire classroom/section and an untreated

class/section is taken as a control group (Campbell & Stanley, 1963; Kenny, 1975).

The general education honors course used in this study is based on understanding the

history and building of a city. The course uses the city of Detroit as an example. The course

objective is to make the learners aware of the history of city making, how the city of Detroit has

evolved over time, and to arrive at certain critical conclusions about the study of the city – the

ways the city is built, the social structures that people living in the city construct, the shifts in the

ways of seeing and interpreting the city over time. The course outcomes are targeted towards

problem solving, critical thinking skills and higher order skills in Cognitive Domain of Bloom's

Taxonomy (Bloom, Engelhart, Furst, Hill & Krathwohl, 1956), Analysis, Synthesis and

Evaluation.

The assignments of the course require the students to be investigators, researchers and

problem solvers and study the city to think critically and answer the questions:

i.   Who are we?

ii.   Where are we going?

iii.   What should we do?

In the problem solving assignments, students are presented with a decision-making scenario or a problem case and are required to use the domain knowledge from the course, problem solving and critical thinking skills to define the problem, analyze issues within the problem comprehensively, propose a solution and justify or evaluate the proposed solution in a narrative essay format.

According to Barrows (2000) and Torp & Sage (2002), problem based learning involves experiential learning and includes investigation, explanation and resolution of real life problems. Students learn problem solving in PBL by practically solving problems and reflecting on their experiences (Hmelo-Silver, 2004). The General Education course in this study, not only provides the students with the background and the context of the city building through the in-class lectures, discussion sections and other carefully designed supplemental instructional materials; the course also provides students opportunities of experiential learning in the form of passport events that take the students to different historical and popular sites of the city as researchers; the learners need to think critically and use different lenses of seeing how the city evolved over time, what changes occurred, various factors that caused the change, whether the changes were beneficial or more harmful, analyze current issues in a comprehensive manner and propose solutions to the issues in order to make the city a better place. The interpretation of the problem, associated causes and proposition of a solution of the problem can be wide ranged as long as it can be justified; there is no right or wrong answer and hence this context made an ideal case for ill structured problem based learning in an undergraduate general education setting.

Though the course was taught in a traditional classroom setting, a course management system (Blackboard) was used to deliver the course contents and materials and for submission of assignments to the course. The course also used the Blackboard course site for course announcements, posting of grades as well as for all online collaboration and communication.

The lead instructor of the course is a Professor, an expert in the subject matter, with several years of experience in teaching Honors General Education courses. There is a large lecture session, once every week, delivered by the lead instructor. The main ideas and topics of the course are discussed in the large lecture. The course also has small discussion section meetings once a week, where the ideas and topics of the weekly lecture are elaborated, class activities are conducted and relevant topics related to that week's lecture are discussed at depth. The instructors of the small sections are also Senior Lecturers with a Doctoral degree in social sciences, and with experience in teaching General Education course.

Each small section in this Fall 2015 cohort had 25 - 30 students approximately and the potential pool of all students in the 18 sections combined totals approximately around 400 - 500 students. For the purposes of this dissertation study the researcher chose to work with six discussion/small sections, and with two senior lecturers. The participants of this study were all Honors College freshmen students from the six sections and hence their declared major areas of study were varied and the pool of participants consisted of freshmen students from Engineering, Medical, Pharmacy, Nursing, Business, Communication, Fine Arts, Physical Sciences and several other disciplines.

Honors College Context, Ill Structured Problem and Scaffolding

This study was based on Jonassen's recommendation that not all problems are the same and different problems require different approaches of instruction and scaffolding (Jonassen &

Hung, 2008). The central focus of any PBL is to actively engage students in articulating, comprehending and solving problems thereby improving students' ability to apply knowledge to solve problems and improve self-directed learning skills (Jonassen & Hung, 2008). Jonassen & Hung (2008) recommended that in PBL, knowledge and problems are reciprocally related, where problems act as stimulus to learning and gaining knowledge; and knowledge is then applied back to solve the problems. Many PBL researchers (Hung, 2006; Jacobs, Dolmans, Wolfhagen, & Scherpbier, 2003; Duch, 2001) have suggested general principles of designing good PBL problems. Jonassen and Hung (2008) summarized the general principles as problems in PBL should be authentic, open ended, ill-structured, designed with a moderate degree of structuredness; complexity of the problem should be challenging to the students at the same time should be motivating and engaging the students' interests; the problems should be adapted to students' readiness, provide opportunities for considering the problem from multiple perspectives, or disciplines and relate to students' prior knowledge. For successfully implementing PBL programs, Jonassen & Hung (2008) recommend problems adapted in programs to be moderately ill structured and little above average in complexity.

As discussed in Chapter II, Jonassen (2011) provided a set of recommended components for different kinds of problems. Table 1 (adopted from Jonassen, 2011) provides a recommended set of case components and cognitive scaffolds for designing PBLEs. According to Jonassen (2011), many more empirical studies over various disciplines need to be done in order to validate his recommendations for instructional conditions to support different kind of problem solving learning.

Table 1. Case and scaffold requirements by problem type (Adopted from Jonassen, 2011)

Problem Types	Case Components	Cognitive Scaffolds
Story	Problems, examples,	Analogical, causal,

	analogues	questioning, argumentation, modeling
Rule using/Induction	Problems, examples, analogues	Analogical, causal, questioning
Decision Making	Problems, case studies, prior experiences, alternative perspectives	Causal, argumentation, modeling, (scenario construction)
Troubleshooting	Problems, prior experiences	Causal, argumentation, modeling
Policy Analysis	Problems, case studies, prior experiences, alternative perspectives	Analogical, questioning, argumentation, modeling
Design	Problems, prior experiences, alternative perspectives	Causal, argumentation, modeling
Dilemmas	Case studies, alternative perspectives	Argumentation

The context of this dissertation research study was a general education honors course "The City". This course is a requirement for the freshmen at the university who secure Honors membership. The participants of this study were members of Honors College and drawn from different disciplines, like Engineering, Medical, Pharmacy, Nursing, Fine Arts, Languages, Physical Sciences etc. Since the participants came from different majors or disciplines, the students of this course brought with them different perspectives and ways of seeing and interpreting the city, its problems and alternative solutions. This multiple perspectives that the students brought in to this course from their major disciplines made this course and the context of this study a good fit for PBL research. As discussed earlier in Chapter 3, the participants also take part in various passport events in which they go out to different sites in the city for experiential learning in addition to the lectures and the discussion sections.

The problem solving assignments that the students were assigned in this course fall under decision making problem category from Jonassen (2011). The components of the posed problems include the problems, case studies, alternative perspectives that relate to the prior experiential learning situations that the students engage in within the course and outside. Jonassen (2011) in

his framework, suggested modeling as one of the scaffolding strategies for this kind of PBL context. This study investigated the effects of using expert modeling as a scaffolding strategy for ill structured decision making problem based learning situations for undergraduate honors students at a public research university. A document with expert's analytical guideline or suggested approach to solving problem and a sample of expert's problem solving report were used as a scaffold strategy for the problem solving assignment in this course. According to Jonassen (2011), expert modeling should be an effective scaffold in this context and should improve student experiences and student learning in the PBL situation.

Research Design

A Nonequivalent (Pre-Test and Post Test) control group design (Creswell, 2009) experiment was conducted to investigate the effect of the scaffolding strategy on the PBL performance of the students. This method is one of the most popular quasi-experimental designs where the control group and the experimental groups are not selected randomly. The control group and the experimental group both take a pre-test and post-test; only the experimental group receives the treatment (Creswell, 2009).

In this study, both the control and the treatment group received identical task, Task I (Appendix C). Then, both groups were assigned Task II, where, the control group got only Task II (Appendix D); and the treatment group got the Task II, and the treatment in this study at the same time (Appendix E). This study was conducted in 6 discussion sections/classroom of a large university undergraduate cohort, with 3 sections receiving the treatment and 3 sections as the control group. As discussed earlier, nonequivalent control group design was suitable in this situation, where randomization would have been difficult to achieve for practical purposes and a

treatment was administered to an entire classroom/section and an untreated class/section was taken as control group (Campbell & Stanley, 1963; Kenny, 1975).

Figure. 3.2 illustrates the research design.

Experimental Group
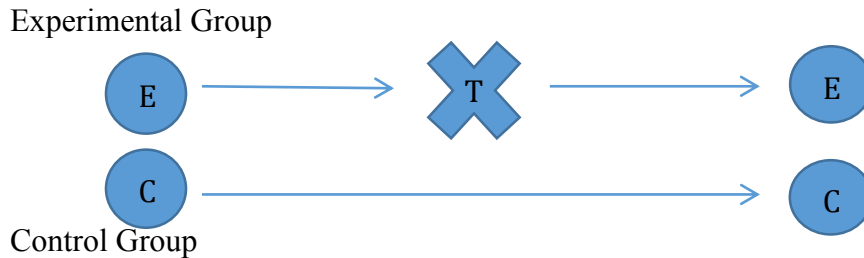
Control Group

Figure 3.2. Non-Equivalent Pre-test Post-test Control Group Design

Students who register in this honors course are assigned to one of eighteen small sections taught by six different Senior Lecturers. This quasi experimental study investigated the effect of the independent variable, expert modeling (expert's analytical guideline and expert's problem solving report) on the students' problem solving performance as measured by the students' problem solving reports which formed the dependent variable in this study. In conjunction to the quantitative data, self-reflection reports of the problem solving assignment from treatment group students, with guided questions, will provide data for a qualitative analysis of the impact of expert's modeling on student learning.

Table 3.1 below provides details of Research Design Outline.

Table 3.1.Research Design Outline

Research Question	Variables/ Key Factors	Sample/ Participants & Contexts	Method(s)	Data collection Methods, Resources & Instruments	Data Analyses
Quantitative					
1. What is the effect of using expert	Independent variable- expert	Honors college freshmen	Quantitative	Students' problem solving	Statistical Analysis: Multidime

modeling as a scaffolding strategy on students' problem solving performance?	modeling Dependent variable- Task II total score on student problem solving report	students in a research university in mid-west US		reports; honors college rubric rows	nsional Pearson's Chi Square Test
1a. What is the effect of using expert modeling as a scaffolding strategy on students' ability to define a problem?	Independent variable- expert modeling Dependent variable- "define problem " score on student problem solving report for Task II	Honors college freshmen students in a research university in mid-west US	Quantitative	Students' problem solving reports; honors college rubric row 1	Statistical Analysis: Multidimensional Pearson's Chi Square Test
1b. What is the effect of using expert modeling as a scaffolding strategy on students' ability to analyze issues within a given problem?	Independent variable- expert modeling Dependent variable- "issues analyzed" scores on student problem solving report for Task II	Honors college freshmen students in a research university in mid-west US	Quantitative	Students' problem solving reports; honors college rubric row 2	Statistical Analysis: Multidimensional Pearson's Chi Square Test
1c. What is the effect of using expert modeling as a scaffolding strategy on students' ability to evaluate proposed solutions?	Independent variable- expert modeling Dependent variable- " evaluate proposed solution" score on student problem solving report	Honors college freshmen students in a research university in mid-west US	Quantitative	Students' problem solving reports; honors college rubric row 3	Statistical Analysis: Multidimensional Pearson's Chi Square Test

	for Task II				
	Qualitative				
2. How do the students experience problem solving when expert modeling is used as a scaffolding strategy?	Independent variable- expert modeling; dependent variable- Student reflection	Treatment Group in the study	Qualitative	Student reflection essay, reflective prompts;	Coding and Qualitativ e Analysis
2a. What did the students perceive they learned from the expert's modeling of problem solving?	Independent variable- expert modeling; dependent variable- Student reflection	Treatment Group in the study	Qualitative	Student reflection essay, reflective prompts;	Coding and Qualitativ e Analysis
2b. What did the students see as benefits when expert modeling is used as a scaffolding strategy?	Independent variable- expert modeling; dependent variable – Student reflection	Treatment Group in the study	Qualitative	Student reflection essay, reflective prompts;	Coding and Qualitativ e Analysis

Data Collection Procedures, Intervention and Instruments

Three methods of data collection were used in this study. Task I - problem solving assignment, Task II- problem solving assignment and self-reflection reports.

Phase 1. During the first two weeks of the Fall semester of 2015, the researcher went to each of the six participating discussion sections and read aloud the research information sheet (Appendix H) to the participants. Any questions that the participants raised were answered by the researcher. At this time the researcher also referenced the enrollment database of the university

and deleted the names of the participants who were less than 18 years of age at the start of the Fall 2015 term. These students were considered minors and were not considered in the research study, in order to follow the IRB regulations.

Phase 2. Both the control and the treatment groups were assigned the same ill structured problem solving assignment as Task I during Week 4 of the Fall term. Appendix C describes the Task I-Problem Solving Assignment. The problem solving reports of the students were collected by the instructor during Week 5 seminar sections. The instructor then shared hard copies of student task reports with the researcher. The researcher eliminated the participants who were less than 18 years at the start of the Fall term from the study (as per the research information sheet). Then the researcher removed all personal identifiers from the reports and assigned alphanumeric participant IDs for each of the participant assignments using MS EXCEL program. No record linking the participant names to the alphanumeric IDs were kept for this study. After this, the researcher made 2 copies of the Task I reports and forwarded paper copies of all the problem solving reports to two graders, for blind review. The researcher also provided the graders with excel form sheets for recording the scores. The two reviewers scored the problem solving reports independently using the rubric (Appendix B). Once the grading was completed, any discrepancy of more than 3 points in scoring the Task I reports, between the reviewers were discussed by the graders to come to a mutually agreeable point. The mutually agreed upon score was considered for the purpose of this research. The scores from the Task I problem solution report provided the baseline score of the problem solving abilities for both the groups and was used to establish comparability between the control and treatment groups.

Phase 3& 4. During Week 10, the second ill structured problem assignment was presented to both of the control and the treatment groups. The control group got the assignment

as described in Appendix D, and the treatment group got the assignment as described in Appendix E (with the treatment) and the self-reflection paper, Appendix F. In Appendix E, in addition to the problem assignment, the treatment group also received the treatment - an analytical guideline/suggestions that demonstrated the experts' strategies as he/she progresses through the problem solving process and an expert's problem solving report (for a similar problem solving assignment for example). The section instructor also presented the treatment group with two reflection questions (Appendix F) on their problem solving experience with the expert modeling as a scaffold. The reflection questions presented to the students prompted the participants to organize and focus their responses. The reflective prompts can be found in Appendix F.

The students in Control group did not receive the expert's report. All participants in the control and treatment group worked through the Task II assignment and submitted the work to their respective section instructors, during Week 12. Same grading procedure as was adopted in the first ill structured problem solving assignment, Task I, were followed.

Figure 3.3. **Treatment Group** activities for the study
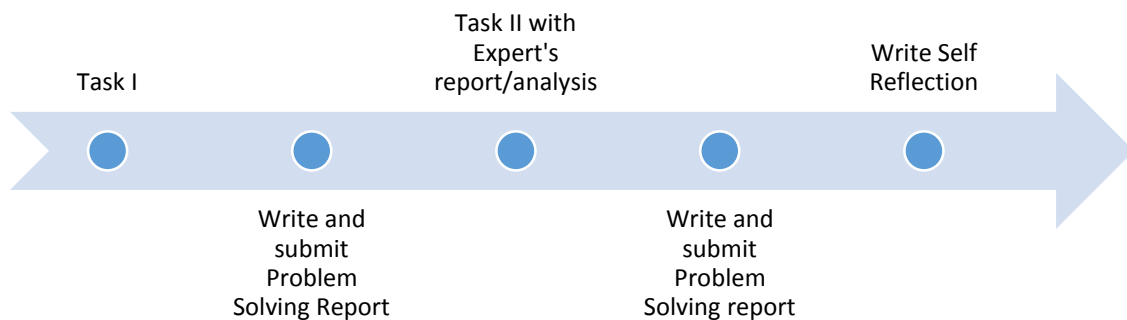
Figure 3.4. **Control Group** activities for the study

Task I   Task II

Write and submit Problem Solving Report   Write and submit Problem Solving Report

Data Collection Process	Treatment Group	Task I Problem Solution Report	Task II Problem Solution Report	Self-Reflection Report
	Control Group	Task I Problem Solution Report	Task II Problem Solution Report	
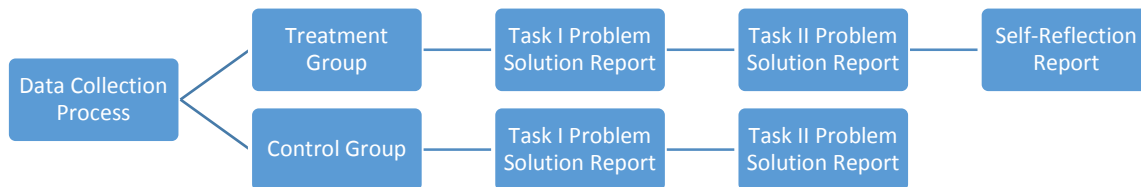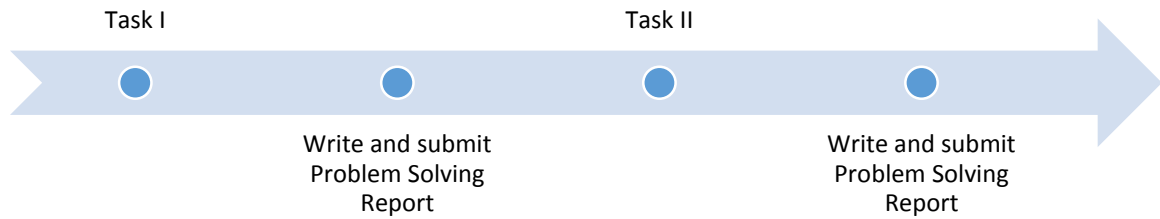
Figure 3.5 **Data Collection Process** in the study

The Rubric – addressing Validity and Reliability

The rubric that was used to assess the problem solving report was developed by an expert educator in general education/social sciences and a subject matter expert, with several years of experience of teaching and research in higher education setting, following the guidelines from Association for American Colleges and Universities (AACU) problem solving VALUE rubric.

Additionally the rubric was also reviewed by the Honors College Assessment and Curriculum Committee, composed of faculty and academic administrators, to ensure validity of the rubric. The rubric measures the problem solving learning outcomes of ability to define a problem, ability to analyze issues critically and comprehensively and ability to evaluate proposed solutions to problems.

Prior to the start of the research study, the researcher met with the instructors and reviewers who volunteered to participate in the study and conferred with them and trained them regarding the use of the rubric for this study. This meeting provided an opportunity to clear any questions in connection to this study. The session also enabled the researcher to explain and provide guidelines to the instructors and the reviewers about the study and the blind review process that was used in this study.

To address reliability of the assessment tool, blind review mechanism was used for both Task I and Task II assignment. Two reviewers graded students' problem solving assignment reports independently without any form of communication or consultation.

The reviewers met after all the grading was done and discussed the grades that differed between the two raters by more than three points. They collaborated on the scores and reached a mutually agreed upon score that was considered for data analysis. Inter-rater reliability for the two independent graders was also computed using Percentage Agreement and Cohen's Kappa. Triangulation of data from several sources was done to ensure trustworthiness.

Reviewer Identity

The reviewers in this study were Honors College faculty/staff/instructors engaged in higher education for several years. They were highly qualified individuals in their respective fields and had teaching experience in undergraduate and graduate courses for several years. The

reviewers had worked very closely in the planning for the HON1000 curriculum and were familiar with the course learning outcomes and the purpose of the course. Blind and independent review mechanism was followed in this study to eliminate reviewer bias, if any, while grading the problem tasks. Inter-rater reliability was also computed using Cohen's Kappa and percentage agreement to analyze the degree of agreement between the independent raters/reviewers.

Data Analysis Techniques

Quantitative Analysis

Pearson Chi Square analysis was conducted to examine the quantitative research question. The chi-square test is an appropriate statistical test to measure the relationship between variables when we work with nominal or ordinal data. Since the scores that were assigned to the problem solving report were assigned using the rubric, the data that was collected, the individual scores at each problem solving step and the total score, were ordinal data; hence chi-square analysis was used as the quantitative analysis to determine the effect of expert modeling on the problem solving performance of the students. All quantitative data analysis was done using the software SPSS (Statistical Package for the Social Sciences).

Qualitative Analysis

The reflection essay from the treatment group was manually coded and analyzed by the researcher to identify themes and to answer the qualitative research questions. The analysis, coding and organization of data was done using excel by the researcher herself.

Researcher Identity

The researcher has been associated with the education field in various capacities for many years. She is currently a professional in higher education administration working with Higher Education assessment, curriculum, instruction, instructional design, research and

technology integration in a public, research university. The researcher has experience in teaching undergraduate and graduate courses and had also assumed the role of a K-12 school administrator for a brief period. The researcher's current professional experience and interest as a practitioner in Instructional Design and Technology led her to conduct this study in this context. The researcher's familiarity with the context, the gatekeepers and experts in this study helped in gaining access to the classrooms and in conducting this study. Blind second expert review of the problem reports, qualitative data from student reflection journals and triangulation of various data was done to ensure trustworthiness of the results and to minimize any possible researcher bias in this study.

Summary of Chapter 3

A Nonequivalent control group design experiment was conducted to investigate the impact of the scaffolding strategy on the PBL performance of the students. This method is one of the most popular quasi-experimental designs where the control group and the experimental groups are not selected randomly. The control group and the experimental group were both given a pre-test (Task I) and post-test (Task II); only the experimental group received the treatment with Task II. Chapter three discussed the research design, the context, participants, data collection instruments, data analysis techniques and the researcher identity.

CHAPTER 4   RESULTS

This chapter presents the results of the data analyses for this study. The data analyses is presented in two sections. The first section describes the sample and participants of the study and reports the results of the quantitative data analysis to the research question 1 and its three sub questions, for Task I and Task II. The second section reports the qualitative data analysis results for research question number 2 and its two sub questions.

The purpose of this quasi experimental, mixed methods research study was to investigate the effect of using expert modeling of ill-structured problem solving as a scaffolding strategy on undergraduate students' problem solving outcomes. A document containing expert's analytical guideline to approach and solve the ill structured problem and an example of the expert's problem solving report was used as a scaffold for the problem solving task. The problem solving performance of the undergraduate honors students were measured on the three major problem solving learning outcomes:

i.   Ability to define problem

ii.   Ability to analyze issues critically and comprehensively

iii.   Ability to evaluate proposed solutions/hypotheses to problems

Expert modeling, formed the independent variable in this proposed study and students' problem solving outcomes as measured by the scores of students' problem solving reports on their ability to (a) Define problem, (b) Analyze issues critically and comprehensively and (c) Evaluate Proposed Solutions/Hypotheses; were the dependent variable in this study.   In conjunction to the quantitative data, self-reflection reports of the problem solving assignment from treatment group students with guided questions, provided data for a qualitative analysis of the effect of expert's modeling on student learning.

The study addressed the following research questions:

1. What is the effect of using expert modeling as a scaffolding strategy on students' problem solving outcome?

   1a. What is the effect of using expert modeling as a scaffolding strategy on students' ability to define a problem?

   1b. What is the effect of using expert modeling as a scaffolding strategy on students' ability to analyze issues within a given problem?

   1c. What is the effect of using expert modeling as a scaffolding strategy on students' ability to evaluate proposed solution?

2. How do the students experience problem solving when expert modeling is used as a scaffolding strategy?

   2a. What did the students perceive they learned from the expert's modeling of problem solving?

   2b. What did the students see as benefits when expert modeling is used as a scaffolding strategy?

Description of the sample

Participants of this study were recruited from 2015 freshmen cohort of Honors College. Table 4.1 shows the number of students registered for the six sections that were a part of the study. Sections C1, C2, C3 were the Control Group and the Sections T1, T2, T3 were the Treatment Group.

Table 4.1. Participants in the study

Section C1	Section C2	Section C3	Section T1	Section T2	Section T3	Total	Participants who qualified = Total registered – Students < 18 years of age

28	29	29	30	30	30	176	176 – 32 = 144

32 freshmen (11 from sections C1, C2, C3 combined; 21 from sections T1, T2, T3 combined) registered for these sections were less than 18 year old at the term beginning, and were not considered in this study. This brought the sample size for this study to 144 participants.

Section I - Quantitative Data Analysis

Task I

For Task I, 22 students from Control and Treatment group combined did not submit their assignment to the instructor or were late submissions. These students and their scores were not considered for the analysis. This brought the total number of participants in Task I to 122.

122 participants were considered for the data analysis of Task I in this study. There were 58 Participants in the Control Group and 64 participants in the Treatment Group.

To address reliability of the assessment tool, blind review mechanism was used for both Task I and Task II assignment. Two graders graded students' problem solving assignment reports independently without any form of communication or consultation. The reviewers met after all the grading was done to discuss grades that differed between the two raters by more than three points and to collaborate and negotiate on the scores and reach at a mutually agreed upon score. The mutually agreed score was considered for data analysis in those cases.

Pearson Chi Square analysis was conducted to examine the quantitative research question. The chi-square test is an appropriate statistical test to measure the relationship between variables when we work with categorical data. Since the scores assigned to the problem solving report were assigned using the rubric, the data that was collected, the individual scores at each problem solving step and the total score, were ordinal data; hence chi-square analysis was used as the quantitative analysis to determine the effect of expert modeling on the problem solving

performance of the students. All quantitative data analysis was done using the software SPSS (Statistical Package for the Social Sciences).

Since the scores varied over a large number of categories, for each of the individual problem solving steps and the overall problem solving score, pooling of some categories where the numbers (frequencies) were very small was done before running the chi-square analysis. A large number of categories with small entrees, makes the test less powerful to detect significant difference, and makes the p-value of the test of independence less accurate. Hence pooling is an accepted solution in such situations, even with small total sample size, as that decreases the degrees of freedom while increasing the accuracy of the test and does not impact the chi square value (McDonald, 2014).

Task I Results

For the Task I part 1 analysis the null hypothesis was that there is no significant difference between the two groups on the problem solving learning outcome: Define Problem. The hypothesis was tested against the alternate hypothesis that there is a difference in problem solving outcome "Define Problem" between the two groups – Groups 1 (Control) and Group 2 (Treatment). The result of the data analysis is shown below.

Table 4.2 "Ability to Define a Problem" Cross Tabulations and Chi Square Analysis

part1 * trt Crosstabulation

			trt		Total
			1.00	2.00	
part1	4.00	Count	8	10	18
		Expected Count	8.6	9.4	18.0
		Adjusted Residual	-.3	.3	
	5.00	Count	19	22	41
		Expected Count	19.5	21.5	41.0

	Adjusted Residual	-.2	.2	
6.00	Count	21	15	36
	Expected Count	17.1	18.9	36.0
	Adjusted Residual	1.5	-1.5	
7.00	Count	10	17	27
	Expected Count	12.8	14.2	27.0
	Adjusted Residual	-1.2	1.2	
Total	Count	58	64	122
	Expected Count	58.0	64.0	122.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.969[a]	3	.396
Likelihood Ratio	2.988	3	.394
Linear-by-Linear Association	.050	1	.823
N of Valid Cases	122		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.56.

Interpretation

For the Pearson Chi Square row, Chi Square (3) = 2.969, df = 3 and p value is equal to 0.396. Chi Square interpretation involves comparing the p-value to the significance level (0.05), and rejecting the null hypothesis when the p-value is less than the significance level. Since p = 0.396 >0.05(level of significance), the chi square result is not statistically significant, or in other words, the result indicates that there is no significant difference between performance of the two groups on the first problem solving criterion for Task I.

Again, for the Task I part 2 analysis the null hypothesis was that there is no significant difference between the two groups on the problem solving learning outcome: Analyze Issues Critically and Comprehensively. This hypothesis was tested against the alternate hypothesis that there is a difference in problem solving outcome "Analyze Issues Critically and Comprehensively" between the two groups – Groups 1 (Control) and Group 2 (Treatment). The result of the data analysis is shown below.

Table 4.3 "Ability to Analyze Issues" Cross Tabulations and Chi Square Analysis

Part2 * trt Crosstabulation

			trt		Total
			1.00	2.00	
Part2	4.00	Count	19	15	34
		Expected Count	18.4	15.6	34.0
		Adjusted Residual	.2	-.2	
	5.00	Count	18	20	38
		Expected Count	20.6	17.4	38.0
		Adjusted Residual	-1.1	1.1	
	6.00	Count	21	14	35
		Expected Count	19.0	16.0	35.0
		Adjusted Residual	.8	-.8	
Total		Count	58	49	107
		Expected Count	58.0	49.0	107.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.228[a]	2	.541
Likelihood Ratio	1.229	2	.541

Linear-by-Linear Association	.123	1	.726
N of Valid Cases	107		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 15.57.

Interpretation

For the Pearson Chi Square row, Chi Square (2) = 1.228, df = 2 and p value is equal to 0.541. Again, Chi Square interpretation involves comparing the p-value to the significance level (0.05), and rejecting the null hypothesis when the p-value is less than the significance level. Since p = .541 >0.05(level of significance), the chi square result is not statistically significant, or in other words there is no significant difference between performance of the two groups on the second problem solving outcome for Task I.

Lastly, for the Task I part 3 analysis the null hypothesis was defined as that there is no significant difference between the two groups on the problem solving learning outcome: Evaluate Proposed Solution. This hypothesis was tested against the alternate hypothesis that there is a difference in problem solving outcome "Evaluate Proposed Solution" between the two groups – Groups 1 (Control) and Group 2 (Treatment). The result of the data analysis is shown below.

Table 4.4 "Ability to Evaluate Proposed Solutions" Cross Tabulations and Chi Square Analysis

Part3 * trt Crosstabulation

			trt		
			1.00	2.00	Total
Part3	3.00	Count	19	23	42
		Expected Count	20.0	22.0	42.0

	Adjusted Residual	-.4	.4	
4.00	Count	24	10	34
	Expected Count	16.2	17.8	34.0
	Adjusted Residual	3.2	-3.2	
5.00	Count	8	21	29
	Expected Count	13.8	15.2	29.0
	Adjusted Residual	-2.5	2.5	
6.00	Count	7	10	17
	Expected Count	8.1	8.9	17.0
	Adjusted Residual	-.6	.6	
Total	Count	58	64	122
	Expected Count	58.0	64.0	122.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.237[a]	3	.007
Likelihood Ratio	12.599	3	.006
Linear-by-Linear Association	1.433	1	.231
N of Valid Cases	122		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.08.

Interpretation

For the Pearson Chi Square row, Chi Square (3) = 12.237, df = 3 and p value is equal to 0.007. Chi Square interpretation involves comparing the p-value to the significance level (0.05), and rejecting the null hypothesis when the p-value is less than the significance level. Since p=.007 <0.05(level of significance), the chi square result is significant, which implies that, there

is a difference between performance of the two groups on the third problem solving outcome for Task I. Group 2 or the Treatment Group performed better on the third problem solving outcome than Group 1 or the Control group for Task I.

Task II

22 participants from Control and Treatment group combined were not considered for analyses of Task II in the study. Of the 22 participants, 13 participants did not submit assignment or submitted a late assignment and 9 students were not considered as their work was considered incomplete by the reviewers. The reviewers held a meeting after grading all the tasks and mutually decided that the 9 responses were too incomplete to assign any grade. These incomplete scores were not considered for analysis. This brought the total number of participants for Task II to 122. There were 54 participants in the Control Group or Group 1 and 68 participants in Group 2 or the Treatment Group for Task II.

Task II Results

The data analysis started with a null hypothesis that there is no significant difference between the two groups on the problem solving learning outcome: Define Problem. This hypothesis was tested against the alternate hypothesis that there is a difference in problem solving outcome "Define Problem" between the two groups – Groups 1 (Control) and 2 (Treatment). The result of the data analysis for Task II is shown below in tables 4.5.

Table 4.5 "Ability to Define a Problem" Cross Tabulations and Chi Square Analysis

Crosstab

			Group #		
			1	2	Total
Sum1	4	Count	15	7	22
		Expected Count	9.7	12.3	22.0
	6	Count	27	42	69

		30.5	38.5	69.0
	Expected Count	30.5	38.5	69.0
8	Count	12	19	31
	Expected Count	13.7	17.3	31.0
Total	Count	54	68	122
	Expected Count	54.0	68.0	122.0

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.226[a]	2	.044
Likelihood Ratio	6.248	2	.044
Linear-by-Linear Association	3.746	1	.053
N of Valid Cases	122		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.74.

Interpretation

For the Pearson Chi Square row, Chi Square (2) = 6.226, df = 2 and p value is equal to .044. Chi Square interpretation involves comparing the p-value to the significance level (0.05), and rejecting the null hypothesis when the p-value is less than the significance level. Since p=.044 <0.05(level of significance), the chi square result is significant, which implies that, there is a difference between performance of the two groups on the first problem solving outcome "Ability to Define Problem" for Task II. Group 2 or the Treatment Group outperformed Group I on the first problem solving outcome for Task II.

For the Task II part 2 analysis the null hypothesis was defined as there is no significant difference between the two groups on the problem solving learning outcome: Analyze Issues

Critically and Comprehensively. This hypothesis was tested against the alternate hypothesis that there is a difference in problem solving outcome "Analyze Issues Critically and Comprehensively" between the two groups – Groups 1 (Control) and Group 2 (Treatment). The result of the data analysis is shown below.

Table 4.6 "Ability to Analyze Issues Critically and Comprehensively" Cross Tabulations and Chi Square Analysis

Crosstab

			Group #		Total
			1	2	
Sum2	3	Count	8	5	13
		Expected Count	5.8	7.2	13.0
	5	Count	22	18	40
		Expected Count	17.7	22.3	40.0
	6	Count	13	17	30
		Expected Count	13.3	16.7	30.0
	8	Count	11	28	39
		Expected Count	17.3	21.7	39.0
Total		Count	54	68	122
		Expected Count	54.0	68.0	122.0

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.528[a]	3	.057
Likelihood Ratio	7.689	3	.053
Linear-by-Linear Association	7.128	1	.008

N of Valid Cases	122			

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.75.

Interpretation

For the Pearson Chi Square row, Chi Square (3) = 7.528, df = 3 and p value is equal to 0.057. Chi Square interpretation involves comparing the p-value to the significance level (0.05), and rejecting the null hypothesis when the p-value is less than the significance level. Since p = .057 > 0.05(level of significance), the chi square result is not significant, and it can be concluded that there is no difference between performance of the two groups on the second problem solving outcome for Task II. It needs to be mentioned here, that p = .057 which is very close to the alpha value or .05, and so it just barely misses to be a significant difference in performance of the two groups in this category.

For Task II part 3 analysis the null hypothesis was defined as there is no significant difference between the two groups on the problem solving learning outcome: Evaluate Proposed Solutions. This null hypothesis was tested against the alternate hypothesis that there is a difference in problem solving outcome "Evaluate Proposed Solutions" between the two groups – Groups 1 (Control) and Group 2 (Treatment). The result of the data analysis is shown below.

Table 4.7 "Ability to Evaluate Proposed Solutions" Cross Tabulations and Chi Square Analysis

Crosstab

			Group #		
			1	2	Total
Sum3	3	Count	10	4	14
		Expected Count	6.2	7.8	14.0
	4	Count	17	12	29
		Expected Count	12.8	16.2	29.0

5	Count	17	20	37
	Expected Count	16.4	20.6	37.0
7	Count	10	32	42
	Expected Count	18.6	23.4	42.0
Total	Count	54	68	122
	Expected Count	54.0	68.0	122.0

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	13.775[a]	3	.003
Likelihood Ratio	14.275	3	.003
Linear-by-Linear Association	13.640	1	.000
N of Valid Cases	122		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.20.

Interpretation

For the Pearson Chi Square row, Chi Square (3) = 13.775, df = 3 and p value is equal to 0.003. Chi Square interpretation involves comparing the p-value to the significance level (0.05), and rejecting the null hypothesis when the p-value is less than the significance level. Since p=.003 <0.05(level of significance), the chi-square result is significant, which implies that, there is a difference between performance of the two groups on the third problem solving outcome for Task II. Group 2 or the Treatment Group outperformed Group I or Control Group on the third problem solving outcome for Task II.

Lastly, for Task II, the total problem solving outcome of the two groups was also analyzed. The component scores for the three problem solving outcomes were totaled and the

total score for problem solving was analyzed to glean information on effect of the treatment on

the total or overall problem solving outcome for the groups. Table 4.8 shows the results for the

analysis.

For this analysis the null hypothesis was defined as there is no significant difference

between the two groups on the overall problem solving learning outcomes. This hypothesis was

tested against the alternate hypothesis that there is a difference in overall problem solving

outcome between the two groups – Groups 1 (Control) and 2 (Treatment).

Table 4.8 "Overall Problem Solving Performance" Cross Tabulations and Chi Square

Analysis

SumSum * Group # Crosstabulation

			Group #		
			1	2	Total
SumSum	12	Count	11	6	17
		Expected Count	7.5	9.5	17.0
	16	Count	24	23	47
		Expected Count	20.8	26.2	47.0
	19	Count	14	19	33
		Expected Count	14.6	18.4	33.0
	20	Count	5	20	25
		Expected Count	11.1	13.9	25.0
Total		Count	54	68	122
		Expected Count	54.0	68.0	122.0

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.772[a]	3	.021
Likelihood Ratio	10.301	3	.016
Linear-by-Linear Association	7.759	1	.005
N of Valid Cases	122		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.52.

Interpretation

For the Pearson Chi Square row, Chi Square (3) = 9.772, df = 3 and p value is equal to 0.021. Chi Square interpretation involves comparing the p-value to the significance level (0.05), and rejecting the null hypothesis when the p-value is less than the significance level. Since p=.021 <0.05(level of significance), the chi square result is significant, which implies that, there is a significant difference between performance of the two groups on the total problem solving outcome for Task II. Group 2 or the Treatment Group performed significantly better on the overall or total problem solving outcome than Group 1 or the Control group for Task II.

Inter-rater reliability

The quantitative data collected in this study were all ordinal data. Two measures, Percentage Agreement and Cohen's Kappa were used to analyze the inter rater reliability or the degree of agreement of independent grading by the two raters. Cohen's Kappa and percentage agreement are generally the most common inter observer/rater reliability measures for categorical (nominal) and ordinal data that measures the degree of agreement between raters/observers.

The two graders assigned a different grade for 22.1% of the tasks graded by them and had assigned the same grade, grading independently for 77.9% of the problem tasks.

Cohen's Kappa statistic was also computed to determine agreement among the two independent raters. Cohen's Kappa is used to measure inter rater reliability between two raters or observers on assignment of categories for categorical and ordinal data. Since the scores in this case were ordinal data, Kappa was used as a measure of inter rater reliability. The following table below gives the interpretation for the different values of Kappa (Landis & Koch, 1977).

Interpretation of Kappa

	Poor	Slight	Fair	Moderate	Substantial	Almost perfect
Kappa	0.0	.20	.40	.60	.80	1.0

Kappa	Agreement
< 0	Less than chance agreement
0.01–0.20	Slight agreement
0.21– 0.40	Fair agreement
0.41–0.60	Moderate agreement
0.61–0.80	Substantial agreement
0.81–0.99	Almost perfect agreement

The inter rater reliability using un-weighted Kappa in this study was Kappa = 0.62, 95% CI (0.4913, 0.7453). The value of Kappa suggests a substantial agreement between the two independent raters (Landis & Koch, 1977).

Since the categories in the rubric used to assess the tasks were ordered in this context, the researcher also calculated the weighted-Kappa, which accommodates the "close" ratings in the calculation (Viera & Garrett, 2005). The inter rater reliability using weighted Kappa was 0.64 at Confidence Interval = 95% (0.5167, 0.7533). The value of Kappa, again, suggests a substantial agreement between the two independent raters (Landis & Koch, 1977).

Section II – Qualitative Data Analysis

The treatment group in this study was presented with two reflective questions (Appendix F) on their problem solving experience with the expert modeling as a scaffold, along with Task II. The reflective questions presented to the students prompted the participants to organize and focus their responses towards their problem solving experience and their perception of the expert modeling strategy used in this study. Qualitative data analysis of the participant reflection responses were used to understand what the learners perceived they learned from the experts' analytical guidelines; and whether they found the scaffolding strategy used in this study helpful in their problem solving. The reflective prompts can be found in Appendix F. Completion of the reflection questions were optional to the treatment group participants as this was not a part of course work for this course and was required only as a part of this study.

Reflection Responses and Coding

There were 68 participants in the treatment group for Task II. The researcher obtained 51 reflection essays from the participants which imply that 75% of the treatment group participants completed the reflective questions.

General description of Qualitative Data Collected in this study						
Reflection prompt #	Number of participants	Number of pages analyzed (double spaced, 12 point font)	Number of lines (Estimated)		Number of words (Estimated)		**Summary**: In total there were 64 pages, double spaced, 12 point font; 1,472 lines; 19,200 words that were analyzed
			per page	all pages	per page	all pages	
1 & 2	51	64	23	1,472	300	19,200	

The qualitative data analysis process for this study was based on Miles & Huberman's qualitative data analysis model (1994), which consists of three steps: Data Reduction, Data Display and Conclusion Drawing/Verification. The researcher manually coded the data and used the application MS Excel for coding and display graphics.

One of the most important processes in the qualitative data analysis of this study was coding. Coding for this study involved organizing the reflection data in conceptual categories that are mutually exclusive and exhaustive. Each code acted as a set, where pieces of data were placed depending on whether the data belonged to that set. According to Miles and Huberman (1994), "Codes are tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study. Codes are usually attached to 'chunks' of varying size – words, phrases, sentences or whole paragraphs."p. 56. In Vivo Coding (Miles, Huberman & Saldana, 2013) was used to develop the codes. According to Miles, Huberman & Saldana (2013), In Vivo Coding is suitable for any qualitative study and particularly for beginning qualitative researchers. The coded data was then displayed using a matrix in MS Excel using the emergent themes as the rows and the frequencies as another column. This display matrix provided the researcher with an easy visual tool to summarize and draw conclusions.

Learning themes from participant reflection

All of the participants overwhelmingly reported a positive experience with the expert modeling strategy used in this study. There were four main themes of perceived learning that emerged from the qualitative data analysis:

Table 4.9 a. General Description of Perceived Learning themes

Learning - Themes	Description
Problem solving real life skills	Majority participants said that the Expert Modeling strategy helped them learn how to approach a problem

	solving task and learn problem solving skills in real life. Most of them reported that the most valuable thing they learned was to define the problem/issue before starting to research more on causes or propose solutions. Following the analytical guideline helped them learn to approach an ill-structured problem solving task. Participant reflections that indicated this were grouped under the learning theme Problem solving real life skills.
Critical thinking	Another important learning that the participants indicated was the expert's emphasis on digging deep, critical thinking, deep thinking and reasoning, having a rationale behind thoughts. These comments were grouped together under the theme Critical thinking.
Systemic thinking & multiple perspectives	A learning theme that appeared several times in participant reflections was importance of considering multiple perspectives, and taking a holistic and systemic view of the issue while working on a problem solving task. Participants mentioned in their reflection that this was a valuable learning from the expert's guidelines and helped them while dissecting an issue and its causes. Reflections that indicated this as learning were included within the theme systemic thinking & multiple perspectives. Most participants used phrases like "systemic thinking", "holistic approach", "analyze from multiple viewpoints", and "generate ideas from multiple perspectives" interchangeably and sometimes together and hence the researcher coded the theme as Systemic thinking & multiple perspectives.
Proposing practical solution	Another important learning theme that the participant responses indicated was evaluating the feasibility of the solutions that they proposed for any issue; to judge and evaluate if the solutions they proposed were practically possible to implement or not. For example one participant said *effectiveness of solution proposed should also be considered as not all solutions are practical…so barriers to the solutions and how to alleviate those…"* Responses that mentioned similar experiences were grouped under the theme Proposing practical solution.

The matrix and graph displaying the themes and the number of occurrences are shown in Table 4.9 b. and Figure. 4.1.

Table 4.9 b. Learning Themes from the student reflections

Themes	Examples from the participant responses	Number of Occurrence
Problem Solving real life skills	*"learned about approaching the problem, defining the question/problem"* *"learning to define a problem first before researching its cause and trying to come up with solution"* *"I learned to handle problem solving tasks…this task was very vague, I followed the guideline…defined the question"* *"knowing exactly what the problem was and defining the problem helped me to look for information around the problem"* *"learned to define a problem and approach problem solving step by step"*	28
Critical Thinking	*"learned how to do in-depth analysis of root causes to a problem"* *"go deep into the issues to investigate the problem thoroughly"* *"dissecting it deep with critical and deep reasoning, rationale behind thoughts"* *"critical thinking - digging deep more than what appears on surface"* *"learned to think holistically, systematically, questions that would not have come to my mind for consideration, dig deeper"*	26
Systemic thinking & Multiple Perspectives	*"multiple perspectives when answering, different ways of seeing, weighing on different perspectives"* *"identify and recognize all viewpoints that a problem poses"* *"learned importance of investigating root causes and thinking critically from various perspectives…holistic systemic approach"* *"learned it is important to consider an issue from multiple perspectives holistically"* *"generate ideas from multiple perspectives… looking at the problem through different lenses…"*	43

Proposing practical solution	*"It is important to evaluate practicality of the solutions proposed, the barriers , pros and cons"* *"determination of practicality of any solution is important …just proposing a solution is not a good idea…justify and propose a feasible solution"* *"find justification to what you say to back up your claim with well researched details… propose feasible and practical solutions"* *"effectiveness of solution proposed should also be considered as not all solutions are practical…so barriers to the solutions and how to alleviate those"* *"also weighing a proposed solution to justify whether it is practical or not"*	18

Figure 4.1. Perceived Learning from student reflection

Benefits themes from participant reflection

All participants reported that the expert modeling strategy benefited them immensely in responding to the problem Task II. The themes that emerged from the data analysis and the

graphical representation are shown in Table 4.10 a & b and Figure 4.2. There were three major themes that emerged from this analysis.

Table 4.10 a. General Description of Perceived Benefits themes

Benefits – Themes	Description
Organize/Structure Information	Majority participants who responded to the reflection prompts indicated that the modeling strategy helped them organize and structure the information they presented in their solution to the problem task. The students mentioned that the guidelines helped them approach the problem task step by step and provided a starting point to form their response. As one student mentioned: "*I have trouble putting my thoughts into paper and I have not done this kind of writing before, the guidelines were helpful in organizing my ideas and composing the response*". These responses were coded under the theme Organize/Structure Information
Strategies on Critical Thinking and Problem Solving	Many participants also mentioned as benefits the various strategies of problem solving that they found helpful. These included, critical thinking strategies, strategies on approaching a problem task, exploring multiple viewpoints. These were coded under the benefits theme Strategies on Critical Thinking and Problem Solving.
Useful tool for future problem solving	Some participant responses explicitly indicated that the expert guidelines were helpful for this task and would also be a helpful tool for future problem solving tasks. For example, one participant reflection read "*very helpful for this task and future problem solving opportunities…this could be a framework..a powerful tool to help me navigate through any Problem solving task*". Reflections as the above were coded under benefit theme Useful tool for future problem solving

Table 4.10 b. Perceived Benefits Themes from the student reflections

Benefits - themes	Examples from the participant responses	Number of occurrences
Organize/Structure information	*"allowed me to go step by step and answer question; gave me a starting point; helped me to decide how I want to discuss and construct (structure); made it easier for me to write the response"* *"benefited me by showing how to organize and present information"* *"My essay was more thorough because of the guidelines, helped me organize my work better"* *"showed me how to start approaching the task...listing the information that I wanted to gather, the questions to which I sought answers to...helped organize my thoughts"* *"I have trouble putting my thoughts into paper and I have not done this kind of writing before, the guidelines were helpful in organizing my ideas and composing the response"*	42
Strategies on Critical Thinking and problem Solving	*"enhanced my understanding of approaching a problem , importance to critically analyze multiple viewpoints"* *"helped me a lot...when presented with a problem so large in magnitude and vaguely described, it could have been very overwhelming... expert guidelines helped me to break down the main problem to components"* *"the assumptions of the question/task is very broad and one can be overwhelmed...but the guidelines, help in giving structure to organize the thoughts in a step by step way"* *"Looking at an issue from multiple perspectives...and digging deep ...beyond what appears on surface...very helpful for this task and future"* *"The guidelines were like a pathway that provided thought provoking cues and helped me to look into more factors than I would have otherwise explored"*	36

Useful tool for future problem solving	*"very helpful for this task and future problem solving opportunities…this could be a framework…a powerful tool to help me navigate through any Problem solving task"* *"benefited me by showing how to organize and present information...very helpful even for future problem solving opportunities"* *"helped me to ponder upon thought provoking questions, gather my thoughts together and say out loud...Will be a useful tool for future assignments"* *"very helpful for this task and future problem solving opportunities"* *"Will also help me solve other similar real life problem situations"*	15

Figure 4.2. Perceived Benefits from student reflection

Majority of the participants reported that the Expert's Analytical Guideline helped them to structure and organize their response, and gave them a framework that they could follow for any problem solving assignment. The participants also reported that the guidelines helped them immensely with strategies on problem solving and critical thinking which was beneficial for responding to the assignment task.

Summary of Chapter 4

The results of data analyses in this study have been presented in this chapter. The quantitative data included the scores on the three different categories of problem solving tasks, Task I and Task II. The quantitative data was analyzed with Pearson Chi square test using the software SPSS. The qualitative data included the reflection responses from the treatment group participants on their perception of the expert modeling scaffolding strategy used in this study. Qualitative data analysis was done using Miles & Huberman's qualitative data analysis model (1994), which consists of three steps: Data Reduction, Data Display and Conclusion Drawing/Verification. The researcher manually coded the data and used the application MS Excel for coding and display graphics. Conclusions, future implications and recommendations from the study are presented in Chapter 5.

CHAPTER 5 DISCUSSION AND RECOMMENDATIONS

This chapter includes discussion of the findings from this study. Each research question and sub questions are discussed in reference to the results obtained from the data analysis. This is followed by conclusions and implications for practitioners and for future research.

The study addressed the following research questions:

1. What is the effect of using expert modeling as a scaffolding strategy on students' problem solving outcome?

   1a. What is the effect of using expert modeling as a scaffolding strategy on students' ability to define a problem?

   1b. What is the effect of using expert modeling as a scaffolding strategy on students' ability to analyze issues within a given problem?

   1c. What is the effect of using expert modeling as a scaffolding strategy on students' ability to evaluate proposed solution?

2. How do the students experience problem solving when expert modeling is used as a scaffolding strategy?

   2a. What did the students perceive they learned from the expert's modeling of problem solving?

   2b. What did the students see as benefits when expert modeling is used as a scaffolding strategy?

Demographics and Methods

Participants of this study were from 2015 freshmen cohort of Honors College, in a public urban research university in the mid-west of USA. Six Honors College First Year sections participated in this study. Three sections formed the Control group and another three sections

formed the Treatment group. The sections were assigned to Control or Treatment group depending on the instructor and were determined with a coin toss. For practical feasibility, three Control Group sections were taught by the same instructor and three Treatment Group sections were taught by same instructor. Students who were less than 18 years of age at the beginning of the fall semester of 2015 were not considered in the study. Total number of participants who qualified for the study, Treatment and Control group combined was 144.

Task I

122 participants were considered for the data analysis of Task I in this study. There were 58 Participants in the Control Group and 64 participants in the Treatment Group.

Week 4 Fall 2015: Both control and the treatment groups were assigned the same and identical ill structured problem solving assignment - Task I during Week 4 of the Fall term. Appendix C describes the Task I-Problem Solving Assignment. The problem solving reports of the students were collected by the instructor during Week 5 seminar sections. The instructor then shared hard copies of student task reports with the researcher. The researcher eliminated the participants who were less than 18 years at the start of the Fall term and removed all personal identifiers from the reports and assigned alphanumeric participant IDs for each of the entrees using MS EXCEL program. No record linking the participant names to the alphanumeric IDs were kept for this study. After this, the researcher made 2 copies of the task I reports and forwarded paper copies of all the problem solving reports to two graders, for blind review. The researcher also provided the graders with excel form sheets for recording the scores. The two reviewers scored the problem solving reports independently using the rubric (Appendix B). The scores from the Task I problem solution report provided the baseline score or entry level scores of the problem solving abilities for both the groups.

The quantitative data for Task I was analyzed using SPSS and the findings from the data analysis can be found in Chapter 4. The results indicated that there was no significant difference found in the performance of the two groups for Task I for the first two learning outcomes Define Problem and Analyze Issues Critically and Comprehensively. However there was a difference in the performance of the two groups on the third problem solving outcome Evaluate Proposed Solutions, where the treatment group performed better than the control group.

While this result indicates a possibility that the treatment group's entry level abilities on the third component (Evaluate proposed solutions) were higher to start with, there could be several other factors that resulted in the obtained result. Task I was planned at Week 1 of the study during the study proposal. In the implementation, Task I was given to participants during Week 4. This was due to some changes in the timing of the assignments in the course made by the lead instructor. The researcher had little or no control over the timing of the assignments as the researcher was not the main course instructor. This adjustment of time could have had an impact on the Task I results as the scores in Task I could now be impacted somewhat by the teaching skills and strategies of the Control and Treatment Section Lecturers. Hence this could also imply that the treatment section instructor was stronger and that had some impact on student performance and hence on the data analysis results for Task I.

Another possible consideration could be that the treatment group students were more motivated and oriented towards the tasks and hence the difference in the results. It is to be noted though that this study does not compare the performance of the two groups on the two tasks, Task I and Task II. Task I scores are for getting the baseline performance of the two groups on an ill structured problem solving task.

Task II

122 participants were considered for the data analysis of Task II in this study. There were 54 participants in the Control Group or Group 1 and 68 participants in Group 2 or the Treatment Group for Task II.

Week 10 Fall 2015: The second ill structured problem assignment was presented to both the control and the treatment groups. The control group received the assignment as described in Appendix D, and the treatment group received the assignment as described in Appendix E (with the treatment) and the self-reflection paper, Appendix F. In Appendix E, in addition to the problem assignment, the treatment group also received the treatment – expert's analytical guidelines and an expert's problem solving report (for a similar problem solving assignment for example). The expert's analytical guidelines propose the strategies of the expert as they progress through the problem solving process. The section instructor also presented the treatment group with two reflective questions (Appendix F) on their problem solving experience with the expert modeling as a scaffold. The students in Control group did not receive the expert's guideline or the report. All participants in the control and treatment group worked through the Task II assignment and submitted the work to their respective section instructors, by Week 12.

Again, as in Task I, two graders graded students' problem solving assignment reports independently without any form of communication or consultation. The reviewers met after all the grading was done to discuss grades that differed between the two raters by more than three points and to collaborate and negotiate on the scores and reach at a mutually agreed upon score. The mutually agreed score was considered for data analysis in those cases.

Pearson Chi Square analysis was conducted to examine the quantitative research question and the sub questions. As discussed earlier, the chi-square test is an appropriate statistical test to measure the relationship between variables when we work with categorical data. Since the scores

assigned to the problem solving report were assigned using the rubric, the data that was collected, the individual scores at each problem solving step and the total score, were ordinal data; hence chi-square analysis was used as the quantitative analysis to determine the effect of expert modeling on the problem solving performance of the students. All quantitative data analysis was done using the software SPSS (Statistical Package for the Social Sciences).

Discussion

This section discusses the findings from the data analysis and conclusions based on the results obtained from the quantitative analysis of Task II. All results from the quantitative data analysis were reported in Chapter 4. Along with quantitative results, qualitative data analysis results and interpretations were also presented in Chapter 4. Presented below is the summary of the results and conclusions that can be drawn from the results for each question and sub questions in the study.

Research Question 1. What is the effect of using expert modeling as a scaffolding strategy on students' problem solving outcome?

To answer this question, analysis of the total problem solving score in Task II for the two groups was done. The component scores for the three problem solving learning outcomes were totaled and the total score for problem solving was analyzed to glean information on effect of the treatment on the composite/total problem solving outcome for the groups. The results of the analysis are shown in Table 4.8.

From the Chi Square table, the p value for the total problem solving scores data is equal to 0.021. Since p=.021 <0.05(level of significance), the chi square result is significant, which implies that, there is a significant difference between performance of the two groups on the total problem solving outcome for Task II. Group 2 or the Treatment Group performed significantly better on

the overall or total problem solving outcome than Group 1 or the Control group for Task II. The treatment group students worked with the expert analytical guidelines and expert problem solving report and performed superior in the total and overall problem solving learning outcome.

Research Question 1a. What is the effect of using expert modeling as a scaffolding strategy on students' ability to define a problem?

The results of this analysis are shown in table 4.5. Since the p-value p=.044 was found less than 0.05(level of significance), for this set of data, the chi square result is significant. This implies that, there was a difference between the performances of the two groups on the first problem solving outcome "Ability to Define Problem" for Task II. Group 2 or the Treatment Group outperformed Group I on the first problem solving outcome or ability to define a problem for Task II.

Research Question 1b. What is the effect of using expert modeling as a scaffolding strategy on students' ability to analyze issues within a given problem?

The results of this analysis are shown in table 4.6. The p value in this analysis was equal to 0.057. Since p = .057 > 0.05(level of significance), the chi square result is not significant on the second problem solving outcome for Task II. However, we should make an important observation that p = .057 which is very close to the alpha value or .05, and hence it just marginally misses to be a significant difference in performance of the two groups in this category.

Research Question 1c. What is the effect of using expert modeling as a scaffolding strategy on students' ability to evaluate proposed solution?

The results of this analysis are shown in table 4.7. The p value for this data set is equal

to 0.003. Since p=.003 <0.05(level of significance), the chi-square result is very significant, which implies that, there is a significant difference between performance of the two groups on the third problem solving outcome for Task II. Group 2 or the Treatment Group outperformed Group I or Control Group on the third problem solving outcome for Task II.

Research Question 2. How do the students experience problem solving when expert modeling is used as a scaffolding strategy?

Qualitative data analysis of the participant reflection responses were used to understand what the learners perceived they learned from the experts' analytical guidelines; and whether they found the scaffolding strategy used in this study helpful. The reflective prompts can be found in Appendix F. Completion of the reflection questions were optional to the participants as this was not a part of course work for this course and was required only as a part of this study.

There were 68 participants in the treatment group for Task II. The researcher obtained 51 reflection essays from the participants which imply that 75% of the treatment group participants completed the reflective questions. 100 % of the participants who completed the reflection writing mentioned that the expert analytical guidelines have been beneficial and helpful for them for the problem solving task II. The participants have overwhelmingly mentioned that the analytical guidelines helped them to frame their responses and helped them to get started on the assignment. Some participants mentioned that they found the assignment vague and too open until they read through the analytical guidelines which provided them a place to start and organize and structure their thoughts. Many participants reported that they have learned to apply critical thinking and reasoning and problem solving strategies from the analytical guidelines. Several participants thought that these guidelines could be used as a framework and would help them solve other problem solving assignments in the future.

The qualitative data analysis process for this study was based on Miles & Huberman's qualitative data analysis model (1994), which consists of three steps: Data Reduction, Data Display and Conclusion Drawing/Verification. The researcher manually coded the data and used the application MS Excel for coding and display graphics.

Research Question 2a. What did the students perceive they learned from the expert's modeling of problem solving?

Figure 4.1. Perceived Learning from student reflection
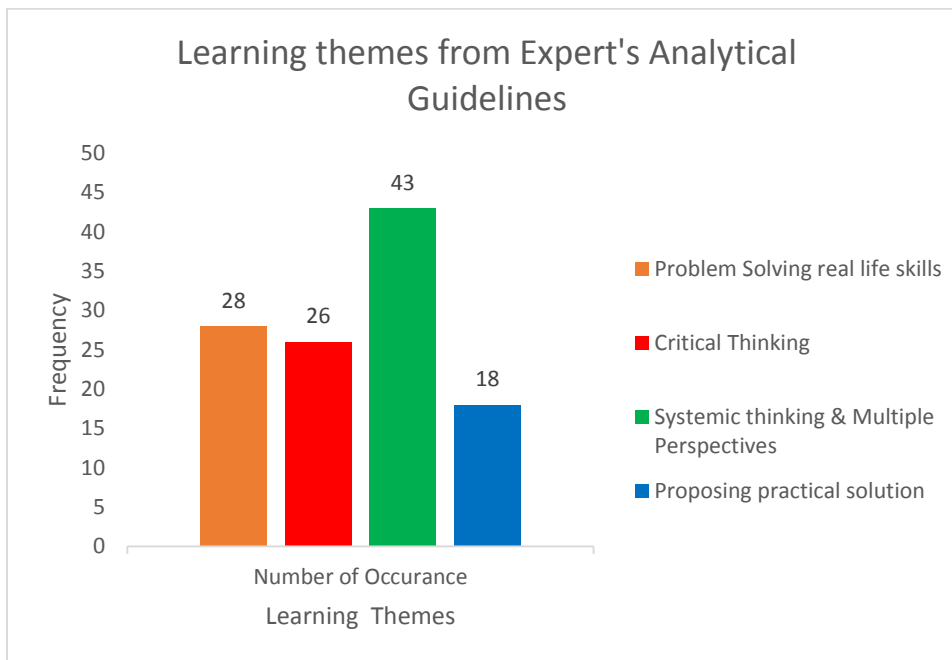
All participants overwhelmingly reported a positive experience with the expert modeling strategy used in this study. The major categories the participants mentioned that they perceived as learning from the expert modeling was systemic thinking & multiple perspectives, proposing practical and feasible solutions, critical thinking skills, and real life problem solving skills. Learners overwhelmingly voted for systemic thinking and multiple perspectives as one of the most important learning from the expert's analytical guidelines which they thought they could

use for most future problem solving assignments. Many students admitted that this kind of problem solving assignments was very new to them and that they used the guidelines as a framework to identify the problem, critically analyze issues from all different perspectives, organize their thoughts based on the information they researched and structure their responses.

Research Question 2b. What did the students see as benefits when expert modeling is used as a scaffolding strategy?

Figure 4.2. Perceived Benefits from student reflection
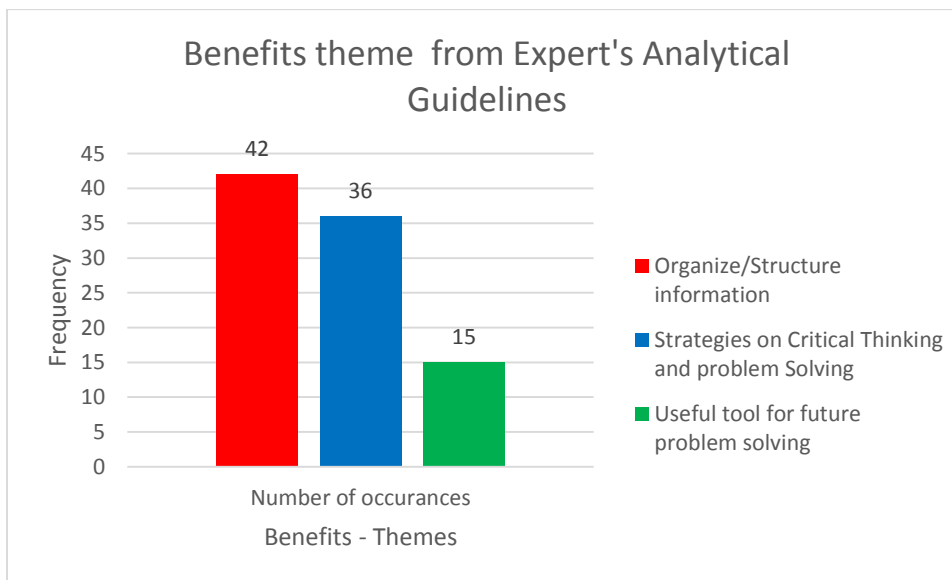
Majority of the participants reported that the Expert's Analytical Guideline helped them to structure and organize their response, and gave them a framework that they could follow for any problem solving assignment. The participants also reported that the guidelines helped them with strategies on problem solving and critical thinking which was beneficial for responding to the assignment task. The participants thought that the expert modeling benefited them by providing a useful tool that they could use in future for other similar problem solving situations; the scaffolding strategy helped them organize and structure the information and helped them

follow expert's strategies on critical thinking and problem solving skills while approaching and working on a problem solving task.

Summary of discussion

This study was based on the conceptual framework from Jonassen (2011) where Jonassen provided recommendations for matching components and scaffolds with learners' needs when solving different kinds of problems in a PBLE. Expert modeling can be used as an effective scaffolding strategy for ill structured problem solving (Jonassen, 1994). According to Collins, Brown & Newman (1989), expert modeling provide learners with an opportunity to learn about the cognitive process of an expert while problem solving and encourage reflective thinking to compare expert's problem solving with their own process with gradual internalization of the problem solving process.

Expert modeling have been used by researchers as a scaffolding strategy for different PBL teaching learning environments (Pedersen & Liu (2002); Simons & Klein (2007); Chen & Ge (2006); Ertmer, et. al. (2009); Ge, Planas & Er (2010)). All findings from this research study confirm the results and findings from previous studies on expert modeling. The themes of perceived learning and benefits of the scaffold strategy that emerged from the qualitative analysis of the reflection data also resonate with and add to the findings from previous studies (Chen & Ge, 2006; Ertmer, et. al. 2009; Ge, Planas & Er., 2010) that have used expert modeling with problem based learning environments within a different setting, level and discipline.

As discussed in the earlier chapters, there has been a growth in adoption of problem based learning in undergraduate education in the recent years (University of Delaware, 2016; Brown University, 2016) in order to respond to the requirements specified by industries and businesses to prepare learners workforce ready and as real world problem solvers. Almost two

decades back, Wingspread Conference report (1994) identified the important skillset that college and university graduates should possess, among them were communication, computation and technological literacy and information retrieval abilities. In addition to these, the report had also emphasized the importance of the ability to make informed decisions, by defining problems, gathering and analyzing information and root causes around these problems and then providing workable solutions. This study measured the performance of the participants in all of these domains, or learning outcomes: specifically ability to define a problem, ability to analyze issues critically and comprehensively and ability to evaluate proposed solutions. The results from this study have indicated that the scaffolding strategy was actually very effective in this context and actually led to better problem solving performance of the treatment group. Participants in this study also found the expert modeling strategy effective and beneficial and had a positive problem solving experience.

Implications for instructors in Higher Education

The findings of the study indicated that expert modeling can be an effective strategy for supporting problem based learning in a general education setting. Historically modeling strategies have been used mostly in medical education. With the increased emphasis on problem solving and problem based learning in different disciplines, many instructors are adopting PBL in curriculum and different aspects of problem solving as their course learning outcomes. However students need to be supported in problem based learning environments and instructors need to design instructional scaffolds that support student learning.

Most of the participants in this study mentioned in their reflection papers that they were working on an ill structured problem solving for the first time, and that the expert's analytical guidelines was a helpful tool that they used to prepare, organize, think through and structure the

assignment. Many participants mentioned that they used the guidelines as a framework and gathered all information, used multiple perspectives/ ways of seeing a problem, and deep thinking strategies while working on Task II. The form of scaffolding that was used in the study does not require any extra funding or budgeting or technological knowledge, and is an inexpensive but effective way to support student learning.

This study is unique in its setting, as it was conducted in Honors College, with students from various disciplines; and also, unique in its disciplinary area - General Education/Social Sciences. Most of the studies discussed in the literature review of expert modeling, were all in either medical education, or health education (Pharmacy, Nursing) or STEM related fields. The findings from this study could be a resource for the social sciences and general education instructors to design problem based learning environments.

The expert's analytical guidelines from in this study could be used as a scaffold design framework for designing ill-structured problem based learning assignments by instructors teaching undergraduate or graduate courses in social sciences or general education or any other course with some changes tailored for that particular context. Research results from this study suggest positive experience of the students with the scaffolding strategy and instructors interested in creating effective problem based learning environments could use the guidelines as a framework to support student learning.

With the rapid proliferation of the Internet and other affordable online educational technology tools, higher education has experienced an increase in the online or blended courses being offered throughout the world in colleges and universities. Expert modeling as a form of scaffolding could also be very useful in creating an effective online problem based learning environment. Expert analytical guidelines could be configured as e-prompt or online analytical

guidelines that help students advance through the problem solving process, learn the strategies of problem solving and gain a positive problem solving learning experience.

Implication for instructors in K-12 Education

In the recent years, with the development and adoption of Common Core standards in K-12 schools, across the states in the USA, there is a great deal of emphasis on preparing students to be college and workforce ready by the time they graduate from high school. Common Core standards list what the students should know and be able to do and the Common Core curriculum explains how the students will learn it. There has been a major shift in curriculum from the traditional, with respect to Mathematics and English, with the Common Core standards; and one of the areas that have been prioritized under Common Core is Problem Solving (Common Core, 2016).

While teachers in K-12 have been implementing the Common Core standards, there has been little research on best practices that could be put to work, in order to achieve the standards and improve the learning experiences of the students. The information gleaned from the results of this study could be used by K-12 educators to support problem solving learning of their students in a Problem Based Learning Environment. Since the implementation of the treatment used in this study does not require additional funding or budget or technical skills, the modeling strategy used in this study could be an attractive method to improve student success in problem solving activities. Expert's analytical guidelines to perform problem solving activities could be used as a scaffold framework with K-12 students to help them organize and structure their responses and approach problem solving with strategies that an expert in the field would do.

Implication for the field of Instructional Design and Technology

It is evident that the importance of preparing learners to be college ready and workforce ready is on the rise. In the recent years, state commissioners of education, higher education administrators, K-12 administrators across USA and globally have recognized and emphasized the importance of learners and graduates to be able to solve real world problems and be critical thinkers and innovators rather than merely being consumers of information. With this growing importance, educators in different levels have adopted problem solving and critical thinking as primary learning outcomes of their curriculum. Research results from different study have indicated that students need learning support for successful learning in Problem Based Learning Environments, which differ from traditional learning environments in many aspects (Jonassen (2011), Savery (2006), Hmelo-Siver (2004).

Instructors and instructional designers can create an effective learning environment with selection of appropriate media and by designing scaffolds that support student learning and enhance the learning experience of students. The scaffold strategy used in this study was found effective from the quantitative data analysis; and feedback from students in the treatment group indicated that students benefited and learned from the modeling strategy used in the research. Instructional technology researchers and instructional designers could use this scaffolding strategy to design future courses at various levels or for designing instructional materials or text-books that are geared towards problem solving activity practice for learners. Analytical guidelines could be included as scaffold strategy with real life problem cases in text books at different levels for problem solving practice case studies in the curriculum to enhance student learning of problem solving strategies.

Recommendations for Future Research

This study attempted to investigate the effect of expert modeling on ill structured problem solving for undergraduate honors students. The findings from this study indicated that expert modeling was beneficial for the treatment group participants and the participants in this study had positive problem solving experience with the modeling strategy used in the study. The study also opens possibilities for further research that could be explored by researchers and educators in the field of education, instructional design, learning sciences or educational technology. Recommendations for future research include:

- The design of this research study was quasi experimental. Since the researcher was not the instructor of the course, she had little control over the course structure; there were several seminar sections involved and the assignment of the treatment and the control conditions could not be randomized. It would be worth redesigning this study as an experimental study, within a section and then randomizing the treatment. It would be interesting to compare and observe the qualitative differences between the problem solving performances of the two groups with an experimental design.

- This study was conducted over seven weeks in a Fall term. Since this was a dissertation research and had time constraints, longitudinal data on the participant's growth in problem solving abilities with scaffolding could not be gathered. Another variation of this study that is definitely worth investigating would be to design this research as a design based research study and observe the learners' growth with expert modelling strategies; then gradually fading and weaning off scaffolding as the learners become proficient in handling ill structured problem solving.

- There is a growing emphasis on designing problem based learning environments. All sectors of education starting from K-12, higher education and workforce training have emphasized on graduating problem solvers of the real world. This study was conducted in a traditional setting using a lecture and a discussion section in classroom. It would be interesting to conduct a similar study in any online general education course setting, with expert modeling as scaffolding, as many higher education courses are now offered as online courses and the findings could provide more specific and targeted inputs for online instructional design.

- Additional studies could be designed where we compare the problem solving abilities of participants between tasks within a group and not between groups: Task I – without scaffolding and Task II – with expert modeling as scaffold and compare growth and qualitative difference in response and performance of the participants.

- Other studies comparing the effectiveness of two forms of scaffolding, like expert modeling and question prompts; or expert modeling and peer collaboration could be designed to compare the effectiveness between scaffolding strategies.

Assumptions and Limitations

Assumptions and limitations of this dissertation research study were as follows:

Assumptions

1. Problem solving is an important skill in the twenty-first century, as businesses and employers seek employees who are problem solvers and want graduates who possess real life problem solving and critical thinking skills.

2. More empirical research is necessary to successfully design and implement scaffold for effective learning in Problem Based Learning Environments.

3. Expert modeling can be an effective scaffolding strategy to enhance student learning and experience in problem based learning.

4. Decision making problem tasks are appropriate problem cases for ill-structured problem solving learning in general education courses.

Limitations

1. Convenience sampling was used to select participants in this research study.

2. The study was limited to undergraduate students in Honors College in a University in the mid-west of USA.

3. For practical and implementation feasibility, the research design chosen for this study was quasi experimental.

4. Due to time constraints of a dissertation research, the study was limited to one semester and longitudinal data over time was not collected or analyzed.

Conclusion

This study investigated the use of expert modeling as a scaffolding strategy for ill structured problem solving in a general education setting. The results indicated a positive experience of students with the modeling strategy in the problem based learning environment. Findings from this study confirmed previous findings on using expert modeling as an effective scaffolding strategy. The perception data from the participants' reflection indicated that the participants found the modeling strategy helpful and beneficial for responding to the problem solving task. The quantitative data analysis confirmed that the treatment group participants who worked with the expert's analytical guidelines performed significantly better in the overall

problem solving abilities. The information gathered from the findings of this study could provide resources to instructional design strategies and practices for problem based learning in various settings and contexts especially for general education or social sciences setting.

APPENDIX A. A SAMPLE OF STUDIES ANS FINDINGS ON DESIGNING PBLEs

WITH SCAFFOLDS

Study on scaffolds in PBLEs	Scaffolds	Findings	Participants	Area
Ge & Land (2003)	Question Prompts, Unguided peer interactions	Positive results on problem solving performance with Question Prompts; Some benefits of peer interactions on cognitive and metacognitive skills - no significant effect on Problem Solving. Recommended guided and monitored peer interactions to maximize benefits.	Higher Education	Information Sciences and Technology
Saye & Brush (2002)	Expert Guidance that give students strategic road maps to understanding; spontaneous support of a highly skilled teacher	Hard scaffolds in the form of multimedia supported learning environments helps lessen the cognitive burden posed by an ill structured problem, but with limits. Master teachers can provide the ultimate scaffold (soft scaffold) that helps in problem solving learning.	K-12	History
Simons & Klein (2007)	Expert Advice, Teachers' guide, Teacher's support	Use of scaffolds have a positive impact on student learning in PBL. Teacher scaffolding throughout the learning cycle is important to support reflective learning and to provide dynamic guidance and meaningful feedback.	K-12	Science
Reid, Zhang, & Chen, (2003)	Interpretative support, Experimental Support and Reflective Support	Positive results for meaningful learning, reflective learning and understanding	K-12	Science

Pedaste & Sarapuu (2006)	Addition of appropriate notes to make students aware of the learning process and then rearranging the sequence of educational tasks according to students' performance	Positive effects on general problem solving ability and development of analytical skills	K-12	Science
Su (2007)	Metacognitive scaffolds and Content Scaffolds	Students given content scaffold performed significantly better than those supported with meta cognitive scaffolds. Students with no scaffolding spent less time on group project than students with content and metacognitive scaffold.	Higher Education	Computer Literacy
Choi & Lee (2009)	Question Prompts	Positive results on ill structured problem solving ability and transfer of learning in problem solving	Higher Education	Teacher Education Students
Ge, Planas & Er (2010)	Question Prompts and peer review (without feedback) with revision opportunity. Expert modeling with self-reflection.	Peer review by itself did not have any significant effect on the problem solving learning. Researchers suggested communication, interaction and feedback exchange among students.	Higher Education	Pharmacy Students

Greene & Land (2000)	a) WWW resources; b) procedural guidelines for the instructional activity; c) student-student interactions; and d) instructor-student interactions	Positive effect on learning; social scaffolding based on face to face dialogue with instructors and peers was critical to helping learners manage the complexity of the open- ended project	Higher Education	Instructional Design
Pedersen & Liu (2002)	Expert modeling with a hypermedia tool	Approach to problem solving and quality of work showed improvement	K-12	Science
Ertmer, Stepich, Flanagan, Kocaman-Karoglu, Reiner, Reyes, Santone & Ushigusa (2009)	Expert analytical guidance	Treatment group performed significantly better than control group on problem representation and problem solving total score	Higher Education	Instructional Design

APPENDIX B. DATA COLLECTION INSTRUMENT: HONORS COLLEGE PROBLEM SOLVING RUBRIC

Heading	Rubric	L Outcomes	4	3	2	1
Problem Defined	Problem Solving	Define Problem	Identifies and articulates problems/issues in a way that facilitates critical analysis and fully takes into account relevant contextual factors, i.e., its historical, ethical, social, cultural and disciplinary dimensions.	Identifies and articulates problems/issues and takes into account most of the relevant contextual factors, i.e., its historical, ethical, social, cultural and disciplinary dimensions.	Begins to demonstrate the ability to identify and articulate a problem/issue statement with evidence of some relevant contextual factors, but problem/issue statement is superficial.	Demonstrates a limited ability to identify and articulate problems/issues or consider related contextual factors.
Issues Analyzed	Critical Thinking	Analyze Issues Critically and Comprehensively	Gathers and critically analyzes all information necessary to thoroughly identify and/or develop actual and potential solutions to the problem.	Gathers and critically analyzes most information necessary to identify and/or develop actual and potential solutions to the problem.	Gathers and analyzes some information necessary to identify and/or develop potential solutions. Issue/problem is stated but description leaves some terms undefined, ambiguities	Does not adequately clarify or describe information necessary to identify issues to be considered.

			unexplored, and boundaries undetermined, and/or backgrounds unknown.			
Evaluate Proposed Solutions	Problem Solving	Evaluate Proposed Solutions/Hypotheses to Problems	Evaluate potential and actual solutions with detailed consideration given to relevant contextual factors, feasibility, and effects/impacts, and recommend or offer conclusions based on same.	Evaluate potential and actual solutions with sufficient consideration given to relevant contextual factors, feasibility, and effects/impacts, and recommend or offer conclusions based on same.	Evaluate potential and actual solutions with adequate consideration given to relevant contextual factors, feasibility, and effects/impacts, and recommend or offer conclusions based on same.	Demonstrates a limited ability to evaluate potential and actual solutions.

APPENDIX C: TASK I

Task I

HON 1000: Writing Diagnostic: Chrysler 200 | Eminem 2011 Super Bowl Commercial

Due: Week 2

Assignment Directive:

Go to YouTube.com and view the commercial at this link. https://youtu.be/SKL254Y_jtc
The commercial talks about the city—Detroit.
What way(s) of seeing Detroit is being reported by the commercial?
Do you believe this "way of seeing" the City? And, why or why not?
Further considerations:

Any overlapping commercial—and broader course (e.g., lecture, texts)—themes, as potentially applicable to essay?
What is considered luxurious? Generally speaking and with respect to automobiles? Are the "finer things" associated with America, let alone Detroit?
Detroit as: Resurgent? Resilient? Do "we" got grit, conviction? Are we hardworking and have generational and institutional know-how? What—if at all—does any of this matter for buying a car? Did it have an effect on sales of the then "new" Chrysler "200"?
Who is "us"—Detroit-proper? Metro-Detroit? If the latter, what is the proper ratio that strikes the most honest balance?
Has misinformation and disinformation produced an untruth caricature of "us"? If so, who's responsible for the misrepresentation and the distribution thereof?
That aside, what are we then—something by what we are not?
What feelings(s) is the commercial meant to invoke? What is it—if anything (Baudrillard and the Nike Swoosh)—supposed to mean or do, beyond car sales?
Why that track—and relatedly, Eminem? And then why the all-African American gospel choir?
The narrator ends: "We are the Motor City. And this is what we do." We who—Eminem and the chorus themselves, or whom they're representatives of? Or is we Chrysler—the corporation, the employees and/or the stake-holding communities?
What does "Imported from Detroit" mean, wish to convey—in terms of, say, luxury? Or a people or a city?
And last, what does the "Motor City" comprise of? Where is the 200 produced? Where is Chrysler domestically headquartered? Where is its parent-affiliation headquartered? And where has it—they—most recently relocated? And most of all, do the answers to these questions matter—that is, relative to the commercial as well as to the course and the first essay?

Housekeeping:

One-page, typed. One-inch margins. One and a half spaced (the one between single- and double-spaced).
Times New Roman font. 12-sized font. Regular font spacing.
Only your name should appear at the top of the paper before your first sentence—that is, no title, date, etc. is necessary. No more than one page, but not less than three-quarters of one, either.

APPENDIX D: TASK II CONTROL GROUP ASSIGNMENT

Task II - Control Group Problem Solving Assignment

Written Assignment: *Where are we going?*

Due: November 16, 2015
750-1,000 words

For this assignment, you will be asked to work individually and with a group of your fellow class members. Your first job is to individually pick a site somewhere in metropolitan Detroit (in the city or surrounding area). Second, come to class prepared to present your site to the other members of your group. After the presentations and discussion, your group will choose one site you think best represents: *Where are we going*. Keep a record of the process by which your group chose the site, who said what and what suggestions people made. That will be one kind of research you assemble to complete this assignment.

Third, your group will work together to do some further research on the site. This research might include analysis or the sites history, photographs of the site, or observations about the physical layout of the site and how people behave there.

Fourth, you will plan your own, individual essay, based on the research you have produced together. In it, you should explain what site you will be writing about, and whether you agree with the choice of your group. Then it is your job to justify a "way of seeing" the site that makes it either a good or a bad illustration of who we are (depending on whether you agree or disagree with your group). You should also document your site photographically and include at least one image in your assignment. Don't just tell us what the site means to *you*, but also what it can teach *all of us* about cities. The aim is to move away from self-inquiry and into shared relevance.

Pick your site from this list:
Book Cadillac (Westin Hotel)
Campus Martius
Compuware Building (old Hudson's Building)
Grand Circus Station
Guardian Building
Hitsville U.S.A.
Piquette Ford Plant
David Whitney Building
Scarab Club
Tiger Stadium former location on Trumbull and Comerica Park

APPENDIX E: TASK II TREATMENT GROUP ASSIGNMENT

Task II - Problem Solving Assignment with Expert Modeling
<u>Due: November 16, 2015</u>

Directions: <u>Respond to this Assignment below.</u>
<u>Written Assignment:</u> *Where are we going?*

<u>**Before you start working on this assignment,**</u> **read carefully on next page, strategies and approaches of an expert in this field to solve this problem assignment. Then carefully examine the expert's report.**

750-1,000 words

For this assignment, you will be asked to work individually and with a group of your fellow class members. Your first job is to individually pick a site somewhere in metropolitan Detroit (in the city or surrounding area). Second, come to class prepared to present your site to the other members of your group. After the presentations and discussion, your group will choose one site you think best represents: *Where are we going*. Keep a record of the process by which your group chose the site, who said what and what suggestions people made. That will be one kind of research you assemble to complete this assignment.

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Book Cadillac (Westin Hotel)
Campus Martius
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Grand Circus Station
Guardian Building
Hitsville U.S.A.
Piquette Ford Plant
Scarab Club
David Whitney Building
Tiger Stadium former location on Trumbull and Comerica Park

(APPENDIX E CONTD.)

Treatment Group - Expert's Guidelines to Problem Solving

While analyzing the problem, consider these guidelines:

1. Read and define the question.

2. Select a site from the list.

3. Have your rationale behind selecting the site.

    a. Why did you choose this site

    b. What do you want to find out about the site?

    c. Why do you think the site stands for "where are we going" as Americans, Detroiters, and urban people in general?

4.   List any information that you want to research, i.e. historical background, reason for existence, funding, past use, current use, changes in appearance or use, etc. Then make a list of possible sources. (Make sure to consult the library's website for books, journal articles, newspaper and magazine articles, pictures, and/or primary sources.)

5. Visit the site. Bring a journal to record your thoughts and findings while there. What does the site look like? How is it being used today? How do people act around/on the site? What do you think about how it looks and is being used?

6. Justify a "way of seeing" the site – as the site evolved with time from the beginning to present and how it is a representation of "where are we going" and whether it is a good or a bad representation of "where are we going." Be specific when you explain "where are we going" and which groups of people you are talking about. Everyone in metro Detroit, or just certain groups?

7. Investigate the root causes behind the issue or problem that this site represents.

8. Do research to find out the most critical issues or historical events that had the greatest impact on the site.

9. Generate ideas from multiple perspectives; consider multiple issues and how they worked together at the site to represent what it is today. Consider different groups of people and different ideologies to determine the factors that played a role in the site's current picture.

10. Propose your solution to the problem represented by the site.

11. Evaluate the practicality and feasibility of your solution using research. Find issues that might be barriers to this solution. Is the solution worthy and cost effective? Evaluate the pros and the cons.

12. Justify your solution with support/reference from the texts or supplemental materials from this course, or other readings and class/lecture discussions.

(APPENDIX E CONTD.)

Treatment - Dr. Expert's Report on Site : Renaissance Center

Here is an example of a problem solving report to the Task II . Read this as a model to see how the expert approaches problem solving, proposes/evaluates solutions and supports claims with appropriate references.

We Are NOT The Renaissance Center

When I saw the Renaissance Center as one of the options for this assignment, I immediately signed up for it. What could be a better representation for the city of Detroit than the large skyscrapers that I can see from my hometown, Windsor? After all, it is owned by one of Detroit's "Big Three" automobile companies, General Motors, and is a beautiful piece of architecture that shows a brighter side to the city. However, as I started to delve into the center's history and the impact it had on Detroit, I realized that it was a gaudy distraction from the city's true nature and a detriment to that nature. Detroit is a city rich in history, comprised of a large proletariat class and a tight knit community. The reason for creating the Renaissance Center, its typical visitors, and the architectural aspects of the center neglect those characteristics.

Many of Detroit's Caucasian residents had already left the city by the 1960s[1], but the Detroit riots of 1967 drove out more of the city's remaining Caucasian residents due to the huge safety concerns the event raised among the public[2]. What was left was an unstable feeling that loomed over the city. Henry Ford II and other successful Detroit businessmen created Detroit Renaissance, Inc.[3], a group dedicated to giving the city new businesses and a new image. Ford especially wanted to help the city because his company had been accused of not doing enough

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[1] Beth Fowler, Microsoft Word note, September 21, 2014.
[2] Francis Desiderio, "'A Catalyst for Downtown': Detroit's Renaissance Center," *Michigan Historical Review Vol. 35* (Dearborn: Central Michigan University, 2009), 84-85.
[3] Desiderio, "'A Catalyst for Downtown': Detroit's Renaissance Center," 85.

for it.[4] Lawrence Doss, the president of another pro-Detroit group called "New Detroit" suggested a large development project for the city, similar to the projects he had seen in Pittsburgh and Atlanta;[5] Pittsburgh's Allegheny Conference is an economic and community developing program that works with private and public sectors to improve the city[6] and Atlanta's "Forward Atlanta" project was an advertising campaign that encouraged new businesses to come to the city and resulted in thousands of jobs for its residents.[7] And Ford thought this was a good idea because it would be better for the city's image to be an imitation of another city than to be a true representation of itself. This point is proven through Ford hiring the architect, John Portman, who designed a cylindrical theme that he had already used for the Peachtree Center's Plaza Hotel in Atlanta and the Hyatt Regency at Chicago's O'Hare Airport;[8] Ford's approval for this unoriginal design and multiple partnerships with large companies in order to afford the cost of building it show that he didn't want something that was special or unique to Detroit, just something that would impress outsiders. As Francis Desiderio states in his paper, "the Renaissance Center's development was the result of private interests working to create an environment . . . comparable to the malls and office parks found in the suburbs . . . that could be easily controlled and monitored."[9] This project was not spurred by pure intentions to revitalize Detroit or to represent the city in an honest manner; the companies involved wanted a better image for themselves so that their businesses would still be prosperous.

This unfaithfulness to the city continued after the center was built. The Renaissance Center is a stunning set of glass buildings with a great hotel and fine-dining options. It is a great

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[4] Desiderio, "'A Catalyst for Downtown': Detroit's Renaissance Center," 86.

[5] Al Stark, "The Challenge and the Reality," *Detroit News* (Detroit: Sunday News Magazine, June 24, 1973), 5.

[6] "Allegheny Conference on Community Development: About Us," http://www.alleghenyconference.org/AboutUs.php (accessed September 23, 2014).

[7] Andy Ambrose, "Atlanta," *New Georgia Encyclopedia* http://www.georgiaencyclopedia.org/articles/counties-cities-neighborhoods/atlanta (accessed September 23, 2014).

[8] Desiderio, "'A Catalyst for Downtown: Detroit's Renaissance Center," 97.

[9] Desiderio, "'A Catalyst for Downtown': Detroit's Renaissance Center", 83.

tourist attraction and an excellent office space for the employees of companies like General

Motors and Hewlett-Packard.[10] The people mentioned above do not make up the majority of

Detroit's residents; these people are part of the middle to upper-middle class, which a large sector

of the population does not belong to. Some critics, such as Roger Williams, have actually

referred to the center as a "Noah's Ark for the white middle class."[11] There is no doubt that this

center has probably given many jobs to the members of the proletariat, even if most of them only

pay minimum wage, but that is not what people see when they come to the center. On my visit, I

saw a lot of people in suits sitting in glass rooms, well-dressed Caucasian families eating in the

restaurants, and security guards patrolling the premises. This environment is not welcoming

towards the working class, the people who define Detroit, so it is not a positive symbol for the

city.

John Portman's design for the Renaissance Center solidifies it as a misrepresentation of

Detroit. It was fashioned using Portman's unique concept of "coordinate units," which are spaces

that have necessities such as offices, entertainment, and dining in an area that is small enough

that a person can walk around without needing another mode of transportation.[12] Basically, a

person can live happily in a confined area without ever having to leave; this is where the center

gets the nickname of "a city within a city." This system has had an extremely negative impact on

Detroit because it isolates the inhabitants from the rest of the city and it damaged local

businesses. Keeping middle-class workers separate from the real environment of downtown

Detroit perpetrates negative ideas of the area in the workers and other visitors. In fact, one of the

only large views that can be seen from inside the center, right in front of the main entrance, is of

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[10] "Renaissance Center," Wikipedia en.m.wikipedia.org/wiki/Renaissance_Center.html (accessed September 13, 2014).
[11] Quoted in Conway, "Case against Urban Dinosaurs," 9.
[12] Desiderio, "'A Catalyst for Downtown': Detroit's Renaissance Center," 93.

the Detroit River and the city of Windsor; there is no large window displaying downtown Detroit, just a tranquil river and unknown city. Also, by having everything the workers need in one area, people don't feel the need to step outside and buy from local vendors, causing small businesses to shut down.

Another aspect of Portman's design that misleads people about the nature of Detroit is the modernist architecture.[13] The buildings are covered in glass and have no semblance to any of the features from Detroit's architectural history; the French history provided the city with ornate statues and large dome-shaped buildings with pillars, which Portman chose to ignore. The Renaissance Center is a terrible representation of Detroit because of its negligence towards the city and its inhabitants.

After visiting and analyzing the Renaissance Center, I have realized that it is not at all the great symbol of Detroit that I thought it was. The center was built under the negative motivation to give the city a different image in order to avoid any loss in profit for the large companies in Detroit. The building is not targeted towards the working class inhabitants who make up the majority of the city and it shields its workers and visitors from enjoying other aspects of downtown Detroit due to the "coordinate unit" system John Portman implemented. The center is a piece of modern architecture and has no elements of Detroit's history in its design. It is very easy to fall into the trap of believing the Renaissance Center is a good representation of the city because of its looks and association with the automobile industry, but a deeper look into the magnificent glass buildings reveals a much uglier truth.

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[13] "Renaissance Center," *Wikipedia* en.m.wikipedia.org/wiki/Renaissance_Center.html (accessed September 13, 2014).

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     24, 1973.

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APPENDIX F: TREATMENT GROUP REFLECTION PROMPTS

Treatment Group Self - Reflection Questionnaire

Please provide thoughtful responses to the following questions.

1. Please explain and make a list of what according to you were the important problem solving strategies that you learned from Expert's guidelines and response to the problem situation? How can you use them in solving other problems?

2. How do you think the expert's guidelines and report helped you to prepare your own problem solving report in how to approach a problem and propose solution?

APPENDIX G: RESEARCH INFORMATION SHEET

Title of Study: Effect of Expert Modeling on Ill-Structured Problem Solving in an Undergraduate General Education Honors Course

Principal Investigator (PI):   Minakshi Lahiri
                                    Administrative and Organizational Studies
                                    Instructional Technology
                                    (313)577-9872

Purpose:
- You are being asked to be in a research study that will investigate the effect of using a scaffolding strategy for Problem Based Learning, because you are a student of Irvin D Reid Honors College at Wayne State University. This study is being conducted at Wayne State University.

Study Procedures
- You should be 18 years old or older to participate in the study. If you take part in the study, you will be assigned to one of the two groups, depending on the Senior Lecturer's section you belong to. All of you will be asked to complete two problem solving tasks/assignments which are also a part of your course assignments in HON1000. Some of you may be also asked to write a self-reflection essay with some reflection question prompts with the second assignment depending on the group to which you belong. The first problem solving task will be given to you by your instructor during the first week of class and the second problem solving task will be made available at the second week of class. Please follow all of the instructions and supplemental materials provided with the assignment (if any) carefully as you work on the tasks. In addition to the problem solving assignment, some of you may be asked to write a self-reflection essay (guided with reflection prompts) with the second task (depending on the group you belong to). Your participation in the study ends after you submit the task II problem solving report and the reflection essay to your instructor.

Benefits
- As a participant in this research study, there will be no direct benefit for you; however, information from this study may benefit other people/students/instructors now or in the future.

Risks
- There are no known risks at this time to participation in this study.

Costs
- There will be no costs to you for participation in this research study.

Compensation
- You will not be paid for taking part in this study.

Confidentiality:
- You will be identified in the research records by a code name or number. No record linking your identity to the code number will be preserved or be required for this study.

Voluntary Participation /Withdrawal:
Taking part in this study is voluntary. You may withdraw your participation at any time, however it may not be possible to withdraw your data once all participant identifiers have been removed. You are free to not answer the/any reflection questions. In that case your files will not be considered in the study. Your decision will not change any present or future relationships with Wayne State University or its affiliates

Questions
If you have any questions about this study now or in the future, you may contact Minakshi Lahiri at the following phone number (313)577-9872. If you have questions or concerns about your rights as a research participant, the Chair of the Institutional Review Board can be contacted at (313) 577-1628. If you are unable to contact the research staff, or if you want to talk to someone other than the research staff, you may also call the Wayne State Research Subject Advocate at (313) 577-1628 to discuss problems, obtain information, or offer input.

Participation
By completing the reflection essay, you are agreeing to participate in this study.

APPENDIX H: APPROVED RESEARCH INFORMATION SHEET FROM IRB

Effect on Expert Modeling on Ill Structured Problem Solving

Research Information Sheet

Title of Study: Effect of Expert Modeling on Ill-Structured Problem Solving in an Undergraduate General Education Honors Course

Principal Investigator (PI):   Minakshi Lahiri
Administrative and Organizational Studies
Instructional Technology
(313)577-9872

Purpose:
- You are being asked to be in a research study that will investigate the effect of using a scaffolding strategy for Problem Based Learning, because you are a student of Irvin D Reid Honors College at Wayne State University. This study is being conducted at Wayne State University.

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Benefits
- As a participant in this research study, there will be no direct benefit for you; however, information from this study may benefit other people/students/instructors now or in the future.

Risks
- There are no known risks at this time to participation in this study.

Costs
- There will be no costs to you for participation in this research study.

Compensation
- You will not be paid for taking part in this study.

Submission Date: 6/29/2015   Page 1 of 2

Form Date: 04/2015

Effect on Expert Modeling on Ill Structured Problem Solving

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Voluntary Participation /Withdrawal:
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Participation
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APPROVED

JUL 01 2015

WAYNE STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD

Submission Date: 6/29/2015   Page 2 of 2

Form Date: 04/2015

APPENDIX I: APPROVAL LETTER FROM HONORS COLLEGE

Approval Letter from Irvin D Reid Honors College

May 15, 2015

Minakshi Lahiri, Ph.D Candidate,
Instructional Technology Program,
College of Education.

Dear Ms. Lahiri,

I am writing to offer the support of Irvin D. Reid Honors College to your research proposal titled "Effect of Expert Modeling on Ill-Structured Problem Solving in an Undergraduate General Education Honors Course". We have always encouraged implementing research based effective teaching strategies in our college, and are pleased that you want to work with some of our students.
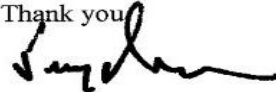
We understand that this proposal requires the support and cooperation of Irvin D Reid Honors College at Wayne State University. We are willing to cooperate with this project as long as our policies and rules are followed and our expectations in a number of areas are met.
This includes the following:

- That faculty whose discussion/seminar sections are part of this study are participating voluntarily.
- That students who volunteer to participate in the study can change their mind and leave the study at any time during the semester without impact to their grade. They are free to not answer any qualitative reflective questions and may withdraw at any time.
- That the results of the research be shared with the IDR Honors College staff and faculty on an on-going basis and in a timely manner
- That the study design/protocol be reviewed and approved by the IRB at Wayne State University

We support this research and look forward to working with you on this unique and worthwhile project. Please contact me at 313-577-3030 or jerry.herron@wayne.edu should you have any questions.

Thank you

Jerry Herron

Dean, Irvin D Reid Honors College.

Wayne State University.

APPENDIX J: IRB CONCURRENCE NOTICE

WAYNE STATE UNIVERSITY

IRB Administration Office
87 East Canfield, Second Floor
Detroit, Michigan 48201
Phone: (313) 577-1628
FAX: (313) 993-7122
http://irb.wayne.edu

CONCURRENCE OF EXEMPTION

To: Minakshi Lahiri
Honors College

From: Dr. Deborah Ellis *M. Boyt /2-2*
Chairperson, Behavioral Institutional Review Board (B3)

Date: July 01, 2015

RE: **IRB #:** 065215B3X

Protocol Title: Effect of Expert Modeling on Ill-Structured Problem Solving in an Undergraduate General Education Honors Course

Sponsor:

Protocol #: 1506014106

The above-referenced protocol has been reviewed and found to qualify for **Exemption** according to paragraph #1 of the Department of Health and Human Services Code of Federal Regulations [45 CFR 46.101(b)].

- Revised Social/Behavioral/Education Exempt Protocol Summary Form (revision received in the IRB office 6/11/15)
- Research Protocol (received in the IRB office 06/11/15)
- Research Information Sheet (revision dated 06/29/2015)
- Data Collection Tool (4): (i) Grading Sheet for Task 1 Control Group, (ii) Grading Sheet for Task 1 Treatment Group (iii) Grading Sheet for Task 2 Control Group, and (iv) Grading Sheet for Task 2 Treatment Group
- Reference Tool (6): (I) Appendix A: A sample of studies on designing PBLEs with scaffolds (ii) Appendix B - Data Collection Instrument: Honors College Problem Solving Rubric, (iii) Appendix C-Task 1, (iv) Appendix D-Task II - Control Group Problem Solving Assignment, (v) Appendix E – Task II – Treatment Group Problem Solving Assignment with Expert Modeling, and (vi) Appendix F - Treatment Group Reflection Prompts

This proposal has not been evaluated for scientific merit, except to weigh the risk to the human subjects in relation to the potential benefits.

- Exempt protocols do not require annual review by the IRB.
- All changes or amendments to the above-referenced protocol require review and approval by the IRB **BEFORE** implementation.
- Adverse Reactions/Unexpected Events (AR/UE) must be submitted on the appropriate form within the timeframe specified in the IRB Administration Office Policy (http://irb.wayne.edu/policies-human-research.php).

NOTE: Forms should be downloaded from the IRB Administration Office website http://irb.wayne.edu at each use.

APPENDIX K: QUALITATIVE DATA CODING SAMPLE

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
		1. How do the students experience problem solving when expert modeling is used as a scaffolding strategy?																				
		2a. What did the students perceive they learned from the expert's modeling of problem solving?																				
		2b. What did the students see as benefits when expert modeling is used as a scaffolding strategy?																				

a awareness, critical thinking - digging deep more than what appears on surface

learned to use a prompt and focus on ideas, learned to pick the relevant ideas, gave me a direction to how to begin constructing my essay, questions to ask and strategies to follow while dissecting a problem

to be able to think of multiple perspectives when answering, different ways of seeing, weighing on different perspectives and choosing a solution most feasible and reasonable

how to structure a problem solving report and approach problem solving in real life, consider multiple perspectives

think about rationale behind a selection, listing information to research, evaluating and justifying the practicality of the solution, multiple perspectives,

to think about rationale behind selection and dig deep for root causes to the problem, looking from multiple perspectives.

learned about approaching the problem, defining the question/problem, diiging deep to go to root causes, feasibility check for the solution, multiple propositions/perspectives

learned to think holistically, systematically, questions that would not have come to my mind for consideration,, dig deeper, multiple perspectives, justify solution with feasibility

to identify an issue, determine how to solve an issue, evaluate strength and liabilities of utilizing the solution, and feasibility

importance of defining a problem and dissecting it deep with critical and deep reasoning, rationale behind thoughts, and consideration of multiple perspectives... learned a holistic way to approach problem solving

important to consider multiple possibilities and dig root causes and go beyong surface appearance

identify and recognize all viewpoints that a problem poses, analyze issues deeply and propose feasible and practical solution

learned to approach step by step... analyze issues from all perspectives

it is important to identify root causes before jumping to solve a problem...and evaluating practicality of the solutions proposed, the barriers, pros and cons,

defining the problem and looking at it through different lenses...before coming to any conclusion

Defining a problem and looking at it through multiple lenses

learned to view a problem from multiple perspec tives,

learned how to do indepth analysis of root causes to a problem, from various view points

learned to approach a problem solving assignment...defining the problem and analyzing issues, thinking critically, considering multiple perspectives

learned importance of investigating root causes and thinking critically from various perspectives...holistic approach

learned that all problems and solutions have different ways of seeing...determination of practicality of any solution is important ...just proposing a solution is not a good idea...justify and propose a feasible solution

Helped me to consider the whole problem in a holistic way... Learned the importance of seeing one problem from different angle

helped me to dig deeper, learned it is important to consider an issue from multiple perspectives

importance of defining a problem from different viewpoints and explaining the viewpoints

learned the importamce of considering multiple perspectives...and delving deep to find the root causes to the problem

learned how to approach a problem task...form questions and outline

learned to define a problem and approach problem solving step by step...analyze issues, consider root causes and multiple perspectives...weigh the most feasible and practical solution

learned the importance of defining the problem I n question...analyzing the issues and from various ways of seeing the issues...

learned to think critically about the various issues around any problem from multiple perspectives

important lesson: address the root causes and find feasible practical solution

most importantly I learned to consider several viewpoints... and take a systemic view of the problem...who benefits and who suffers...

learned that it is important to check both sides of an argument/solution... find justification to what you say to back up your claim with well researched details... propose feasible and practical solutions

understood the importance of evaluating issues around a problem from multiple perspectives

learned to define a problem and go deep into the issues to investigate the problem throughly...also weighing a proposed solution to justify whether it is practical or not

one of the most important things that I learned was the importance of considering multiple perspectives

APPENDIX L: SAMPLE REFLECTION PAPERS

Sample Reflection paper from Treatment Group student -1

Sample reflection response (1)

████████████

████████████ Extra Credit Assignment

While writing essay two I came across many important problem solving strategies that I learned from the expert's guideline to problem solving which helped me better analyze and explain my site as a whole. Some of the guidelines that I found most helpful while writing my essay were guidelines number 6, 7,9 and 11. Guideline number 6 was to justify a "way of seeing" about our site. This guideline helped me research how my site evolved throughout the years and figure out how it represented "where are we going". Was the site a good or bad representation and who did this site effect. Guideline number 7 was important because it was important to find the issue/problem that the site represented so that a solution could be proposed. A solution cannot be proposed without a given problem. Guideline number 9 was to generate ideas from multiple perspectives. This helped me with my research because instead of researching one certain perspective about the site, I researched and found multiple perspectives of different people and different ideologies that helped me solidify my argument. Finally, guideline number 11 was to see if the solution was worthy and cost effective. This helped me when I proposed my solution, I had to see if my site helped everyone and see if it benefited some more than others. It helped me figure out the pros and cons of my solution. The expert guideline to problem solving helped me a lot when writing essay number two because the guidelines made it easier for me to find the problem and solution to my site. They helped me better analyze and structure my essay making it easier to write. I usually have trouble figuring out what to include in my essay and it sometimes causes me to go off topic, but with the help of the expert guidelines I was able to stay on topic and knockout all the needed information that I needed to include for

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Sample Reflection paper from Treatment Group student -2

Sample reflection response (2)

Jeremy Bojnowski

HON 1000

Dr. Martin

11/19/15

→ positive.

After reflecting on the process needed to craft essay two, I am much more impressed with how

this essay turned out. The problem solving strategies that were provided were greatly helpful, honestly

without them I don't think I would have been able to have gone as in depth with the entire paper. Not

only does the worksheet cause you to answer questions that normally do not come to mind, but when

you answer the questions you need to slow down breathe and think. This act of slowing down allows

you to look over information with a fine toothed comb. These details make the essay seem more in

depth and fully recognize the questions that are being asked. Many of the questions that were asked

allowed me to not only think about my way of seeing but the ways of seeing for other groups of people, multiple perspective

this allowed me to really inform myself on the Russel industrial center. For example, I would have never

thought about the people that think that Russel is more of an issue and an eyesore, which now that I

reflect on it, there are multiple things about the area that are not esthetically pleasing.

Out of all of the questions, I feel that the following are the most important to the effectiveness

and helpfulness of the worksheet, Justification of the "way of seeing", it causes you to truly think about

how you see the site not just what you think, if you can't justify what you see than it may not be a

deep thinking root cause complete thought. Critical issues in the area require you to do some extra research on the area to think

of not just the exact issues but the more underlying issues required by the area, including social issues

that are represented such as civil rights or poverty. Finally propose your solution with and provide how

feasible the situation is, this allows you to think of an idea but the idea must be something that is

actually possible, anyone can think of a solution but you most work in depth and truly think to find a

solution that is truly possible.

feasible solution -

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ABSTRACT

EFFECT OF EXPERT MODELING ON ILL-STRUCTURED PROBLEM SOLVING IN AN UNDERGRADUATE GENERAL EDUCATION HONORS COURSE

by

MINAKSHI LAHIRI

May 2016

Advisor: Dr. Ke Zhang

Major: Instructional Technology

Degree: Doctor of Philosophy

This dissertation research was based on David H. Jonassen's recommendation that not all problems are the same and different types of problems require different approaches of instruction and scaffolding (Jonassen & Hung, 2008). Jonassen (2011) provided a set of recommended components (problem types, case components, cognitive supports) for designing effective Problem Based Learning Environments (PBLEs).

The purpose of this research was to investigate the effect of using expert modeling of ill-structured problem solving as a scaffolding strategy on undergraduate students' problem solving outcome. Expert's analytical guideline to approach and solve an ill structured problem and an example of the expert's problem solving report was used as scaffold for the problem solving task.

The problem solving performance of the undergraduate students were measured on the three major problem solving learning outcomes as listed below:

i. Ability to define problem

ii. Ability to analyze issues critically and comprehensively

iii. Ability to evaluate proposed solutions/hypotheses to problems

The above mentioned problem solving outcomes and performance scales and categories were defined by a rubric that was developed following the guidelines from the Association for American Colleges and Universities (AACU) problem solving VALUE rubric (Valid Assessment of Learning in Undergraduate Education).

Participants of this study were from 2015 Fall freshmen cohort of Honors College, in a public urban research university in the mid-west of USA. Six Honors College First Year sections participated in this study. Three sections formed the Control group and another three sections formed the Treatment group. The sections were assigned to Control or Treatment group depending on the instructor and was determined with a coin toss. For practical feasibility, three Control Group sections were taught by the same instructor and three Treatment Group sections were taught by same instructor. Students who were less than 18 years of age at the beginning of the fall semester of 2015 were not considered in the study. Total number of participants who qualified for the study, Treatment and Control group combined was 144.

Two groups received an identical problem Task I. 122 participant scores from treatment and control sections combined were analyzed for problem solving Task I to give a baseline problem solving score for the two groups. After Task I, 122 participants were considered for the data analysis of the problem solving task - Task II in this study. There were 54 Participants in the Control Group and 68 participants in the Treatment Group for Task II. The treatment group received the treatment (expert modeling scaffolding) along with Task II and the control group received only the problem solving task - Task II, no scaffold. The problem solving reports from the two groups were graded using the rubric by two reviewers using blind review mechanism for reliability. Reflection responses (optional) were also collected from the treatment group

participants on their problem solving experience with the scaffold. Percentage agreement and Cohen's Kappa were calculated as measures of reliability.

Results of the quantitative data analysis indicated that the treatment group performed significantly better than the control group in the overall problem solving outcome as well as for the components "Ability to define problem" and "Ability to evaluate proposed solutions". The result was slightly insignificant for the category "Analyze issues critically and comprehensively". Qualitative data analysis of the treatment group reflection responses were highly positive and indicated that the learners perceived that the scaffold strategy was beneficial for them and that they learned from the experts analytical guidelines. The participants thought that the expert modeling benefited them by providing a useful tool and framework that they could use in future for other similar problem solving situations; the scaffolding strategy helped them organize and structure the information and helped them follow expert's strategies on critical thinking and problem solving while approaching and working on the problem solving task.

AUTOBIOGRAPHICAL STATEMENT

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EDUCATION:

Ph. D. Wayne State University, Instructional Technology

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PROFESSIONAL EXPERIENCE:

2014 – Current	Instructional Technology Specialist Irvin D Reid Honors College, Wayne State University
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1998 – 2005	Lecturer (Mathematics, Statistics and Computer Science) MHS for Girls, Calcutta, India

Minakshi Lahiri is currently Instructional Technology Specialist at Irvin D. Reid Honors College, Wayne State University, Detroit, Michigan. She provides leadership and manages the e-Portfolio initiative at Honors College and works closely with the honors faculty on emerging technology integration within course pedagogy and instructional design. Minakshi also works to promote Research@Honors to facilitate and encourage undergraduate research and with different aspects of program assessment and performance improvement.

Minakshi has extensive teaching and research experience in Higher Education in USA and in India, and has authored and published several scholarly articles on educational technology. Her research interests include Technology Integration, Interactive Technologies, Emerging Educational Technologies, Online, Blended and Mobile Learning and Performance Improvement. Minakshi is also member of the Academic Technology Advisory Group (ATAG), 2014 – Present, Wayne State University, Detroit, MI.