

SCAFFOLDING HIGHER-ORDER REASONING DURING
ILL-STRUCTURED PROBLEM SOLVING: A DESIGN RESEARCH INQUIRY

by

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(Under the Direction of Michael J. Hannafin)

ABSTRACT

Higher-order reasoning, fundamental to ill-structured problem solving, was highlighted by many research studies that engaged learners in problem-centered learning activities. However, most studies did not clarify what higher-order reasoning skills are and how to scaffold them. On the other hand, important as problem solving is, few studies have been conducted to scaffold preservice teachers' higher-order reasoning in solving technology integration problems.

This dissertation focused on refining scaffolds to promote preservice teachers' analytic, generative, and evaluative reasoning skills in planning technology-based lessons through iterative studies. Fixed scaffolds, provided as lesson design guides, were initially created based on propositions to support procedural, metacognitive, conceptual, and strategic scaffolding functions and directive and/or supportive mechanisms. Emerging evidence and theories were used to validate and extend the scaffolding propositions.

Three journal-style manuscripts were included in this dissertation. The first paper delineates an overarching framework that defines higher-order reasoning skills during problem solving and presents ten tentative scaffolding propositions. The second paper is a design research study depicting three semester-long iterations during which scaffolds were designed, evaluated,

and refined to support preservice teachers' higher-order reasoning in an educational technology course. The first two iterations were qualitative studies involving four and two preservice teachers respectively. The third iteration was a mixed methods study, in which preservice teachers from four sections participated in the quantitative component and eight were selected for the qualitative component. The third paper contains a detailed description and evaluation of the fourth iteration, which used a two-stage scaffolding approach informed by previous iterations and the overarching framework. Again, the quantitative component included preservice teachers from four sections, and the qualitative component involved ten selected preservice teachers. Scaffolding strategies integrating multiple functions and mechanisms were refined. Finally, the dissertation concluded by comparing findings from the four iterations with the initial scaffolding propositions to discuss refined understandings and future research directions.

INDEX WORDS: Higher-order reasoning, Scaffolding, Ill-structured problem solving,
Preservice teachers, Technology integration, Educational design research

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DEDICATION

This dissertation is warmly dedicated to my parents, Weijian Shen and Mingli Feng, my husband, Min Tang, and my baby Charles Yuran Tang. Your love, encouragement, and support made it possible for me to finish the journey of pursuing a terminal degree in a foreign country. I am very blessed to have a loving family to give me strength to face the many challenges I have encountered on this journey.

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CHAPTER 1

INTRODUCTION

Real-world, *ill-structured* or *ill-defined* problems have unspecified problem space, divergent perspectives, multiple solutions, and unclear evaluation criteria that entail a dialectic and iterative problem-solving process (Chi & Glaser, 1985; Kitchner, 1983; Sinnott, 1989; Voss & Post, 1989). Constructivism researchers (e.g., Bransford, Brown, & Cocking, 2000; Bransford & Stein, 1993; Jonassen, 1997) emphasize the importance of engaging students in situated ill-structured problem solving.

Studies have been conducted in various domains to support problem-centered learning (e.g., Ge & Land, 2003; Oh & Jonassen, 2007; Oliver & Hannafin, 2000; Saye & Brush, 2002). Emphasis is typically placed on providing scaffolds (Wood, Bruner, & Ross, 1976) designed to develop learners' problem solving skills, such as analyzing and representing the problem space, and creating and evaluating alternative solutions. These skills are consistent with the higher-order reasoning categories (Anderson et al., 2001). Following this trend, my dissertation research intends to enhance theory and practice by scaffolding higher-order reasoning during ill-structured problem solving. While these skills are broadly applicable, this dissertation focuses on scaffolding preservice teachers' effective technology use in their classrooms.

With the advance of technology in the digital age, educational agencies have made large investments in technology to provide means for integrating technology into the classroom. The emergence of National Educational Technology Standards (NETS, 2007) has helped to establish benchmarks to guide and assess the focus and impact of such investments. Both researchers and

teacher educators have underscored the importance of preparing preservice teachers to integrate technology to support teaching and learning (Brush, Glazewski, & Rutowski et al., 2003; Doering, Hughes, & Huffman, 2003; Strudler, Archambault, Bendixen et al., 2003).

Teaching with technology is an archetype of an ill-structured problem requiring higher-order reasoning (Koehler & Mischra, 2008). Shulman (1987) viewed teaching as reasoning using Pedagogical Content Knowledge (PCK). Likewise, to teach with technology, preservice teachers need to reason with and transform Technological Pedagogical Content Knowledge (TPACK) (Mishra & Koehler, 2006) into appropriate teaching and learning strategies. However, according to Kay (2006), preservice teachers have not received adequate training before entering the field. A recent national survey showed that educational technology courses often concentrate more on technology use for personal productivity and/or professional presentation rather than on solutions to real-world teaching and learning problems (Gronseth, Bruh, Ottenbreit-Leftwich et al., 2010). Moreover, previous studies incorporating problem solving activities into educational technology courses often focused on the affective rather than the cognitive domain of preservice teacher development (e.g., Bates, 2008; Lambert & Gong, 2010; Park & Ertmer, 2008; Smith, Draper, & Sabey, 2005). Few studies in preservice teacher education investigated or scaffolded the reasoning and decision-making skills required to integrate technology to support classroom practice. Little is known about how reasoning using TPACK influences preservice teachers' intended practice and what supporting strategies can be used.

Research Purposes

This research originated from explorations of preservice teacher preparation approaches in a typical educational technology course. Guided by the design and development goals of educational research (Reeves, 2000), I engaged in sustained collaboration with the course

instructor to identify and scaffold the reasoning skills needed to teach with technology. The practical purpose of this research was to refine scaffolds to guide preservice teacher reasoning based on theories and research on scaffolding problem solving. The theoretical goal was to examine and refine the overarching framework and associated scaffolding propositions through iterative studies. I used design research as the mode of inquiry to iteratively create a tangible design for the local context and generate evidence-based claims to increase knowledge of the field (Barab & Squire, 2004). During my inquiries, I implemented four research iterations to design, implement, evaluate, and refine scaffolds to progressively promote higher-order reasoning during technology integration (see Figure 1.1). I used mixed methods (Greene, 2008) in Iterations 3 (chapter #3) and 4 (chapter # 4) to increase the legitimacy of evidence (Johnson & Onwuegbuzie, 2004) for refining scaffolds and building theories.

Dissertation Overview

This dissertation consists of three journal-style manuscripts. The collective purpose is to further our understanding of what and how to scaffold in problem-centered learning (Merrill, 2002). The individual manuscripts are intended to contribute theoretical and practical knowledge to the field of preparing preservice teachers to integrate technology.

The first paper delineates the theoretical framework underpinning the research. It begins with identifying three higher-order reasoning skills and their roles during ill-structured problem solving, and clarifying scaffolding functions and mechanisms. I then apply the reasoning and scaffolding types to current literature on scaffolding learners to solve ill-structured problems. Next, I presents ten propositions of using different scaffolding functions and mechanisms to support learners' higher-order reasoning skills. Finally, I discuss implications of the framework for instructional design and future research.

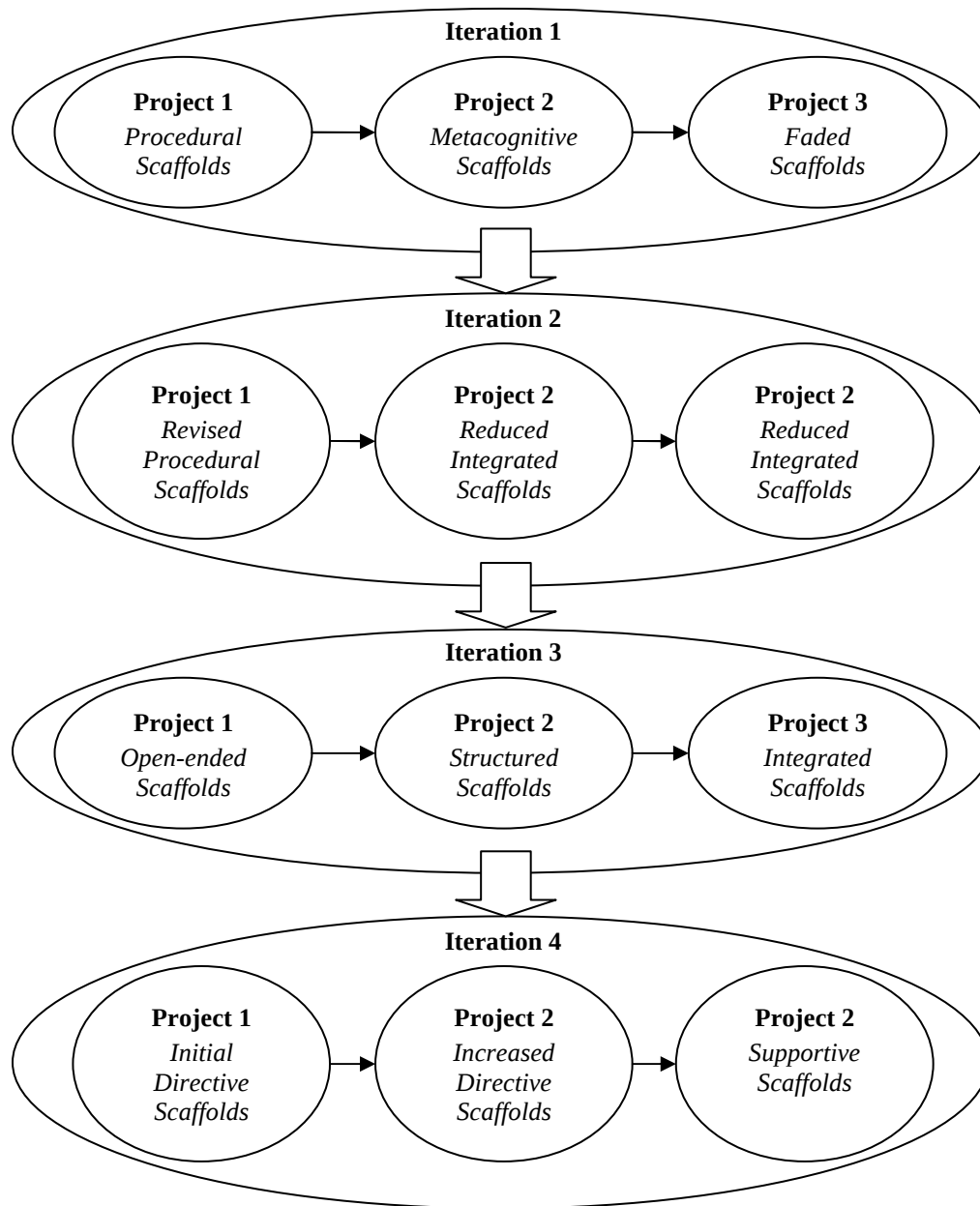


Figure 1.1. Design research inquiry process

The second paper presents the first three design research iterations and focuses on the influence of instructional technology. It first reviews the need for design research in scaffolding problem solving and connects to the local context of an educational technology course involving problem solving projects. Next, it gives an overview of scaffolding interventions and methodologies across the three iterations. The paper continues with details of individual

iterations. Each begins with the purposes, context, scaffold descriptions, and research methods, followed by findings and implications for the next iteration. Iteration 1 examines the effects of switching procedural scaffolds into metacognitive scaffolds for preservice teachers' reasoning during three separate lesson design projects. Iteration 2 refined the procedural scaffolds based on Iteration 1 and tentatively integrated metacognitive, conceptual, and strategic scaffolds to reexamine their effects. Iteration 3 progressively increased scaffolds across the three projects and integrated procedural, metacognitive, conceptual, and strategic scaffolding functions to investigate impact on reasoning. Finally, the paper compares preservice teachers' reasoning skills and scaffolding influences across iterations to generate scaffolding principles and strategies based on evidence.

The third paper is a detailed analysis of Iteration 4 from a teacher education perspective. Informed by the framework and previous iterations, it introduces a two-stage scaffolding approach transitioning from directive to supportive scaffolding to develop preservice teacher reasoning in designing technology-supported lessons. It examines scaffolding effects by comparing preservice teachers' reasoning skills under the two scaffolding stages and seeking connections to the provided scaffolds. Finally, the paper discusses the influences of the directive and supportive scaffolds on preservice teachers' reasoning performance and recommended strategies for integrating multiple scaffolding mechanisms and functions to promote preservice teacher reasoning during technology integration.

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CHAPTER 2
LITERATURE REVIEW

SCAFFOLDING HIGHER-ORDER REASONING DURING
ILL-STRUCTURED PROBLEM SOLVING: A CONCEPTUAL FRAMEWORK¹

¹ Shen, Y., & Hannafin, M. J. To be submitted to *Educational Psychologist*

Abstract

Higher-order reasoning skills are critical to ill-structured problem solving. However, it is unclear which higher-order reasoning skills are needed and how to scaffold learners as they solve ill-structured problems. Grounded in problem solving and scaffolding theories and research, this framework identified three higher-order reasoning skills—analytic, generative, and evaluative reasoning—and focused on procedural, metacognitive, conceptual, and strategic scaffolding functions as well as fixed vs. dynamic, directive vs. supportive mechanisms. We applied the higher-order reasoning and scaffolding categories to 23 selected research papers on ill-structured problem solving by analyzing the effects of scaffolding functions and mechanisms on reasoning skills. Ten empirically-derived scaffolding propositions were proposed and their implications for instructional design and research in problem-centered learning were discussed.

Introduction

“The central point of education is to teach people to think, to use their rational powers, to become better problem solvers” (Gagné, 1980, p. 85). Problem solving helps to situate learning in authentic contexts and support knowledge and skill transfer (Bransford, Brown, & Cocking, 2000; Bransford & Stein, 1993). Increasingly, educational researchers regard problem solving as critical to meaningful learning processes and outcomes (Ge & Land, 2003; Hmelo-Silver, 2004; Jonassen, 1997).

Real-world, *ill-structured* or *ill-defined* problems reflect complexity, uncertainty, and value conflicts evident in unspecified problem space, divergent perspectives, multiple solutions, and unclear evaluation criteria (Chi & Glaser, 1985; Kitchner, 1983; Schön, 1993; Sinnott, 1989; Voss & Post, 1989). Higher-order reasoning skills are essential to solving ill-structured problems (Lee & Cho, 2007; Mumford, Baughman, & Threlfall et al., 1996, 1997; Schunn, McGregor, & Saner, 2005; Shin, Jonassen, & McGee, 2003), but novice learners often lack proficiency due to insufficient domain knowledge and metacognitive skills (Bransford, Sherwood, Vye, & Rieser, 1986). They may also have difficulty retrieving relevant knowledge, recognizing meaningful patterns, or monitoring thinking process, leading to naïve, superficial problem analysis, and depth-first approaches to generating solutions (Perez, Johnson, & Emery, 1995). Dufresne, Gerace, Hardiman, & Mestre (1992) argued that simply engaging learners in problem solving does not ensure the development of expertise; novices often require guidance during problem-based inquiry learning (Kirschner, Sweller, & Clark, 2006).

Many studies on scaffolding learners during ill-structured problem solving have been reported to develop various higher-order cognitive skills, such as reasoning (Gillie & Khan, 2008; Saye & Brush, 2002), argumentation (Cho & Jonassen, 2002; Oh & Jonassen, 2007),

knowledge integration (Chen & Bradshaw, 2007; Davis & Linn, 2000), and comprehensive problem-solving skills (Choi & Lee, 2009; Ge & Land, 2003). However, it is unclear which skills are crucial to ill-structured problem solving. Researchers employed different scaffolds to guide reasoning, including activity prompts (Oliver & Hannafin, 2000; Davis & Linn, 2000), question prompts (Bulu & Pedersen, 2010; Ge, Chen, & Davis, 2005), message types (Ng, Cheung, & Hew, 2010; Oh & Jonassen, 2007), modeling (Pedersen & Liu, 2002; Saye & Brush, 2002), and peer interactions (Ge & Land, 2003; Uribe, Klein, & Sullivan, 2003). Little is known, however, about the attributes shared across scaffolds, making it difficult to generalize across contexts.

To guide research and practice in applying problem-solving supports, this paper proposes a framework for *what* and *how* scaffolding can facilitate ill-structured problem solving. By integrating complementary theories and research, higher-order reasoning skills and scaffolding types are proposed. Ten empirically-supported scaffolding propositions are identified and their implications for practice and research are discussed.

Higher-Order Reasoning Skills

Historically, higher-order reasoning skills comprise advanced cognitive skills beyond basic remembering, comprehension, and application (Bloom, 1956). Bloom classified the higher-order objectives in his *taxonomy*—analysis, synthesis, and evaluation—as essential components of problem-solving skills. In Guilford’s *structure-of-intellect model* (1967), three higher-order operations—divergent production, convergent production, and evaluation—provide theoretical roots for creativity as a “discovered problem-solving process” (Csikszentmihalyi & Getzels, 1971). Dewey (1933) described problem solving during *reflective thinking* by highlighting “a state of doubt” and “an act of inquiry to resolve the doubt” (p.12). Ennis (1987) compared *critical thinking* skills to the problem-solving process of deciding on an action. In this paper,

higher-order reasoning indicates thinking skills situated in problem-solving contexts. Table 2.1 presents three higher-order reasoning skills: *analytic reasoning*, *generative reasoning*, and *evaluative reasoning*.

Table 2.1

Higher-order reasoning skills during ill-structured problem solving

	General Definition	Roles in Problem Solving
Analytic Reasoning	Recognize constituent elements of an entity. Differentiate relevant from irrelevant elements. Detect implicit values, viewpoints, or perspectives. Identify organizational structure among components.	Encode stated problem space information with schema. Determine unstated assumptions, perspectives, purposes, or biases. Use schema to search for additional problem-related information. Structuralize problem space into interconnected elements.
Generative Reasoning	Produce divergent ideas characterized by fluency, flexibility, originality, and elaboration. Produce convergent ideas through logical deduction from input information. Construct products based on plans emerging from divergent and convergent productions.	Further represent the problem by integrating identified information to hypothesize possible causes and alternative solutions. Devise a convergent solution plan based on analyses and divergent hypotheses. Implement the solution plan to develop products for solving the problem.
Evaluative Reasoning	Use internal criteria including consistency and credibility to monitor arguments or procedures. Use external criteria, such as effectiveness and appropriateness for goals, to critique products or operations to decide the extent to which they will be used in subsequent actions.	Judge information quality based on internal consistency, credibility, and relevance to goals. Compare multiple representations and solutions with goals and constraints to determine the best option for a solution plan. Justify the selected solution with internal and external criteria.

Analytic Reasoning

Analytic reasoning is fundamental to identification of ill-structured problems. Analytic thinking, generally, involves specifying constituent elements of an entity, determining the perspectives they represent, and identifying their organizational structure (Anderson et al., 2001).

Analytic reasoning, synthetically, involves recognizing key information in various forms (Guilford, 1967), differentiating relevant from irrelevant elements (Mayer, 2002), detecting implicit values or viewpoints (Ennis, 1987), and examining connections among components (Bloom, 1956). Problem solvers' schema, refined from prior knowledge and updated through experience, is invoked to encode information in the problem space (Jonassen, 1997; Mumford et al., 1991). To construct a comprehensive representation, the solver needs to look beyond stated facts, evidence, or arguments to determine underlying assumptions, perspectives, purposes, or biases (Jonassen, 1997), apply schema to guide the search for additional information (Lee & Cho, 2007; Mumford et al., 1991), and structuralize the problem space into interconnected elements (Treffinger, 1995; Voss, 1988). Analytic reasoning, therefore, is applied to deconstruct large problems into sub-problems in order to guide hypotheses generation and to integrate possible solutions (Geol & Pirolli, 1992).

Generative Reasoning

Generative thinking was originally defined as the process of synthesizing identified information to create a new structure to resolve perplexity (Bloom, 1956; Dewey, 1933). Generative thinking involves divergent productions, which emphasize fluency, flexibility, originality, and elaboration of ideas satisfying the task, and evolves to convergent productions to deduce logical answers from input information (Guilford, 1967). In effect, it requires executing solution plans from divergent and convergent productions to construct products (Anderson et al., 2001). Generative reasoning can promote problem representation through divergent productions, during which the problem solver further integrates information to hypothesize possible causes and alternative solutions (Sinnott, 1989; Treffinger, 1995; Voss & Post, 1989). A variety of strategies can support divergent production of hypotheses, including brainstorming (Osborn,

1953), making remote associations (Stoyanov & Kirschner, 2007), and considering different perspectives (Jonassen, 1997). Using divergent productions and integrations, the solver devises a convergent solution plans and develops products based to solve the problem (Mayer, 2002).

Evaluative Reasoning

Evaluative thinking generally involves making judgments based on internal or external criteria (Bloom, 1956; Anderson et al., 2001). Internal criteria are applied to monitor arguments or procedures to ensure consistency and credibility (Mayer, 2002), while external criteria, such as effectiveness and appropriateness for ultimate purposes, are used to critique products or operations to decide the extent to which they will be used in subsequent actions (Dewey, 1933; Ennis, 1987). Evaluative reasoning, therefore, supports problem identification by allowing the solver to judge the quality of information according to internal consistency or credibility and relevance to established goals. Evaluative reasoning is also employed to assess solution options when comparing multiple problem representations and candidate solutions with perceived goals and constraints (Mumford et al., 1991; Sinnott, 1989; Treffinger, 1995). Additionally, evaluative reasoning helps to support or refute arguments for decisions based on internal and external criteria (Jonassen, 1997; Shin, Jonassen, & McGee, 2003).

Scaffolding Types

Scaffolding, originally defined as the process by which an adult or more capable other assists a child or novice to achieve goals within the zone of proximal development (Wood, Bruner, & Ross, 1976; Vygotsky, 1987), has been applied to various structure designed to support tasks beyond the individual's competency (Puntambekar & Hubscher, 2005). Hannafin, Land, and Oliver (1999) proposed four scaffolding functions for achieving instructional purposes in an open-ended learning environment. The individually identified scaffolding functions and

mechanisms are often combined, however, to types and strategies designed to promote higher-order reasoning during problem-centered learning.

Procedural scaffolding guides learner through operational steps to complete a task (Sharma & Hannafin, 2007). *Metacognitive* scaffolding helps learner to reflect on how to think about the problem. *Conceptual* scaffolding prompts learner to consider key knowledge concepts. *Strategic* scaffolding offers learner alternative approaches to a problem or task. According to Puntambekar and Hubscher (2005), scaffolding mechanisms include scaffolder, ongoing diagnosis, calibrated support, and fading. Since not all scaffolders can easily provide adaptive supports, Wang and Hannafin (2008) distinguished *fixed* scaffolds (designed in advance, static in nature, and appropriate for typical learning needs) from *dynamic* scaffolds (generated through dynamic interactions and tailored to individual learning needs). To highlight the transition of regulatory responsibilities from scaffolder to learner, Silliman and Wilkinson (1994) proposed *directive* and *supportive* scaffolding. Directive scaffolds give explicit directions and require the learner to respond accordingly to support shared goals. In *Supportive* scaffolding, however, the scaffolder and learner jointly regulate cognitive activities until complete transfer of responsibilities.

Scaffolding Framework and Propositions

Informed by the above theories and associated research, Figure 2.1 presents the framework for scaffolding higher-order reasoning skills during ill-structured problem solving, which was conceptualized from *what* and *how* to scaffold. The intersection between ill-structured problem-solving skills and higher-order thinking skills—particularly analytic, generative, and evaluative reasoning—include essential competencies needed among effective problem solvers. They do not represent general, independent thinking skills but rather reasoning skills that are

situated in domain-specific problem-solving contexts and supported by conceptual, procedural, metacognitive, and strategic knowledge (Anderson et al., 2001).

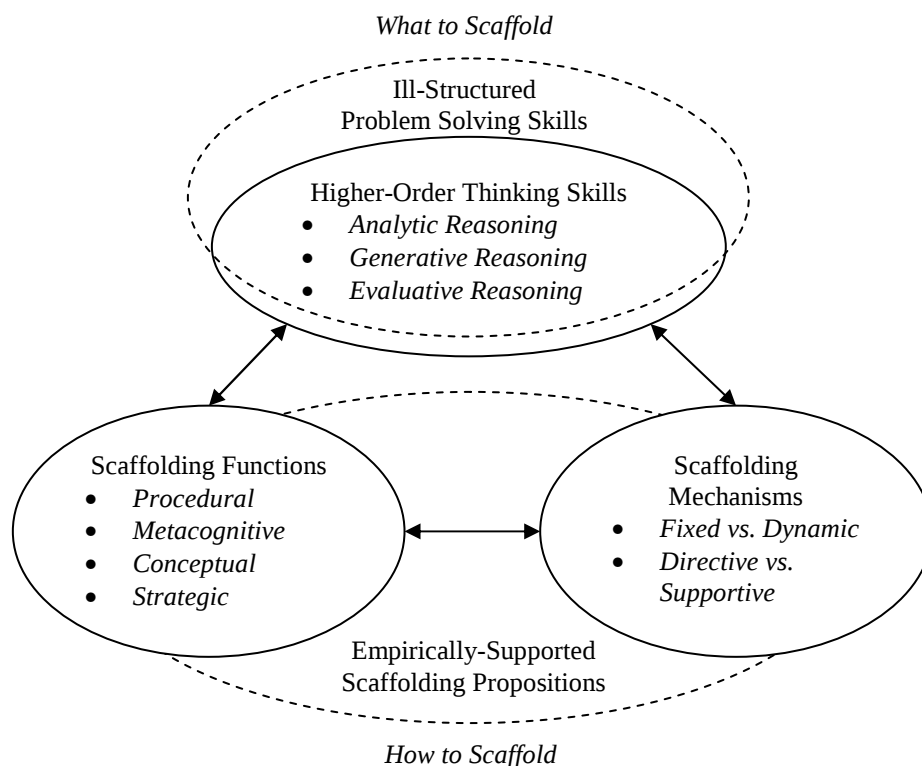


Figure 2.1. Framework for scaffolding higher-order reasoning during problem solving.

We organized research findings related to and generated propositions defined by scaffolding functions and mechanisms. A total of 23 refereed research studies were analyzed (see Appendix A) which scaffolded ill-structured problem solving and examined the effects on learners' reasoning. We cross-indexed scaffolding functions and mechanisms, the higher-order reasoning skills supported, and relationships between the reported scaffolding features and reasoning skills.

Tables 2.2 and 2.3 list the propositions derived from previous research. The fixed scaffolding propositions were organized by functions and mechanisms to address established instructional goals, while the dynamic scaffolding propositions were organized by scaffolder,

suggesting approaches to address learning goals or needs emerging from dynamic interactions.

The following section discussed each proposition using empirical examples to illustrate how they were applied in various domains to support higher-order reasoning.

Table 2.2

Fixed scaffolding propositions

Functions	Directive Scaffolding Propositions	Supportive Scaffolding Propositions
Procedural	Proposition 1: Use directive procedural scaffolds to support requisite step-by-step reasoning.	Proposition 2: Use supportive procedural scaffolds to support self-regulation of intended reasoning.
Metacognitive	Proposition 3: Use directive metacognitive scaffolds to support monitoring of intended reasoning.	Proposition 4: Use supportive metacognitive scaffolds to support self-regulated reasoning.
Conceptual	Proposition 5: Use directive conceptual scaffolds to support reasoning with requisite domain knowledge.	Proposition 6: Use supportive conceptual scaffolds to guide self-regulated problem analyses.
Strategic	Proposition 7: Use directive strategic scaffolds to support synthesis across perspectives.	Proposition 8: Use supportive strategic scaffolds to support reasoning for self-regulated problem solving.

Table 2.3

Dynamic scaffolding propositions

Scaffolder	Scaffolding Propositions
Instructor	Proposition 9: Use dynamic teacher guidance to as alternative reasoning support.
Peer	Proposition 10: Use peer interactions to enhance reasoning through exchanges.

Proposition 1: Use directive procedural scaffolds to support requisite step-by-step reasoning.

Learners, who characteristically possess limited metacognitive facility related to higher-order reasoning (Bransford, Sherwood, Vye, & Rieser, 1986), often require procedural support

during problem-solving analysis, generation, and evaluation. Researchers have provided directive, procedural scaffolds to structuralize learners' problem solving with successive support for analytic, generative, and evaluative reasoning. Ge and Land (2003) scaffolded undergraduates as they solved an information system design problem by categorizing procedural question prompts into problem representation (e.g., What information do you need for this system?), generating solutions (e.g., What should the system do?), and making justifications (e.g., How would I justify this specific system design?), which guided students to identify the problem space, plan and articulate solutions, and justify with grounded arguments. Similarly, Choi and Lee (2009) scaffolded preservice teachers through stages involved in analyzing problems, creating solutions, and making decisions to address classroom management problems. They supported analytic reasoning by directing the students to consider multiple stakeholders' perspectives (e.g., principals, teachers, and parents) with their underlying assumptions. Saye and Brush (2002) designed and modeled a storyboard template that engaged 11th graders in generative and evaluative reasoning of a social studies problem by prompting to develop possible actions, examine positive and negative consequences, and defend the best action to the problem. These findings indicated that scaffolding explicit problem-solving steps can reduce novice problem solver's cognitive load and focus attention on higher-order reasoning processes, including analyzing problem space operators and associated perspectives, generating multiple possible solutions to address the problem, and evaluating alternatives to determine and justify the solution plan.

Proposition 2: Use supportive procedural scaffolds to support self-regulation of intended reasoning.

Directive procedural scaffolds help to regulate the learner's problem-solving process, but when used exclusively, may engender piecemeal approaches by emphasizing individual reasoning steps (Davis & Linn, 2000). In contrast, supportive procedural scaffolds afford learners' control over reasoning processes by providing guidelines rather than as mandatory directions. Ge, Chen, and Davis (2005) provided procedural question prompts to scaffold novice instructional designers during needs analysis (e.g., Do you think the provided information is sufficient? What information do you need to find out? What specific questions should be asked?). They compared a question-elaboration condition, during which participants were required to respond to every prompt, with a question-guidance condition, during which participants were prompted by rather than required to consider the guiding questions. Participants performed comparably in identifying factors and constraints, exploring need-assessment plans, and justifying solutions, even when they used question prompts intentionally to monitor their problem-solving process. Modeling, supportive procedural scaffolding designed to promote purposeful completion of reasoning steps, has also been studied. While scaffolding 6th graders as they solved a science problem, Pedersen and Liu (2002) employed videos illustrating expert modeling cognitive processes during consecutive problem-solving stages, including differentiating relevant information, synthesizing evidence to form hypotheses, and developing solution plan with rationale. The transfer test indicated a positive impact for modeling on students' information identification and solution justification skills, indicating sustained evidence of the modeled reasoning processes. Supportive procedural scaffolds partially transferred regulatory responsibilities to learners by embedding intended reasoning processes in procedural guidance while promoting self-regulated implementation of important higher-order reasoning strategies.

Proposition 3: Use directive metacognitive scaffolds to support monitoring of intended reasoning.

Procedural scaffolds, directive or supportive, may not elicit reasoning skills when they are ignored, misunderstood, or otherwise compromised during implementation (Greene & Land, 2000; Oliver & Hannafin, 2000). Directive metacognitive scaffolds can be integrated to promote scaffolder-driven monitoring of intended reasoning activities. Ge and Land (2003) supplemented procedural question prompts with directive monitoring and evaluation prompts (e.g., Are there alternative solutions? How are they compared with my proposed system?) designed to remind students to consider alternatives during generating and comparing solutions. Likewise, while scaffolding 6th graders' science problem solving, Bulu and Pedersen (2010) mixed procedural prompts (e.g., What is the possible solution to the problem? What is your evidence to support your solution?) with monitoring prompts (e.g., Is your evidence appropriate for the problem? Is your evidence enough to convince someone of your solution?). This approach yielded superior competence in identifying alternative solutions, substantiating ideas with evidence, and evaluating pros and cons of solutions than students only receiving procedural prompts. The above findings indicate that directive metacognitive scaffolds can highlight the desired reasoning embedded in procedural support and prompt learners to monitor depth of reasoning as they respond to procedural scaffolds.

Proposition 4: Use supportive metacognitive scaffolds to support self-regulated reasoning.

Supportive metacognitive scaffolds are designed to promote transfer of regulatory responsibilities to learners. Previous research indicated their promising effects for planning, monitoring, and evaluating higher-order reasoning strategies and processes during self-regulated problem solving. In Davis and Linn's (2000) study, one group of 8th graders received self-

monitoring prompts for planning (e.g., In thinking about doing our design, we need to ...) and reflection (e.g., Our design could be better if we ...) before and after using procedural activity prompts to solve real-world science problems. The researchers reported that supportive metacognitive prompts more likely than activity-only-prompts to result in retrieval and integration of scientific principles when generating and justifying solutions. Similarly, Wolf, Brush, and Saye (2003) provided supportive metacognitive prompts to summarize progresses and plan future activities to support 8th graders' self-regulatory social studies problem solving. Their findings indicated that the students better planned to identify and differentiate information and assessed progress using a step-by-step problem-solving model. Moreover, with the advent of computer supported collaborative learning, constraint-based message types were used to assist self-regulated problem solving in groups (e.g., Cho & Jonassen, 2002; Ng, Cheung, & Hew, 2010). Oh and Jonassen (2007) defined intended reasoning activities as message types (e.g., What information do I need to solve the problem? What should I do about it?). They also provided type-related hints (e.g., How do I define the problem? What are possible solutions?) to scaffold preservice teachers' online discussion to address student behavior problems. As participants were prompted to determine the most appropriate type of argument to make and to monitor responses with hints, they performed superior to controlled groups in generating and assessing alternative hypotheses.

Proposition 5: Use directive conceptual scaffolds to support reasoning with requisite domain knowledge.

Typically lacking well-organized and structured knowledge, novices experience difficulty retrieving relevant knowledge needed to detect critical information (Bransford, Brown, & Cocking, 2000), leading to superficial problem representations. Directive conceptual scaffolds

can be used to enhance analytic reasoning by focusing attention on important concepts prior to or during problem identification. Chen and Bradshaw (2007) designed knowledge integration prompts requiring undergraduates to critique, interpret, and explain key concepts before solving an educational measurement problem. Students receiving directive prompts were more successful in identifying critical concepts and relationships while analyzing and organizing problem elements. Bulu and Pedersen (2010) embedded domain-specific knowledge concepts into procedural question prompts to guide 6th graders to analyze a novel science problem (e.g., What does Akona need to survive? Think about the facts including body, food, habitat, dwellings, communication, and technology). They reported that the domain-specific prompt group outperformed those without conceptual prompts when identifying relevant information needed to represent the problem. Likewise, while scaffolding a 5th-grade science *WebQuest*, MacGregor and Lou (2005) embedded data collection prompts (e.g., habitat of endangered species, reasons for endangered status) and a concept mapping template to highlight key connections between relevant data and major concepts, effectively supporting students as they identified and organized science information. Together, these findings suggest that directive conceptual scaffolds may be important to compensate for limited domain knowledge by amplifying key concepts, information, and organizational structures, thereby enriching analytic reasoning.

Proposition 6: Use supportive conceptual scaffolds to support self-regulated problem analyses.

Novices often simplify or overlook problem analysis, and tend to emphasize solutions over analysis during independent problem solving (Perez, Johnson, & Emery, 1995). Supportive conceptual scaffolds highlight problem space operators to promote self-regulated identification of knowledge or information. Zydney (2010) provided a conceptual organizing template

comprised of general operators (e.g., problem, hypothesis, questions, and resources) and question prompts (e.g., Problem: What issue(s) is your client trying to solve What are your client's objectives and goals for this case?) to assist 10th graders in analyzing and solving an air pollution problem. Students using the template scored significantly higher than those who did not in identifying problem-causing factors from multi-disciplinary materials. Furthermore, Oliver and Hannafin (2000) scaffolded 8th graders to solve an earthquake engineering problem by providing conceptual question prompts (e.g., What is the problem described by this evidence? Why would this problem be difficult to keep from happening?) to support problem finding from web resources. While they reported the students successfully identified premises and existing solutions of the problem, students rarely considered restrictions or patterns during analysis and failed to gather relevant data to frame the problem once the prompts were faded. This suggests a sustained need for directive conceptual scaffolding until independent evidence of internalizing the scaffolding guidance. While potentially effective for eliciting self-regulated domain problem identification, supportive conceptual scaffolds may be more appropriate for learners with prior knowledge to discover and attribute relevant information to suggested problem space operators.

Proposition 7: Use directive strategic scaffolds to support synthesis across perspectives.

Novices try to solve problems prematurely by focusing on single representation and solution rather than exploring alternatives (Schoenfeld, 1983). Directive strategic scaffolds cause learners to examine multiple perspectives that reflect the complexity of ill-structured problems. In Zydney's (2010) study, in addition to the conceptual template, video cases of experts offering varying viewpoints toward possible solutions encouraged students to examine a wider range of disciplines (e.g., law, economics, environmental science, and engineering) during problem identification and hypotheses generation. Choi and Lee (2009) embedded different stakeholders'

perspectives while scaffolding preservice teachers to analyze problems and create solutions, and provided directions (e.g., Critically examine each stakeholder's perspective by considering ...) and prompts (e.g., Considering these constraints of the multiple stakeholders' perspectives, how would you expand your view of the problem?) associated with reasoning from multiple perspectives. Scaffolded preservice teachers considered diverse perspectives and alternatives to solving problems during the study as well as on a transfer test. Directive strategic scaffolds, therefore, may stimulate consideration of alternative perspectives by providing strategic resources related to the problem, and promote synthesis during analytic and generative reasoning.

Proposition 8: Use supportive strategic scaffolds to support reasoning for self-regulated problem solving.

Supportive strategic scaffolds guide learners as they apply or adapt ideas derived from analogous cases. Demetriadis et al. (2008) scaffolded undergraduates' software management problem solving with "observe-recall-conclude" question prompts (e.g., In what other case do you recall having encountered similar project development problems? What are some useful implications for the successful development of a project?) and a "case archive" link designed to help students identify connections to and draw implications from advice cases. They reported significantly higher scores in identifying problem indicators and suggesting resourceful alternatives during a transfer task for the scaffolded group. Similarly, to scaffold preservice teachers' technology integration, Kim and Hannafin (2011) provided a case-based activity tool comprising experienced teachers' technology integration practices with guiding questions to assess and extract key ideas. Preservice teachers identified student characteristics from expert cases to guide lesson planning and resource selection, and integrated technology in a variety of

learning activities based on its identified roles in education. In contrast, Hernandez-Serrano and Jonassen's (2003) study featured a case library designed to facilitate undergraduates' food product development problem solving; however, no significant impact on reasoning was reported. They underscored the importance of scaffolding to connect local problems with case examples. While potentially off-setting the influence of limited prior experience with analogous cases, supportive strategic scaffolds may promote self-regulated reasoning by guiding learners to study and utilize exemplary cases illustrating how experts identify and solve similar problems.

Proposition 9: Use dynamic teacher guidance to as alternative reasoning support.

Teachers and live agents are able to interact with learners dynamically to identify gaps in reasoning and provide directive or supportive scaffolds. Yelland and Masters (2007) scaffolded primary school children's mathematics problem solving through participative demonstration, during which students were guided to consider prior knowledge, give all possible solutions, and critically evaluate each solution based on task requirements. During independent problem-solving task, the teacher prompted student pairs (e.g., Is there are better way to do this?) to monitor and evaluate their solution plans and modify as needed. Students that were scaffolded demonstrated more advanced understanding of the problem and were efficient in converging on optimal solutions. Lajoie et al. (2001) examined supplementary teacher guidance while 9th graders were provided a fixed scaffolding tool to diagnose digestive system problems. The teacher prompted students to retrieve knowledge concepts (e.g., Remember we talked about peptic ulcers) and solicited important items to consider when making a diagnosis, allowing students to better understand and define the problem. Greene and Land (2000) examined instructor-student interactions while assisting preservice teachers as they planned lessons designed to integrate web resources. Instructor questioning (e.g., How does it address learning?

Why would you use that?) was found to strengthen justifications and induced students to confront rather than ignore confusion or inconsistencies. Thus, dynamic teacher guidance may direct learners to relevant knowledge concepts just-in-time to enhance analytic reasoning, as well as to provide metacognitive questioning designed to foster evaluative reasoning of identified factors or hypothesized solutions.

Proposition 10: Use peer interactions to enhance reasoning through exchanges.

Peer interactions offer the potential for dynamic scaffolding through reflective social discourse (Lin et al., 1999). Learners negotiate meanings, exchange explanations, and offer viewpoints to solve problem in collaboration (Ge & Land, 2004). Peer questioning may serve as metacognitive scaffolds to externalize and amplify reasoning. In Uribe, Klein, and Sullivan's (2003) study, computer-mediated interactions within dyads of Reserve Officer Training Corps students (e.g., requesting information or clarification, responding to questions, and discussing solution opinions) improved understanding of military personnel problem and elicited additional solution options than students working alone. Similarly among younger learners, peer questioning yielded comparable outcomes when paired with teacher guidance. Gillies and Khan (2008) trained teachers to facilitate 5th-6th graders' dialogic questioning during collaborative problem solving (e.g., seeking or providing information, opinions, and explanations) which improved student consideration of alternative propositions and consequences, as well as synthesis, evaluation, and justifications. An alternative form of peer interaction involves sharing strategic ideas and perspectives. Greene and Land (2000) reported that the availability of different perspectives within collaborative groups prompted preservice teachers to explain and justify teaching approaches. Similarly, collaborative peer groups in Ge and Land's (2003) study initially considered a variety of factors and information for brainstorming and selecting

solutions. Therefore, varied perspectives from peer interactions could support multiple problem representations, solution exploration, and decision making.

Implications

The framework and propositions, derived from theories and research, should extend understanding of and provide guidelines for scaffolding the solving complex problems. The analytic, generative, and evaluative reasoning skills in this framework can be contextualized in various problem-centered learning domains (cf. Merrill, 2002) to establish performance goals and identify zones of proximal development (ZPD) (Vygotsky, 1978) to ground scaffold reasoning.

The integrated functions and mechanisms offer lenses for designing scaffolds to address situated reasoning gaps. Educators and researchers may consider scaffolding from three perspectives: 1) fixed vs. dynamic scaffolding processes; 2) directive vs. supportive mechanisms; and 3) procedural, metacognitive, conceptual, and strategic functions. For example, to support novice problem solvers, fixed, directive procedural and conceptual scaffolds may guide reasoning explicitly to prompt knowledge retrieval or integration, whereas intermediate learners may benefit from supportive scaffolding that gradually transitions to self-regulatory roles. Practitioners' may apply scaffolding differentially to promote learners' reasoning while minimizing extraneous cognitive overload (Chen & Bradshaw, 2007). Researchers' investigations could extend by addressing specific scaffolding propositions to refine or validate based on empirical evidence.

Furthermore, the strategies used to calibrate and fade scaffolds, are often overlooked by current scaffold designers (Puntambekar & Hubscher, 2005). The framework is not intended to provide "permanent" problem-solving scaffolds, but rather to guide designers as they promote

self-regulated higher-order reasoning. Transitioning from directive to supportive scaffolding while applying the four scaffolding functions, evident in fixed scaffolding propositions, could be useful to fade non-adaptive scaffolds. Reasoning gaps diagnosed during progressive scaffolding could be used to adjust directive or supportive scaffolds associated with different functions. The challenge lies in fading or calibrating scaffolds to suit learners' evolving and individualized ZPDs.

Further research is needed to validate and refine the scaffolding propositions and to explore the influence of integrated applications on analytic, generative, and evaluative reasoning skills across problem-solving contexts. What reasoning skills do learners demonstrate before, during, and after scaffolding? How do scaffold features influence learners' higher-order reasoning? How can multiple scaffolding functions be integrated to support ill-structured complex problem solving? How can we transition directive to supportive scaffolds to promote self-regulated higher-order reasoning? How can we blend fixed and dynamic scaffolding to support comprehensive reasoning?

Design research methods (Barab & Squire, 2004) can be used to investigate emergent research questions via iterative design, implementation, and evaluation of propositions and to validate empirically-supported scaffolding principles and strategies. Micro- and macro-design cycles (Gravemeijer & Cobb, 2006) could support the scaffolding process of ongoing diagnosis, calibrating supports, and fading (Puntambekar & Hubscher, 2005). Micro-cycles encourage scaffolding higher-order reasoning through diverse problem-solving projects, which provide opportunities to diagnose evolving reasoning skills and ZPDs, to select and orchestrate appropriate scaffolding types, and to apply or adapt scaffolding propositions based on researchers' conjectured instructional theories (Gravemeijer & Cobb, 2006). Macro-cycles,

which encompass micro-cycles, could support retrospective analysis of scaffold effects for eliciting and internalizing higher-order reasoning, which is needed to inform and refine emerging instructional theories (Gravemeijer & Cobb, 2006).

To increase the legitimacy of evidence, mixed methods can be applied to evaluate scaffolding influences on reasoning skills within micro- and macro-cycles (Johnson & Onwuegbuzie, 2004). Qualitative interviews, observations, and think-aloud protocols (Ericsson & Simon, 1996) of learners' problem-solving processes provide insights into reasoning activities and scaffold utilization. Documented problem-solving processes and products may corroborate interviews and observations and be codified and quantified using rubrics. Surveys may document self-reported reasoning activities and attitudes toward scaffolding interventions. Quantitative evidence of scaffolding effects and qualitative reasoning themes may be triangulated (Greene, Caracelli, & Graham, 1989) as further corroboration to inform scaffold design and framework development.

Conclusions

While research on scaffolding ill-structured problem solving has grown, further studies are needed to identify the effects of different scaffolding types, functions, and mechanisms on higher-order reasoning during problem identification, solution generation, and decision making. Empirical research, situated in ill-structured learning domains and involving iterative scaffolding cycles, should provide evidence needed to validate and generalize design principles needed to guide educators and researchers in to support novices to become effective problem solvers.

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CHAPTER 3

SCAFFOLDING HIGHER-ORDER REASONING

DURING ILL-STRUCTURED PROBLEM SOLVING: A DESIGN RESEARCH STUDY²

² Shen, Y., & Hannafin, M. J. To be submitted to *Instructional Science*

Abstract

This research examined the influences of scaffolds on preservice teachers' reasoning while solving technology-based lesson design problems. Scaffolds were based on an integrated framework for scaffolding analytic, generative, and evaluative reasoning during ill-structured problem solving. The intervention was implemented, evaluated, and refined through three iterations. During Iteration 1, preservice teachers demonstrated limited higher-order reasoning skills under procedural scaffolding but reverted to naïve reasoning when scaffolds were switched or faded. During Iteration 2, preservice teachers' analytic reasoning skills sustained and improved while procedural scaffolds were reduced and metacognitive and conceptual scaffolds were integrated, but their generative and evaluative reasoning skills declined during the iteration. During Iteration 3, where refined scaffolds were provided incrementally, we integrated procedural, metacognitive, conceptual, and strategic functions. Preservice teachers demonstrated progressively improved higher-order reasoning skills. Based on findings across iterations, we generated design principles for scaffolding analytic, generative, and evaluative reasoning skills during problem-centered learning.

Introduction

Problem solving is an important educational goal for meaningful learning (Bransford, Sherwood, Vye, & Rieser, 1986; Gagné, 1980; Jonassen, 1997; Mayer & Wittrock, 2006; Merrill, 2002). Studies designed to scaffold novice learners to address ill-structured, real-world problem solving have been reported, but few validated design principles. Generalizable design principles (cf., van den Akker, 1999) have not emerged because researchers apply diverse scaffolding types (e.g., question prompts, message types, modeling, peer interactions, etc.) to support various problem-solving skills (e.g., knowledge integration, argumentation, cognitive and metacognitive skills, problem-solving strategies, etc). Wide variations in research contexts and populations may further limit the generalizability of scaffolding principles. Design studies, guided by, testing, and refining frameworks are needed to validate the applicability of scaffolds for local contexts while refining working theories (cf., van den Akker, Gravemeijer, McKenney, & Nieveen, 2006).

Educational technology courses, designed to prepare preservice teachers to teach with technology, are ideal candidates for design research on scaffolding problem solving. Although today's preservice teachers are often digital-natives, they lack knowledge, skills, and experience in solving the "wicked" problem of technology integration by using technology to support student learning (Koehler & Mischra, 2008; Lei, 2009; Russell et al., 2003). Currently, however, such courses are often disconnected with real-world teaching and focused on personal productivity and information presentation over in-classroom technology-based teaching skills (Gronseth, Bruh, Ottenbreit-Leftwich et al., 2010). Despite the growth of problem solving in educational technology courses (e.g., Anderson & Maninger, 2007; Lambert & Gong, 2010; Mistretta, 2005; Park & Ertmer, 2008), the emphasis is often on cultivating positive beliefs,

dispositions, and self-efficacy toward teaching with technology. Scaffolding principles and strategies to support beginning preservice teachers' reasoning are rarely investigated.

Figure 3.1 depicts the theoretical framework that guided our initial scaffold design. This framework was derived from theories and research on *what* and *how* to scaffold during ill-structured problem solving and augmented and refined through iterative cycles of analysis, design, and evaluation (McKenney, Nieveen, & van den Akker, 2006). According to theories (Anderson et al., 2001; Bloom, 1956; Dewey, 1933; Ennis, 1987; Guilford, 1967) and research (Araz & Sungur, 2007; DeYoung, Flanders, & Peterson, 2008; Shin, Jonassen, & McGee, 2003), higher-order reasoning skills are essential to successful problem-solving performance. *Analytic reasoning* involves identifying stated and unstated elements in the problem space (Jonassen, 1997; Voss, 1988) in order to create representations (Geol & Pirolli, 1992). *Generative reasoning* involves further hypothesizing causes and solutions (Jonassen, 1997; Sinnott, 1989) and developing products to address the problem (Mayer, 2002). *Evaluative reasoning* involves judging the credibility and consistency of information (Mumford et al., 1991; Sinnott, 1989) in order to evaluate alternative representations or solutions based on internal and external criteria (Anderson et al., 2001; Bloom, 1956; Treffinger, 1995).

Scaffolding interventions should support higher-order reasoning. Hannafin, Land, and Oliver (1999) proposed four scaffolding functions which have been used to scaffold problem solving. Based on these functions, we derived a series of propositions to support higher-order reasoning during problem solving. Procedural scaffolding, steps for completing a task (Sharma & Hannafin, 2007), is designed to guide reasoning processes during problem solving. Metacognitive scaffolding, which supports planning, monitoring, and evaluating problem-solving processes, promotes self-regulated reasoning. Conceptual scaffolding, which prompts to

consider relevant knowledge, supports knowledge retrieval and integration to enhance reasoning. Strategic scaffolding, which exposes learner to alternative approaches, promotes consideration of alternative perspectives or solutions.

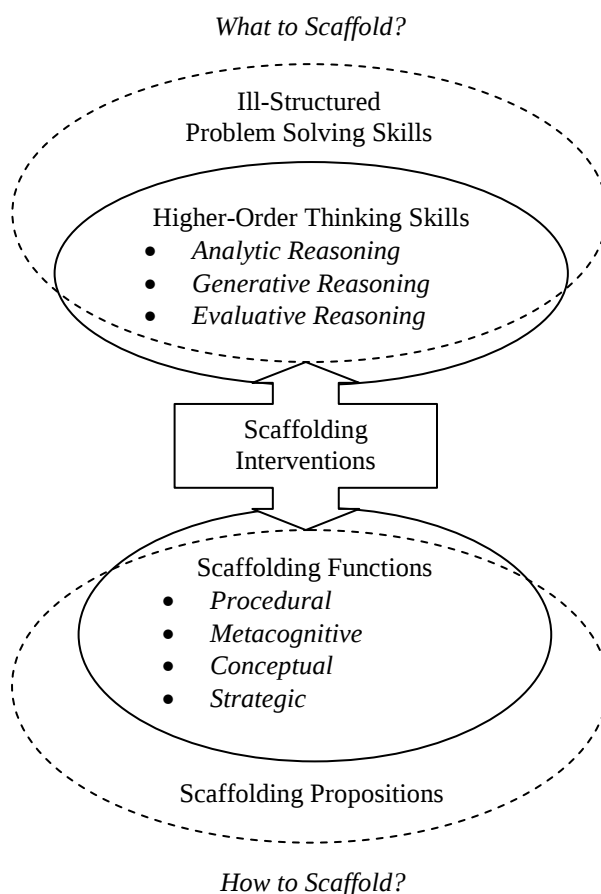


Figure 3.1. Theoretical framework guiding scaffold design.

Design research, therefore, can aid in refining scaffolding interventions for local educational technology courses while informing generalizable theories for solving complex problems (Barab & Squire, 2004). The purposes of this research included a pragmatic goal of designing and refining scaffolds for improving preservice teachers' problem-solving reasoning during technology integration and a theoretical goal of generating scaffold design principles transferable to other problem-centered learning contexts. Specifically, our design research

problem is: How can we scaffold beginning preservice teachers' higher-order reasoning in solving the ill-structured problem of designing technology-supported lesson activities?

Research Design

Research Context

The current research was conducted in a typical educational technology course in a large southeastern university of the United States. Stand-alone introductory educational technology courses are required by 60% teacher preparation programs across the country (Gronseth et al., 2010). They are designed to guide preservice teachers to apply education-related technology tools in classroom settings. Typical audiences are beginning preservice teachers who intend to teach in K-12 settings but have little prior teaching knowledge or experience.

The course instructor, who had six years' experience as a middle school teacher and a Master's degree in instructional technology, had been teaching this course for six years prior to participating in this research. Audiences included undergraduate preservice teachers from a range of teacher education programs as well as non-education majors interested in teaching or technology. Prior to this research, the course instructor noted that preservice teachers were asked to design lesson activities to incorporate a particular tool learned without considering their teaching context, which rarely occurred in real-world settings. She intended to promote "thinking like a teacher" by engaging preservice teachers in selecting and incorporating technology tools to teach their intended subject areas and grade levels. She designed the course to include two components: 1) sessions introducing technology tools related to National Educational Technology Standards (NETS) and 2) sessions of designing technology-supported lesson activities to address NETS. This design research focused on developing preservice teachers' reasoning skills in solving technology-based lesson design problems. Over the course of the

initiative, researchers collaborated with the course instructor by co-designing scaffolds, offering instructional suggestions, and giving feedback during or after scaffolding implementation.

Intervention Overview

The course included three projects of designing technology-supported lessons to address different NETS (2007), including integrating technology to promote Communication and Collaboration, Creativity and Innovation, and Critical Thinking and Problem Solving. Prior to each project, preservice teachers were introduced to a problem context indicating the need to address the targeted NETS by teaching with technology. Due to variations in preservice teachers' majors and interests, subject areas and grade levels were not specified in the problem, allowing preservice teachers to situate it within their own teaching context. At the beginning of each project, scaffolds were delivered as a printed or electronic lesson design guide corresponding to analytic, generative, and evaluative reasoning: 1) analyzing the teaching context, 2) generating possible lesson ideas integrating technology, and 3) evaluating alternatives to select the best lesson idea to develop. Scaffolding functions were selectively used to foster reasoning underlying those components, providing evolving scaffolds across the three projects. The instructor allocated 2-3 class sessions for each project, during which she facilitated reasoning by explaining the scaffolds and expectations, giving examples and resources, as well as leading discussions and offering individual assistance. Preservice teachers were required to document their reasoning process in the lesson design guide and develop a lesson activity with relevant artifacts as the final product.

Methodology Overview

As shown in Figure 3.2, three semester-long iterations were conducted incrementally to implement, evaluate, and refine the scaffolds and framework through macro- and micro-design

cycles (Gravemeijer & Cobb, 2006). The three iterations were macro-cycles, during which the entire scaffolding intervention was revised based on emerging instructional theories and empirical findings. The problem-solving projects within iterations were micro-cycles, during which the scaffolds were adjusted based on the researchers' conjectured instructional theories and preservice teachers' performance. Two research questions were posed:

1. What analytic, generative, and evaluative reasoning skills did preservice teachers demonstrate while designing technology-supported lessons?
2. How did the scaffolding functions influence preservice teachers' reasoning while designing technology-supported lessons?

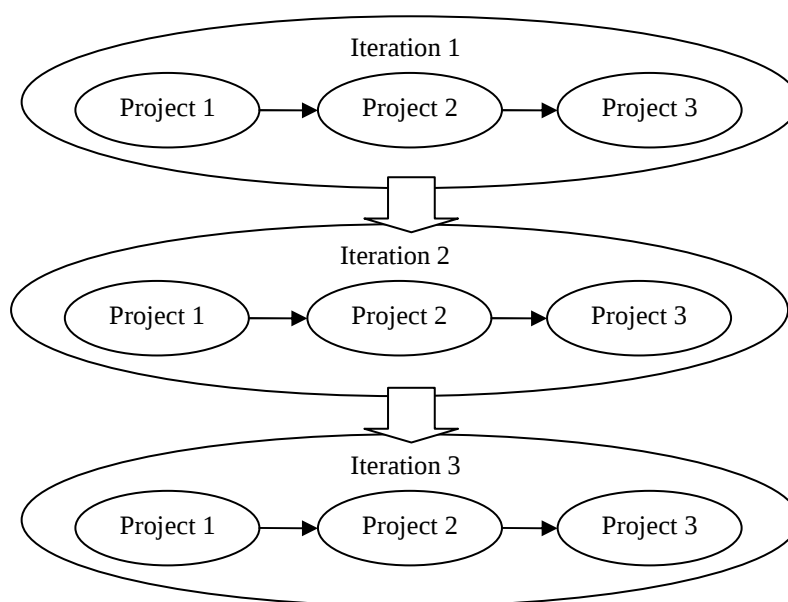


Figure 3.2. Design research cycles.

Iteration 1

Research Design

The purpose of Iteration 1 was to design and evaluate scaffolds for developing and internalizing reasoning skills in identifying, selecting, and integrating appropriate technology tools to teach. The course was divided into two sections: the first section involved workshops on

a variety of technology tools; the second section consisted of three case-based lesson design projects. The case stories (Appendix B) described a fictitious teacher's challenges and goals of teaching with technology, each of which were associated with specific NETS (Creativity and Innovation; Communication and Collaboration; Critical Thinking and Problem Solving). Preservice teachers adapted each case to their intended teaching contexts and designed technology-supported lessons activities. They completed the three projects consecutively, each taking about one and a half weeks in duration.

Intervention

Lesson design guides were delivered through paper-based worksheets (Appendix C). In Project 1, before using the scaffolds, the preservice teachers were asked to select a case-related curriculum standard to teach in the lesson. Procedural scaffolds adapted from the Creative Problem Solving model (Treffinger, 1995) provided the following reasoning steps: identifying up to 10 challenges in the teaching context, selecting an underlying instructional problem to be addressed, producing up to 10 technology-supported lesson ideas to solve the instructional problem, selecting 5 criteria to evaluate the appropriateness of lesson ideas, using an evaluation table to rate the lesson ideas based on criteria, and selecting the best idea to develop a lesson activity and artifacts. In Project 2, electronic version of the procedural scaffolds were linked to the course website as an optional resource to use as needed, and metacognitive scaffolds were designed to support self-regulated reasoning, including: reflecting on the design process in Project 1 (e.g., I did well in..., I had difficulties with...), selecting curriculum standards and planning for what to do in Project 2 (e.g., To identify effective solutions to the instructional problem, I need to...), and identifying evaluation criteria of the final lesson activity. Apart from the instructor's grading rubric, scaffolds were faded completely in Project 3.

Data Sources

Four preservice teachers who expressed intent to become K-12 teachers were selected to participate in the study. All were second year undergraduates who had taken foundational education courses but no methods courses. Brandon and Susan were Middle Grades Education majors focusing on Math and Language Arts respectively. Lily was a Communication Science major and intended to teach speech in elementary school. John was a Foreign Language Education major and planned to teach high school Spanish. Only Susan had observed and facilitated classrooms she intended to teach. A one-hour semi-structured interview (Appendix D) was conducted with each participant at the end of the semester, during which they reflected on their reasoning process during the three projects. Their lesson design guides were collected as document data for analysis.

Data Analysis

The interview data were sorted and analyzed by project and triangulated with the document data. Coding categories reflected the analytic, generative, and evaluative reasoning skills and procedural, metacognitive scaffolding functions. Data related to preservice teachers' reasoning or actions were initially coded into higher-order reasoning categories. Comments related to using scaffolds were coded with specific scaffolding functions (e.g., procedural scaffolding, and metacognitive scaffolding) or general categories (e.g., scaffolded analysis, scaffolded ideation, and scaffolded evaluation). After initial categorizing, codes within category were generated through open-coding and constant comparisons (Glaser & Strauss, 1967). For example, data under the "analytic reasoning" category were further coded into "analyzing problems", "identifying standards", "exploring technology tools", etc. For each project, themes

of reasoning skills and scaffolding influences were generated within and across preservice teachers.

Findings

Project 1

All four preservice teachers started the project by selecting a curriculum standard relevant to the case. Because the case focused on student learning through teacher-centered class instructions, Brandon, John, and Susan identified standards that could not be taught through lecturing. Susan commented on the reason for choosing the language arts standard of “letting students engage with various forms of text and media using multimedia”:

They (students) couldn’t do multimedia if I lecture to them [because] that’s kind of a hands-on computer type of thing you do.

After identifying standards, all preservice teachers focused on the “lecture-based classroom” aspect of the case. No participant considered problems involved in promoting the NETS (Creativity and Innovation) in teaching.

Susan and Brandon considered different technology tools and proposed multiple lesson ideas to address the problems and standards. However, Lily and John completed the scaffolds using their own strategies. They both generated a lesson idea for a preferred technology tool. For example, John decided to use “head phone” to do an “audio activity” for a high school Spanish class, because he had seen the tool in high school but was not able to use it as he wished. He failed to integrate a technology that was introduced in class.

During evaluation, Susan “went through [the evaluation table] and rated all of my solutions” and “took the solution that really addressed all of the criteria the best.” For Lily and

John, evaluation confirmed their already-made decisions. As John commented, “I didn’t mind doing this step just because I want to make sure that was the right way to go.”

Project 2

During the second project, no participant referred to the procedural scaffolds from Project 1. Three preservice teachers focused on a single problem based on prior experience. Brandon stated the problem “was more about higher-achieving students versus lower-achieving students.” Growing up as a high-achiever, he felt it unfair that lower-achievers be grouped separately. He proposed that higher- and lower-achievers collaborate in groups to solve math problems and identified a corresponding curriculum standard.

All preservice teachers generated solutions early. Susan, Lily, and Brandon quickly decided what to do and supplied details. Nevertheless, the metacognitive scaffolds helped John to reflect on the early decision he made in Project 1; thus, he planned to explore multiple tools and lesson ideas in Project 2:

[In] Case one (Project 1) I chose my technology first and one of my difficulties was taking my focus off what tools that I wanted to use to solve my problem... One of the things I had written [in planning] was [to] reconsider: How each technology tool I have used can be used in more than one way? ... What are the different ways that these students would complete these standards?

However, his generative reasoning reflected primarily linear, evaluative searching for “the best way” to teach the standard.

Since all preservice teachers had determined lesson ideas after generating solutions, their evaluation confirmed initial lesson decisions. For example, Susan reported evaluating

“informally in my head”, ensuring that her intended lesson idea met the identified evaluation criteria.

Project 3

The preservice teachers focused on completing the project rather than solving a lesson design problem. Since the case required adapting an existing or creating a new *WebQuest*, Lily, John, and Susan started by searching for *WebQuests* in their subject areas and grade levels; none identified curriculum standards or instructional problems. They focused on finding an existing *WebQuest* that could be adapted to meet the project requirements.

Because alternatives were not considered, the preservice teachers rarely engaged in decision making but focused on producing details. Lily and Susan adapted selected *WebQuests* to meet the NETS and the instructor’s rubric. Brandon developed his own *WebQuest* from scratch because he only found one candidate to adapt.

Implications

The procedural scaffolds supported Brandon and Susan’s reasoning in Project 1 as they identified instructional challenges and problem, generated multiple lesson ideas, and evaluated possible ideas using criteria. However, selecting curriculum standards prior to using procedural scaffolds may have limited scaffolding effects. Identifying challenges was expected to promote divergent problem-finding (Treffinger, 1995) to better define the instructional problem. However, the preservice teachers were focused on avoiding the lecturing-based teaching problem when selecting a relevant curriculum standard, which seemed to minimize their problem analysis. Since John rarely followed the reasoning steps, convergent problem-finding may have limited divergent production (Guilford, 1967) of technology integration plans and opportunities for evaluative reasoning.

The metacognitive scaffolds in Project 2 had little influence on promoting or regulating higher-order reasoning. As the procedural scaffolds were only used for a short period, the preservice teachers did not appear to recognize the intended reasoning skills through reflection and relied on individual depth-first problem-solving strategies common among novices (Perez, Johnson, & Emery, 1995). Based on Project 1, they determined instructional problem, curriculum standard, lesson activity, and evaluation criteria, but rarely attended to underlying reasoning process. Interestingly, John recognized his convergent approach in Project 1 through reflection and, to some extent, demonstrated open-minded reasoning strategies in Project 2. However, his reasoning still required procedural guidance.

The depth-first approach became increasingly evident in Project 3 when scaffolds faded completely. The preservice teachers failed to engage in analysis or evaluation, instead focusing on producing a final product. Reasoning skills declined, indicating that scaffolding may need to be available and utilized over longer periods to become internalized.

Iteration 2

Research Design

Iteration 2 was conducted in a shortened semester to refine the procedural scaffolds, adjust the fading process, and integrate multiple scaffolding functions tentatively. The course structure remained similar to Iteration 1 except for changes in the project contexts. The case stories were revised to increase descriptions of problematic learning activities while avoiding clear indications of problems (Appendix E). The instructor switched Projects 1 and 2 cases since preservice teachers were familiar with the Communication and Collaboration NETS and better able to focus on reasoning from the beginning. The lesson design guides were delivered through *Google Docs* (Appendix F).

Intervention

Informed by Iteration 1, the procedural scaffolds were revised in three ways. First, identifying curriculum standards was included as the first reasoning step. Preservice teachers were prompted to identify a curriculum standard requiring the NETS (e.g., Communication and Collaboration) and justify their selection. Second, to enhance analytic reasoning, problem-finding directions were revised by prompting preservice teachers to identify challenges from NETS and content learning perspectives (e.g., Think about what specific challenges, in terms of communication and collaboration, you might meet in teaching this standard.). Third, to promote divergent productions, preservice teachers were encouraged to list and number lesson ideas they were able to generate.

To reduce the procedural scaffolds progressively, the same reasoning steps were provided in all projects, and preservice teachers were required to complete every step in Project 1 and four major steps in Projects 2 and 3: selecting curriculum standard (required), identifying instructional challenges, framing the instructional problem (required), generating lesson ideas, identifying evaluation criteria (required), applying criteria to evaluate lesson ideas, and designing lesson activity and artifacts (required). Preservice teachers, however, were able to use the optional steps.

To integrate multiple scaffolding functions, in Project 2, metacognitive prompts were provided before procedural scaffolding to support goal setting and planning (e.g., In my opinion, a good lesson designer is..., How can I help my target audiences learn?). In Project 3, conceptual prompts were added to promote consideration of knowledge and experience with the NETS (e.g., Self-evaluate your own understanding on “critical thinking” and “problem-solving” skills.). All

three projects offered strategic scaffolds by suggesting sample lessons in the textbook during the step of generating possible lesson ideas.

Data Sources and Analysis

Two preservice teachers who indicated intent to teach in K-12 settings participated: Claire, a second year Early Childhood Education major, had taught an eight-week crafts class in a preschool enrichment program; Jamie, a third year Technology Education major, had observed and taught one lesson in a high school technology class during practicum. Prior to this course, each had only taken foundational education courses. Data collection (Appendix G) and analysis from Iteration 1 were again applied.

Findings

Project 1

Both preservice teachers identified curriculum standards, explored, and defined instructional problems. Claire selected a math standard focusing on using graphs to organize and display data and explained the need for collaboration. She identified NETS-related challenges from the case (e.g., students “moving off task” and “take-charge students” dominating group work) and defined the problem as students becoming distracted by off-task activities. Jamie selected a “beginning level” standard of technology curriculum and focused on student difficulty accessing online resources based on his practicum experience. He did not analyze the problem from the NETS (Communication and Collaboration) perspective but “decided to address the problem that I faced.”

Both generated three lesson ideas integrating different technology tools. Despite an initial tendency to converge on a single idea, Jamie reported that directions for generating lesson ideas forced him to think of alternatives:

When I selected one idea, I really like it. I want to use that idea and I tend to shut down there ... Because we were in this class, I know that I have to give more solutions than just one, for it (directions) says “number each solutions”, which suggests that there would be more than one. The directions actually list “list your solutions”.

Each identified and applied criteria to evaluate their lesson ideas. Claire commented, “The criteria really make me focus on what was the most important in learning this subject, this standard, because it wasn’t just coming up with a fun lesson.” Interestingly, both reported developing a lesson different from their preferred idea. Jamie changed his mind through evaluation:

I actually I thought another one (lesson idea) would win. And then when I applied to the criteria I was just like, well, that’s not as good as I thought was going to be.

Project 2

The metacognitive prompts scaffolded the preservice teachers to establish design goals based on personal experience. As a gifted student in K-12 schools, Claire reported being “super excited” about the NETS (Creativity and Innovation). She wanted her lesson to be “a little more outside of the box than the previous one.” Influenced by his practicum, Jamie defined a good lesson designer as someone “knowledgeable of what their students are capable of” and decided to design a lesson that will “allow students to fulfill their potential.”

Both explored and identified instructional problems related to their goals. After selecting the American Revolution, a standard that she believed would accommodate creativity and technology, Claire focused on how to “help students absorb, apply, and think in new ways” about the standard. Again, Jamie did not analyze from the NETS perspective. Because he initially decided to reuse the lesson on “inventions” taught previously during practicum, his instructional

problems were “problems I encountered during our lesson”, concentrating on how to set appropriate requirements to “stretch their (students’) limitations,” which was consistent with his goals but not closely related to creativity and innovation.

Both engaged the optional step of brainstorming multiple solutions but did not clarify how to teach with technology. Claire listed three lesson ideas but none specified technology tools or how to integrate (e.g., “Students will make videos on the people of the Revolution”). Likewise, Jamie only mentioned using technology but did not specify its role in learning (e.g., “Allow students to develop rubrics as a class based on in class discussion. Have them generate rubrics at their computer stations.”).

Claire identified multiple evaluation criteria, but did not apply them to her lesson ideas. She chose students writing newspaper articles about American Revolution because it “helped bridged all of those areas that they had to learn with the standards.” Her rationale was related to one of her criteria: “Is the solution applicable in learning the required GPS standards?” Jamie favored the idea of students developing a rubric to guide their project. He rated the possible ideas but reported, “I kind of made it (the preferred idea) fitted into my criteria.”

Project 3

When prompted to consider knowledge and experience with critical thinking and problem solving, both identified curriculum standards and instructional problems relevant to the NETS. Claire chose European exploration in North America because she believed students “need to really understand the reasons, obstacles, and accomplishments of each of the explorers.” She identified the problem as helping students develop “a firm understanding [by] using technology with critical thinking instead of to find out basic facts.” Jamie focused on teaching engineering design process which involved problem solving. Although he continued to identify problems as

stemming from practicum, he adopted the problem solving perspective associated with the NETS. He stated:

The instructional problem I chose was that students won't work through the problems on their own. They will ask me for help and they will expect me to give all the answers ... If they do not find the answers on their own, they will not be learning problem solving.

Both generated multiple lesson ideas, but their ideas were less concrete than Project 1. They described the end-product expected from students but did not describe how to help students to create those products. Although Jamie considered specific technology tools, he listed his lesson ideas as "Develop a class *Wiki* on the engineering design process." Claire did not determine the technology tool she would integrate, instead used phases such as "do a research project" and "make a *Webquest* or something along those lines."

Both identified evaluation criteria for promoting critical thinking and problem solving, integrating technology, and supporting content learning. However, they did not apply criteria to evaluate lesson ideas. Their decision seemed to be influenced by the instructor's advocacy of *WebQuest*. Jamie explained his decision:

I actually used the one (*WebQuest* lesson idea) that she (instructor) suggested we use. She told us this (*WebQuest*) was a good tool, so I should try to use it.

Implications

The procedural scaffolds in Project 1 supported analytic reasoning to some extent and supported generative and evaluative reasoning effectively. The analysis steps guided Claire and Jamie to select curriculum standards, explore instructional challenges, and frame problems. Claire was prompted to consider NETS (Communication and Collaboration) while identifying standards and challenges, but neither participant defined a problem related to communication and

collaboration. Nevertheless, the revised directions for generating divergent solutions appeared to counter the tendency for convergent reasoning and elicited multiple ideas with associated details. Decision-making steps appeared to encourage preservice teachers to select the best lesson idea through criteria-based evaluation versus mainly personal preferences.

Although procedural scaffolds were reduced during Projects 2 and 3, preservice teachers continued to complete the optional steps to explore instructional challenges and generate alternative lesson ideas. This suggests that the initial scaffolds may be internalized to some extent. However, preservice teachers may also have spent less effort in divergent production, given that lesson ideas contained less evidence of technology integration. In Claire's case, by skipping the scaffolds to apply criteria for lesson evaluation, evidence of reasoning appeared to decline: She identified criteria on multiple aspects, but her decision reflected a single criterion. Unlike experts, novices' reasoning skills are not typically organized around "big ideas" (Bransford, Brown, & Cocking, 2000) as newly developed skills are unstable (Oh & Jonassen, 2007). Some preservice teachers, such as Claire, may need sustained support for evaluation to focus on all important criteria.

Metacognitive prompts in Project 2 scaffolded preservice teachers to set general goals that influenced problem identification and lesson idea generation. Claire applied those prompts as intended because her goals were aligned with the NETS (Creativity and Innovation). In contrast, Jamie did not use technology to promote creativity since his goal was only indirectly related to NETS. Therefore, goal setting prompts may need to be more contextualized.

Conceptual prompts for considering knowledge and experience with NETS (Critical Thinking and Problem Solving) in Project 3 appeared to compensate the limitations of procedural scaffolds to support analytic reasoning. Both preservice teachers attended to and

applied the NETS perspective to identify curriculum standards and instructional problems, not previously evident.

Although strategic scaffolds were embedded, neither participant referred to the textbook samples when generating lesson ideas, perhaps due to inadequate examples or incompatible subject areas or grade levels.

Iteration 3

Research Design

During both Iterations 1 and 2, higher-order reasoning skills decreased when procedural scaffolds were reduced, which may negatively impact future technology integration practice. The goal of Iteration 3 was to sustain and increase preservice teachers' reasoning skills throughout the projects. Since mixing procedural, metacognitive, and conceptual scaffolds enhanced reasoning in Iteration 2, we further explored the integration of multiple scaffolding functions.

Since scaffolds were designed to prepare preservice teachers, we focused on preservice teachers who indicated interests in becoming a teacher. Several revisions were made to the course structure and projects. Class sessions introducing technology tools and lesson design projects were alternated during the semester. Before each project, preservice teachers were presented with tools pertinent to the NETS. Simulated teaching environments were created to provide ill-structured problem contexts typical of everyday classrooms (Appendix H). Preservice teachers assumed roles as classroom teachers planning technology-supported lessons on certain subjects for their students. The instructor introduced websites with technology integration lessons and allowed preservice teachers to create original or adapt existing lessons for their projects. Refined lesson design guides were still delivered through *Google Docs* (Appendix I).

Intervention

Scaffolds were provided incrementally from Project 1 through 3 to progressively support reasoning skills. Procedural, metacognitive, conceptual, or strategic scaffolds were incorporated in the three projects based on previous findings and our theoretical framework.

Project 1 featured open-ended scaffolding that delineated major steps but allowed preservice teachers to decide reasoning strategies within steps. Conceptual prompts requested attributes of the teaching context, including grade level, subject area, curriculum standard, and NETS. Step 1 involved metacognitive prompts for setting goals within the teaching context prior to designing the lesson (e.g., What are the important things that you need to consider as a teacher, e.g. your goals?). Steps 2 to 4 provided procedural question prompts for analytic, generative, and evaluative reasoning respectively (e.g., What are the potential instructional problems or challenges you would encounter?), aiming to elicit reasoning products without indicating strategies. Links to websites with technology-supported lesson plans or educational applications (e.g., *Edutopia*, *Go2Web20*, and *Thinkfinity*) were embedded in Step 3 as strategic scaffolds. Step 5 required elaborating on the lesson activity and developing artifacts.

Project 2 included procedural and conceptual supports to scaffold intended reasoning steps; strategic scaffolds from Project 1 were still available. During Step 1, preservice teachers created a concept map to analyze the positives and negatives of promoting creativity in schools, and were asked to identify instructional challenges. During Step 2, the ideation table in Figure 3.3 was provided for generating possible lesson ideas. The columns—*Tools*, *Lesson Activities*, and *Challenges*—prompted essential components while hypothesizing lesson ideas, and the rows encouraged production of different alternatives. Step 3 was scaffolded using the evaluation table in Figure 3.4 to judge whether lesson ideas met the criteria for an effective creativity lesson by

responding “yes”, “no”, or “maybe”. Preservice teachers decided and justified the lesson idea based on evaluation. Step 4 was the same as Step 5 in Project 1.

Step 2: Innovation-in-Action

Brainstorm ideas for lesson activities and align them with the challenges they could address.

Tools	Lesson activities (brief ideas)	Challenges (numbers)

Figure 3.3. Screenshot of ideation table in Project 2.

Step 3: Decision Making

Using the Characteristics of Effective Creativity Tasks listed on p. 129 in your textbook, give each of your possible lessons a “yes”, “no”, or “maybe”. Then, select the lesson activity rated the most “yes” responses.

Criteria	Activity #1	Activity #2	Activity #3	Activity #4	Activity #5
Focuses on content					
Emphasizes divergent thinking					
Incorporates creativity strategies					
Provides informational feedback					

Figure 3.4. Screenshot of evaluation table in Project 2.

Project 3 integrated additional metacognitive and conceptual scaffolds with structured procedural scaffolds. Step 1 asked them to reflect on reasoning strategies they would reuse or change in Project 3 based on previous experience. Step 2 indicated content, pedagogy, and technology factors to consider (e.g., What are the characteristics of a good critical thinking/problem solving lesson? How can technology promote critical thinking/problem solving?) and suggested creating a concept map to analyze those factors. It also required establishing instructional goals and identifying several standards based on analyses. Step 3 used

an ideation table similar as Project 2 but altered the “Challenges” column to “Curriculum Standards” and reminded preservice teachers to keep their goals in mind. In addition to the strategic scaffolds from previous projects, the instructor introduced *QuestGarden* as a resource for *WebQuest* lessons. Step 4 used the same evaluation table as Project 2 without giving evaluation criteria. Preservice teachers were prompted to identify their own criteria from Step 1. They were also asked to rate their lesson ideas using a 4-point scale and justify their decision. Step 5 remained same as Project 1.

Data Sources

Online surveys (Appendix J) to assess preservice teachers’ reasoning processes were conducted at the end of each project; 86% undergraduates across four sections participated in Project 1 survey; 78% participated in Project 2; and 83% participated in Project 3. The survey questions on analytic, generative, and evaluative reasoning activities were based on findings from previous iterations and comparable across administrations. We eliminated survey participants who indicated they did not intend to become K-12 teachers. Among the remaining survey participants, eight preservice teachers who indicated they were very interested in K-12 teaching were selected to participate in the qualitative component of the study. Table 3.1 provides profiles of their background, educational coursework, and field experience. Qualitative data per previous iterations were again collected (Appendix K).

Data Analysis

To triangulate across different measures, quantitative and qualitative data were collected immediately after each project (Greene, Caracelli, & Graham, 1989). The three surveys were merged using anonymous ID number. To compare reasoning skills across projects, we computed analytic, generative, and evaluative reasoning scores for each project by using corresponding

survey questions triangulated with qualitative themes. We then conducted repeated measure analyses to examine changes in higher-order reasoning skills. We also ran a descriptive analysis of survey responses to compare higher-order reasoning skills across projects. During mixed data analysis, qualitative themes of each project were triangulated with repeated measure analyses results and descriptive statistics to seek convergence and divergence.

Table 3.1

Profiles of interviewees in Iteration 3

<i>Preservice teachers</i>	<i>Year</i>	<i>Major</i>	<i>Educational Coursework</i>	<i>Field Experience</i>
Grace	4 th	Science education	Foundational courses, subject matter courses	Observing and teaching in preschool.
Jason	3 rd	Elementary school education	Foundational courses	Volunteering at library working with children of different ages.
Jenny	4 th	English	Foundational courses	Interning in an 8th grade English class, teaching three lessons.
Katrina	2 nd	Social studies education	Foundational courses	Teaching lessons in elementary classrooms during high school.
Maggie	3 rd	Middle grades education	Foundational courses, Methods courses	Observing special education classroom, teaching an 8th grade language arts classroom.
Nora	3 rd	Family and child development	Foundational courses, Methods courses	Interning in a kindergarten classroom during high school, volunteering in a high school special education class.
Rachel	3 rd	Early childhood education	Foundational courses	Teaching STEM in afterschool programs for 60 hours.
Sally	2 nd	Family and consumer sciences education	Foundational courses	N/A

Findings

Project 1

Table 3.2 indicates that analytic, generative, and evaluative reasoning scores were the lowest in Project 1 ($M_{\text{Analytic}}=8.11$, $F(2, 74)=30.686$, $p=.000$; $M_{\text{Generative}}=6.87$, $F(2, 74)=37.581$, $p=.000$; $M_{\text{Evaluative}}=7.53$, $F(2, 74)=4.547$, $p=.014$). Interviews and document analyses indicated that the preservice teachers rarely followed the open-ended scaffolding steps but used their own reasoning strategies.

Table 3.2

Repeated measure analysis across Projects 1 to 3

N=38	Project 1		Project 2		Project 3		Repeated measure ANOVA	
	M	SD	M	SD	M	SD	F (2, 74)	p
Analytic Thinking	8.11	2.523	11.21	1.711	10.65	1.921	30.686	.000**
Generative Thinking	6.87	1.758	9.55	2.101	10.00	2.230	37.581	.000**
Evaluative Thinking	7.53	1.928	8.13	1.877	8.66	2.057	4.547	.014*

As preservice teachers specified curriculum standards and NETS initially, 73.6% decided their lesson from the outset; 81.1% identified only 1-3 instructional challenges; and 86.8% considered more than two possible tools.

Goal setting prompts failed to redirect interviewees' tendency to rapidly generating solutions. Seven of eight started the design process with a clear lesson idea in mind, and emphasized the curriculum standards or proposed specific strategies for communication and

collaboration. To teach a kindergarten vocabulary standard, Nora stated goals with clear indication of intended activities.

The students are able to work collaboratively as a class. Each student contributes newly learned vocabulary to create an interactive class vocabulary book.

All interviewees analyzed instructional problems of and identified technology tools for their predetermined lesson ideas. Rachel planned to use email to support an Indian Pen-Pals project for 2nd grade social studies and questioned, “Am I able to teach my students how to email back and forth in a day?” When identifying technology tools, she commented, “I basically had the lesson I wanted to teach down, so really it was just trying to find what [tool] would help that out.” She explored several email tools and decided to use *K-mail* which was “kids-safe email.” Her analyses emphasized lesson details rather than the lesson design problem.

During generative and evaluative reasoning steps, 81.1% preservice teachers reported generating 1-2 possible lesson ideas; 64.2% selected their initial preference; and 51% were satisfied with the ideas they generated. However, 75% preservice teachers indicated it important to explore multiple lesson ideas though few did so.

Seven of eight interviewees focused on one idea and six developed associated details. Maggie gave a typical reason for failing to explore alternatives, “Because I already knew what I wanted to do, I didn’t bother looking for other ones.” After describing how to create and play a *Powerpoint* game for a middle school social studies class, she noted in her design document:

I knew that I wanted to utilize the above methods (described in ideation step) ...So my answer for this section (evaluation step) is basically the same as above.

Similarly, five of eight interviewees repeated or provided further details of the preferred lesson during the evaluation step, but offered no justification. Interestingly, during interviews they subsequently reflected on their project decisions. Maggie stated:

I wasn't thinking very hard as a teacher ... I could have put a whole bunch of stuff here (ideation step) and then minimize it ... I didn't use enough different options, because in my mind I already knew [what I wanted to do].

Project 2

Table 3.3 indicates that preservice teachers' analytic and generative thinking scores increased significantly from Project 1 to 2 ($M_{\text{Analytic}}=11.12$, $F(1, 41)=47.896$, $p=.000$; $M_{\text{Generative}}=9.50$, $F(1, 41)=58.651$, $p=.000$). A moderate, though not statistically significant, improvement in their evaluative reasoning scores was also noted ($M_{\text{Evaluative}}=8.17$). Interviews and document analyses indicated that scaffolds were followed closely which improved reasoning skills.

Table 3.3

Repeated measure analysis of Projects 1 and 2

N=42	Project 1		Project 2		Repeated measure ANOVA	
	M	SD	M	SD	F (1, 41)	p
Analytic Thinking	8.24	2.516	11.12	1.670	47.896	.000**
Generative Thinking	6.76	1.736	9.50	2.039	58.651	.000**
Evaluative Thinking	7.52	1.916	8.17	1.847	3.126	.084

Through concept mapping and applying the ideation table, 90.7% preservice teachers identified 4 to 5 or more challenges of supporting creativity in learning, and 90.7% considered 3

to 5 or more technology tools. All interviewees analyzed instructional problems and technology tools before designing lessons. Rachel reasoned through various factors inhibiting creativity and also noted the challenge to “keep students focused on the content, without hampering their creativity. Jason identified five creativity tools by “exploring applications [from the *Go2Web20* website] to see the positives and negatives.” Because curriculum standards were not scaffolded, six of eight interviewees failed to identify any specific standards.

Overall, 83.7% preservice teachers generated 3 to 5 or more possible lesson activities by using the ideation table. All interviewees brainstormed ideas of teaching with the different technology tools they identified, but did not specify details initially. Preservice teachers who did not analyze curriculum standards tended to focus more on using creativity tools than supporting content learning. For example, Katrina’s “generic lesson plans” for high school history class only applied the tool: “The students will play *Pictionary* with [*Microsoft*] *Paint* on the projector to review key terms.” Only Jason and Nora used the *Challenges* column of the ideation table to address instructional challenges. The remaining interviewees’ challenges did not influence ideation, but rather made them aware of potential weakness or constraints.

All interviewees used the evaluation table to judge whether lesson ideas met the given criteria. Maggie rejected her preference and selected the lesson idea that “had the most yeses”: “I actually thought I was going to use *iMovie* until I got to this part (evaluation step) and I realize that it (lesson idea) didn’t think about divergent thinking.”

Still, overall 30.2% preservice teachers reported making their decision based on initial preference. During evaluation, Jenny reasoned that her preferred idea had more thoughts thereby meeting the criteria.

I think I already knew I had tons of ideas for the *Puzzle Making* one (lesson idea). And because of that I was able to think of everything. I could think of how to focus on content. I could pull it in the direction I wanted it to.

Her preferred idea, in effect, “had all yeses” and thus was the best choice. However, she did not mention any evaluation criteria, and based her justification on a personal interpretation of creativity in her subject area.

Project 3

As shown in Table 3.4, overall analytic, generative, and evaluative thinking scores increased significantly from Project 1 to 3 ($M_{\text{Analytic}}=10.67$, $F(1, 45)=39.876$, $p=.000$; $M_{\text{Generative}}=9.98$, $F(1, 45)=99.960$, $p=.000$; $M_{\text{Evaluative}}=8.52$, $F(1, 45)=9.165$, $p=.004$). Interviews and document analyses revealed that the interviewees followed the scaffolds step-by-step and demonstrated higher-order reasoning skills.

Table 3.4

Repeated measure analysis of Projects 1 and 3

N=46	Project 1		Project 3		Repeated measure ANOVA	
	M	SD	M	SD	F (1, 45)	p
Analytic Thinking	7.96	2.440	10.67	1.851	39.876	.000**
Generative Thinking	6.80	1.772	9.98	2.124	99.960	.000**
Evaluative Thinking	7.48	2.041	8.52	1.941	9.165	.004*

By using analysis scaffolds, 95.7% preservice teachers reportedly identified 3 to 5 or more instructional goals or challenges; 89.4% identified 3 to 5 or more possible technology tools.

Interviewee responses indicated wider variety and greater depth of consideration. All followed the prompts to clarify lesson goals and characteristics to address NETS (Critical Thinking and Problem Solving). Six of eight interviewees integrated textbook-based NETS knowledge. Katrina's goal emphasized having students "look at multiple sides of the issue because that's really what critical thinking is." This definition was applied to identify several middle school social studies standards:

The only thing I would say really help me decide (on curriculum standards) was that they could see dissenting information, see both sides of the issues.

Likewise, five interviewees identified curriculum standards requiring critical thinking or problem solving prior to designing lessons. The other interviewees, however, identified standards that fit the lesson ideas they generated or adapted. As four of Grace's ideas were adapted from existing *QuestGarden* or *Thinkfinity* lessons, she stated, "If you find a really great lesson that involves critical thinking, then there's going to be a standard related to it." Four interviewees explored a variety of tools. Jason decided to "seek different sources (of technology)" to "broaden my ideas" and subsequently explored critical thinking tools from the textbook, educational website, and class resources. The remaining interviewees used tools from the existing lessons they planned to adapt.

Overall, 87.2% preservice teachers produced 3 to 5 or more original or adapted lesson ideas using the ideation table; and 55.3% reported they did not converge on a single idea early in the project. While reflecting on reasoning strategies, Maggie stated in her design document, "Previously, I thought of exactly what I wanted to do and worked the lesson around the singular idea. This time I hope to explore more ideas." She analyzed factors in concept map to guide divergent production:

I made sure I did a lesson that met a goal, and I define the “goals (factor)” as educational, flexible, they can use many points of view ... That was the *Facebook* one (lesson idea) ... Then I came to the second one (factor), which was the “characteristics of good problem solving lessons.” Given those characteristics, what are some things we could do? That’s when I came up with students creating a *Powerpoint* game regarding their characters and traits and play a game as their character.

Six of eight interviewees generated or adapted ideas to address their initial goals, such as integrating technology to support critical thinking and problem solving. Jason described:

What I did was I created basic ideas first, and went back to them and saw if they match the criteria that I was looking for. If they didn’t, I will try to edit them until they did.

All interviewees associated their lesson activities with curriculum standards identified during analysis as scaffolded by the revised ideation table.

By using the evaluation table, 78.1% preservice teachers considered factors beyond initial preference to select the best lesson idea; 71.7% referred to instructional goals and 52.2% referred to characteristics of effective technology-supported critical thinking and problem solving lesson. Six of eight interviewees were prompted to identify evaluation criteria from analyses. Jenny said, “I pulled from my brainstorming web again for the criteria.” She incorporated one criterion on “application, analysis, synthesis, and evaluation,” from Bloom’s taxonomy in the textbook identified as “good characteristics” of a critical thinking lesson.

Six of eight interviewees reported making decisions by selecting the lesson idea rated the highest on the evaluation criteria. Katrina recalled how she applied each criterion to evaluate the possible lesson ideas and commented, “I really had to decide which one should meet (criteria) adequately and which one just kind of meets it.” Five interviewees justified their decision by

arguing that their selected lesson idea met the criteria. However, Jenny and Grace adapted their ideas from previously evaluated, existing lessons and were not able to base decision on the evaluation table. Jenny stated, “None of them did not meet a requirement that I wanted.”

Implications

Open-ended scaffolds had little influence on the preservice teachers’ naïve reasoning, characterized by superficial analysis, depth-first solution, and lack of evaluation. The preservice teachers generated lesson ideas after specifying curriculum standards and NETS, thereby indicating intended activities in setting lesson goals. The subsequent procedural steps, designed to support reasoning for creating a lesson, elicited different levels of details about the initially generated lesson idea. Technology integration websites, used as strategic scaffolds, served as resources to stimulate convergent ideas rather than alternatives. Progressively refined, however, increasingly repetitive responses to procedural scaffolds prompted preservice teachers to reflect on the weakness of their reasoning approach, which was an important step of learning to solve problems (Kapur, 2008).

Structured procedural and conceptual scaffolds appeared to guide higher-order reasoning process without increasing extraneous cognitive load. Concept mapping on the NETS (Creativity and Innovation) topic, for example, deepened analytic reasoning and helped preservice teachers to identify related instructional challenges. The ideation table scaffolded analytic and generative reasoning in two ways. The *Tools* column encouraged preservice teachers to explore different tools and strategic resources before producing lesson ideas. The *Lesson Activities* column elicited brainstorming of multiple ideas to integrate tools in teaching. However, the *Challenges* column, designed to scaffold addressing instructional challenges, was misunderstood by six of eight interviewees who repeated the challenges contained in each idea. Moreover, six of eight

interviewees failed to consider curriculum standards when generating ideas. Therefore, the *Challenges* column was replaced with a *Curriculum Standards* column in Project 3, which yielded desired results. In addition, the evaluation table scaffolded preservice teachers to apply criteria to evaluate before selecting lesson ideas. Although not all decisions in Project 2 were made based on evaluation, more preservice teachers applied criteria during evaluative reasoning in Project 3.

Structured, procedural scaffolds that integrated conceptual and metacognitive scaffolds appeared to enhance preservice teachers' higher-order reasoning. Reflection supported knowledge integration (Linn & Hsi, 2000) by prompting preservice teachers to reconcile naïve and guided reasoning approaches from previous projects and to apply acquired reasoning strategies in Project 3. Scaffolds designed to highlight key concepts also improved the breadth and depth of analytic reasoning by transitioning from discursive problem-finding to a variety of interconnected factors. Clarification on those factors helped preservice teachers to identify appropriate curriculum standards, technology tools, and instructional goals. Reminders to consider goals during divergent production helped to scaffold ideation with analyzed factors. Furthermore, the user-completed evaluation table scaffolded individual self-regulated evaluative reasoning. Preservice teachers identified their own criteria by referring to analyses and weighed alternatives against criteria to select the option best aligned with their lesson goals. However, those who mostly adapted existing lessons based on strategic scaffolds may have engaged in less higher-order reasoning, since their lesson design task was not as ill-structured as those generating original lesson ideas based on analyses.

General Discussion

This research was designed to both develop and refine scaffolds to improve beginning preservice teachers' reasoning during technology integration and to extend the theoretical framework underpinning the scaffolds. Three iterations were conducted to design, evaluate, and refine the scaffolds based on conjectured and emerging instructional theories (Gravemeijer & Cobb, 2006). Figures 3.5, 3.6, and 3.7 plotted the preservice teachers' analytic, generative, and evaluative reasoning skills in each project on a scale of 1 to 5.

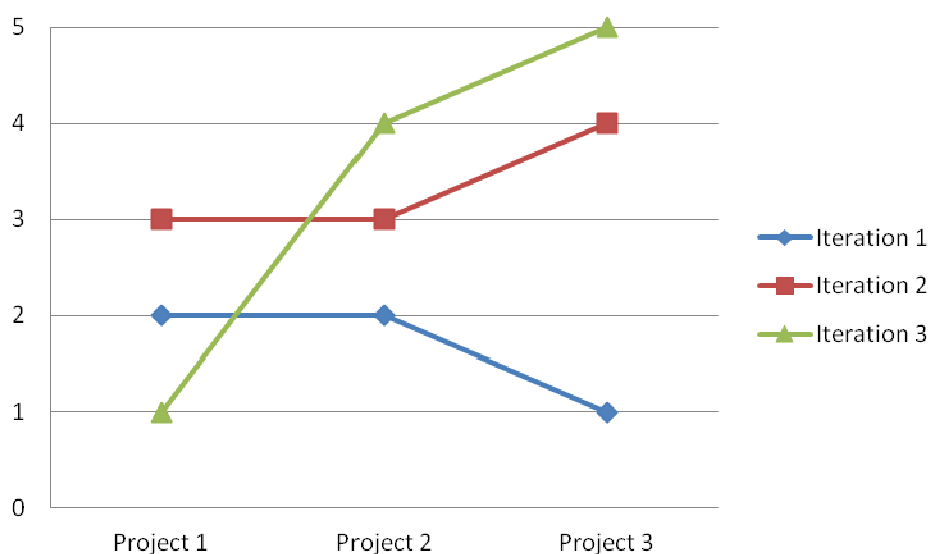


Figure 3.5. Plots of analytic reasoning skills.

Notes: 1 = Little, 2 = Limited, 3 = Moderate, 4 = Intermediate, and 5 = Satisfying analytic reasoning.

Analytic Reasoning

Initially during Iteration 1, the first two projects revealed limited analytic reasoning. The preservice teachers rarely related instructional problems to the NETS. This may be a result of attempting to address the lecturing-based teaching problem when selecting a case-relevant curriculum standard. Most failed to consider alternative tools, and tended to use depth-first over breadth-first reasoning strategies (Perez, Johnson, & Emery, 1995), especially when procedural

scaffolds were removed. Nevertheless, John began to explore multiple tools during Project 2 after reflecting on favoring one tool during Project 1. Analytic reasoning skills further decreased in Project 3 when scaffolds were faded completely. The preservice teachers rarely internalized why, what, and how to analyze.

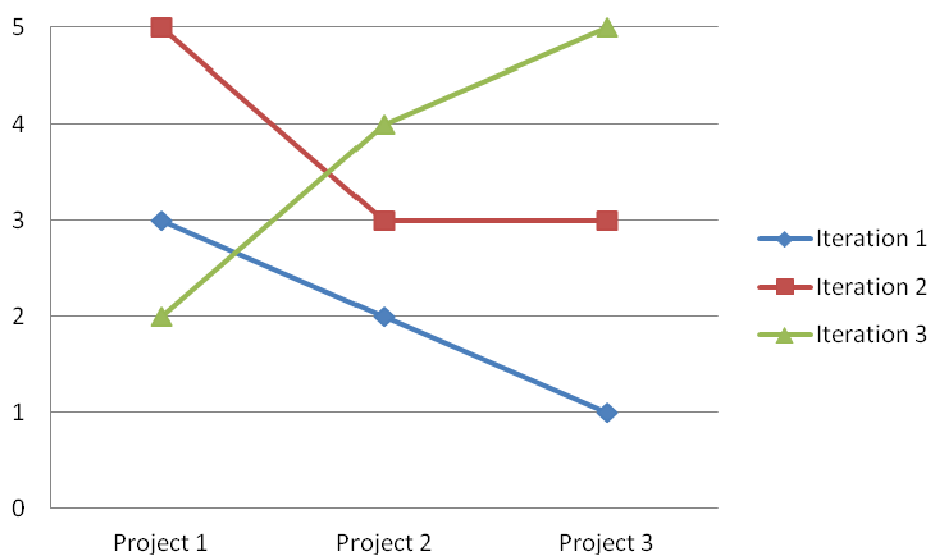


Figure 3.6. Plots of generative reasoning skills.

Notes: 1 = Little, 2 = Limited, 3 = Moderate, 4 = Intermediate, and 5 = Satisfying generative reasoning.

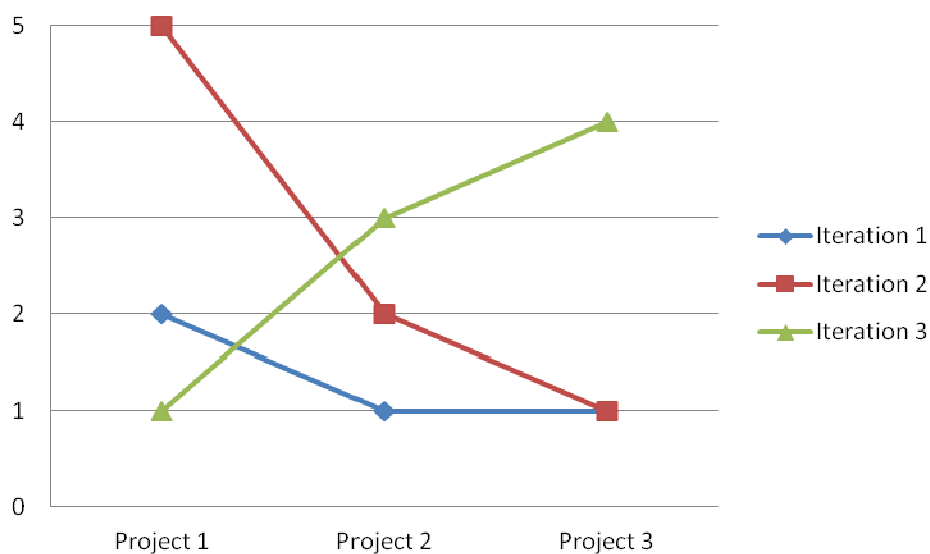


Figure 3.7. Plots of evaluative reasoning skills.

Notes: 1 = Little, 2 = Limited, 3 = Moderate, 4 = Intermediate, and 5 = Satisfying evaluative reasoning.

In contrast, analytic reasoning skills began to emerge during the first two projects of Iteration 2. Refined procedural steps guided preservice teachers to select standards, explore challenges, frame problems, and identify different tools. Revised analysis directions prompted some preservice teachers to consider the NETS, whereas others referred only to personal experience. Analytic reasoning skills improved further during Project 3, as preservice teachers analyzed multiple factors and connected their lesson ideas to the NETS. Conceptual prompts may have focused preservice teachers' attention on NETS and influenced their analysis. Voluntary completion of the optional analysis steps in Projects 2 and 3 may also have contributed to their reasoning performance.

In contrast to previous iterations, preservice teachers progressively increased their analytic reasoning during Iteration 3. For example, since they determined their lesson in the first project immediately after selecting standards, little analysis was initially observed. However, analytic reasoning was significantly enhanced by the structured scaffolds in Project 2. Concept mapping of NETS-related topic broadened and deepened their assessments of instructional problems. The ideation table prompted them to integrate a variety of tools. During Project 3, prompting what and how to analyze also increased analytic reasoning. Preservice teachers searched and incorporated conceptual NETS knowledge to guide their analyses beyond only instructional problems.

Generative Reasoning

Generative reasoning declined steadily during Iteration 1. During the first project, the reasoning steps scaffolded some preservice teachers to brainstorm multiple lesson ideas to address the instructional problem whereas others still converged on a single idea. During Project 2, as procedural scaffolds were removed and limited analysis was evident, most preservice

teachers' generative reasoning were dominated by their preferred lesson idea, except John who critically reflected on convergent reasoning. The third project required adapting or creating a *WebQuest* but did not scaffold exploration of alternatives, thus stimulating little generative reasoning.

During Iteration 2, generative reasoning declined from Project 1 to Project 3, but improved over Iteration 1. During Project 1, directions for brainstorming engaged preservice teachers in generating alternative, concrete technology-supported lesson ideas that addressed problems and standards, manifesting desired generative reasoning skills. Switching solution generation to an optional step in Projects 2 and 3 sustained the number of lesson ideas but reduced the quality in technology integration. Preservice teachers may have embraced the exploration of alternatives before selecting a solution, but focused on completing the final product rather than generating lesson ideas.

In contrast, Iteration 3 improved generative reasoning. Preservice teachers started with limited reasoning skills, as they were not scaffolded to analyze or consider alternatives. The ideation table in Project 2 increased their tools options and resulted in multiple ideas for integrating technology. However, most interviewees failed to address specific curriculum standards or instructional challenges in their ideas, perhaps due to the lack of explicit prompts. The preservice teachers continued divergent reasoning in Project 3, supported by the remained ideation table and critical reflection on reasoning strategies. Moreover, revised directions and ideation table prompted to apply a variety of analysis factors while generating lesson ideas.

Evaluative Reasoning

During Iteration 1, the preservice teachers initially demonstrated limited evaluative reasoning, which decreased further as scaffolds were changed. Most preservice teachers did not

utilize the procedural scaffolds for evaluation due to a convergent idea. During Project 2, none demonstrated decision making as their lesson ideas reflected convergent, deductive reasoning. The evaluation criteria reported merely confirmed conclusions. Project 3 results also demonstrated little evaluative reasoning perhaps due to little internalization and to the use of a relatively well-structured case that indicated few problems but a clear solution.

Evaluative reasoning during Iteration 2 continued to reveal decreases. Preservice teachers followed the evaluation steps provided in Project 1 to select their lesson idea based on criteria, which influenced initial preferences by revealing potential weaknesses in their favored ideas. However, during Project 2, some preservice teachers skipped the evaluation step to systematically apply criteria before making decisions. Project 3 revealed even less evaluative reasoning as no participant applied the evaluation step. Decisions may be influenced by the instructor's recommendation for *WebQuest*.

During Iteration 3, however, evaluative reasoning increased progressively. Predetermined ideas of Project 1 appeared to make decision making unnecessary. Most preservice teachers repeated or elaborated rather than evaluating lesson ideas. During Project 2, the evaluation table scaffolded preservice teachers to use given NETS-related criteria to judge alternatives. When prompted to identify evaluation criteria from analyses in Project 3, most preservice teachers considered instructional goals and NETS when deciding and justifying which lesson to develop.

Design Principles

Scaffolding design principles (cf., van den Akker, 1999) for solving ill-structured problems can be generated based on themes across iterations and underlying theories. Design strategies may be inferred from the scaffolding functions applied in this research.

To develop analytic reasoning skills, scaffolds need to emphasize and clarify key factors of the problem space. Novices tend to analyze ill-structured problems superficially by simplifying the complexity, overlooking multiple factors, and rapidly generating solutions (Powell & Willemain, 2007; Perez, Johnson, & Emery, 1995). This was evident during Iterations 1 and 3 when scaffolds did not highlight key factors. Procedural scaffolds can guide learners to analyze major factors and their connections through logical steps. Ge and Land (2003), for example, reported that procedural questions help to direct undergraduates' attention to important aspects of a design problem. In the current design studies, Iterations 2 and 3 revealed that preservice teachers analyzed a variety of key factors (e.g., NETS, curriculum standards, technology tools, and instructional problems) when scaffolded step-by-step. The sequence and directions for implementing analytic reasoning prompted consideration of connections among factors. Moreover, conceptual scaffolds can deepen analyses by highlighting knowledge or information underlying the factors. Bulu and Pederson (2010) used domain-specific concepts to scaffold 6th graders to identify relevant information needed to represent science problems. Similarly, in Iterations 2 and 3, when preservice teachers were prompted to consider concepts from the NETS (e.g., creativity, critical thinking), they retrieved or integrated knowledge to differentiate relevant standards, problems, and tools.

To support generative reasoning among novices, scaffolds should stimulate exploration of alternative solutions. Novices tend to quickly converge on a single solution without considering alternatives (Osana, Tucker, & Bennett, 2003; Schoenfeld, 1983). They typically lack the experience or expertise needed to solve problems through logic-tight deductions (Voss & Post, 1989). To counter the convergent reasoning tendencies of novices, procedural scaffolds should require or encourage consideration of alternative solutions until they internalize and

demonstrate these skills. In the present investigations, when procedural scaffolds were removed or reduced, generative reasoning skills declined for most, while a few spontaneously considered alternatives and began to demonstrate this skill. Oliver and Hannafin (2000) attempted to scaffold strategically 8th graders to seek existing solutions before attempting to solve an earthquake engineering problem, but students tended to ignore the importance. It is often necessary to initially scaffold exploration of alternatives procedurally, particularly among novices, to ensure opportunities and experience critical to effective generative reasoning. Metacognitive scaffolds may encourage novices progressively to contrast depth-first approach with breadth-first reasoning strategies (Perez, Johnson, & Emery, 1995). In the current design research, naïve approaches that initially limited problem solving were extended to divergent generative reasoning skills through metacognitive reflection.

To support evaluative reasoning, scaffolds need to guide novice to assess solution alternatives to criteria. Novices usually make rapid decisions based on local criteria (Osana, Tucker, & Bennett, 2003; Perez, Johnson, & Emery, 1995), leading to initially preferred solutions that limit consideration of alternatives. Procedural scaffolds can guide through applying evaluation criteria, weighing alternatives using criteria, and justifying decisions based on evaluation once generative reasoning is evident. Saye and Brush (2002) designed and modeled procedural scaffolds to assist 11th graders to assess alternative actions to a social studies problem: Students who made effective decisions based them on persuasive arguments. Similarly, in the present investigation, preservice teachers who used procedural scaffolds to evaluate ideas based on relevant criteria were able to warrant their decision. However, there were also cases in which preservice teachers simply “fit” or aligned pre-established goals and preferences with external criteria. Metacognitive prompts could scaffold learners to reconsider initial beliefs and

refer to analyses before identifying and applying internal and external evaluation criteria (cf., Bloom, 1956).

Limitations and Future Directions

Scaffolds in the present design studies were designed and implemented with the intent to refine and improve preservice teachers' reasoning as they prepare to teach with technology. The primary researcher and the instructor developed and updated the scaffolds during successive implementations. In some instances, additional opportunities and time to analyze quantitative and qualitative data prior to making revisions may well have changed en-route design and implementation decisions. In addition, all three iterations involved multiple sections, each with expected differences. Instructor explanations, class discussions, and peer interactions will likely vary depending on the timing of the sections and the audience populations. These differences are typical of and represent real-world class and course implementation, but the revisions and evidence collected still needs further confirmation with additional sections and settings to verify utility beyond the given course and setting. Finally, the analytic, generative, and evaluative reasoning skills examined in this study were limited to specific aspects of the problem-solving process. Reasoning skills and scaffolding influences during the development of the final products, such as lesson plan and artifacts, were not investigated.

The support strategies in this research were dominated by procedural scaffolding, which may engender piece-meal reasoning when used excessively or exclusively (Davis & Linn, 2000). Metacognitive and conceptual scaffolds were integrated on a limited basis, and little evidence was obtained supporting the effects of strategic scaffolds. Future research is warranted to investigate how multiple, integrated scaffolds influence higher-order reasoning. Moreover, scaffolds are designed to be faded, not provided permanently (Puntambekar & Hubscher, 2005).

Fading was not successful in the first two iterations, and was not done in the third iteration.

Future research is needed to examine both the roles and effects of progressive scaffolding and fading (Choi & Lee, 2009) on higher-order reasoning. In addition, prior domain knowledge and experience have been strongly associated with problem solving (Chi, Feltovich, & Glaser, 1981; Mayer, 1983). Teaching knowledge and experience varied among preservice teachers but were not examined or supported in this research. Future research is needed to investigate the extent to which the application of and supplementation for prior knowledge and experience influence reasoning during problem solving.

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CHAPTER 4

SCAFFOLDING PRESERVICE TEACHERS' HIGHER-ORDER REASONING DURING TECHNOLOGY INTEGRATION³

³ Shen, Y., & Hannafin, M. J. To be submitted to *Teaching & Teacher Education*

Abstract

During this study, we implemented a two-stage scaffolding approach during which preservice teachers received directive to supportive scaffolding to support reasoning while designing technology-supported lessons. Findings indicated that the directive scaffolds assisted the preservice teachers' analytic, generative, and evaluative reasoning. When directive scaffolds were switched into supportive scaffolds, the preservice teachers demonstrated comparable breadth but reduced depth in analytic reasoning. They also continued to produce divergent lesson ideas, but showed limited reasoning for technology integration and attended less to initial analyses during elaboration. Preservice teachers who referred back to directive scaffolds made and warranted decisions through criteria-based evaluation, whereas others based decisions on personal preference. Finally, we discussed scaffolding strategies for developing and internalizing preservice teachers' technology integration reasoning.

Introduction

Recently, more and more preservice education programs have emphasized teachers' technological pedagogical content knowledge (Koehler & Mishra, 2008) to prepare them for teaching in the digital age. Preservice technology integration coursework has evolved from standalone technology skills to applying technology to support instructional goals. Studies showed positive impact of the redesigned courses on preservice teachers' beliefs, attitudes, and self-efficacy in using technology to teach and on the technology-supported instructional products they created (e.g., Bates, 2008; Lambert & Gong, 2010; Park & Ertmer, 2008; Smith, Draper, & Sabey, 2005). However, little is known about how technology integration reasoning processes affect their intended teaching practice. Furthermore, it is unclear how to support preservice teachers' reasoning skills required for successfully solving technology integration problems.

Shulman (1987) viewed teaching as reasoning using Pedagogical Content Knowledge (PCK), which involved transforming teachers' comprehension of subject matter into effective teaching strategies. Preparation of preservice teachers to teach with technology requires transforming their Technological Pedagogical Content Knowledge (TPACK) into appropriate teaching or learning strategies (Mishra & Koehler, 2006). Our recent scaffolding research on technology integration (Shen & Hannafin, 2011) indicated that preservice teachers tended to decide what and how to teach based on specific technology tools they favored or activities they preferred. Since tomorrow's teachers are expected to think strategically in using technologies to support student learning (Niess, 2008), we need to cultivate their reasoning skills for meaningful technology integration.

The purpose of the current study was to refine scaffolding strategies to help preservice teachers develop and internalize higher-order technology integration reasoning. Consistent with

scaffolding research, theory, and guidelines (Hadwin & Winne, 2001; Sharma & Hannafin, 2007; Silliman & Wilkinson, 1994), we employed a two-stage scaffolding approach. Stage 1 provided structured, directive scaffolds that guided the preservice teachers through higher-order reasoning in designing technology-supported lessons. Stage 2 switched the directive scaffolds to supportive scaffolds that required the preservice teachers to self-regulate higher-order reasoning. Qualitative and quantitative data regarding the preservice teachers' cognitive processes under the directive and supportive scaffolds were collected to examine the scaffolds' influences.

Methods

Research Context

This study was conducted in a semester-long introductory educational technology course at a major southeastern U.S. institution. The course goals included: 1) learning to use technology tools associated with National Educational Technology Standards (NETS, 2007); and 2) thinking like a teacher by selecting and applying technology tools to support teaching and learning. The course instructor was an educational technology faculty with six years' experience in teaching middle school and eight years in teaching preservice teachers. Four sections of the course were involved in the study, with a total of 90 primarily second-to-fourth year undergraduates: 63% enrolled in teacher education related programs and 56% indicated they were somewhat or very interested in becoming K-12 teachers. Among the preservice teachers, 53% had never observed classroom teaching and 74% had never taught, while 26% reported 20 or more hours' in-class observation and 10% reported 20 or more hours' teaching experience.

To emphasize teacher reasoning, the course was designed to simulate professional development for new, practicing teachers. Students were given a fictional classroom context and assumed the role of beginning teachers attending technology professional development

workshops on technology tools. They completed three technology-supported *Think Like A Teacher* (TLAT) projects by designing lessons to address the NETS goals of promoting Communication and Collaboration, Creativity and Innovation, Critical Thinking and Problem Solving. As shown in Figure 4.1, workshop sessions and TLAT projects alternated throughout the semester. Prior to each project, *new teachers* received a letter that established a problem context for designing a technology-supported lesson and were provided with a class roll listing diverse student information and aptitudes (e.g., learning styles, learning abilities, motivation levels, and socio-economic status) (Appendix L). They were then provided a lesson design guide—co-designed by the researchers and the instructor—through *Google Docs* (Appendix M), which required them to type their responses to a series of scaffolding prompts. Figure 4.2 is a sample screenshot of a lesson design guide. Details of the scaffolds were described in the following section.

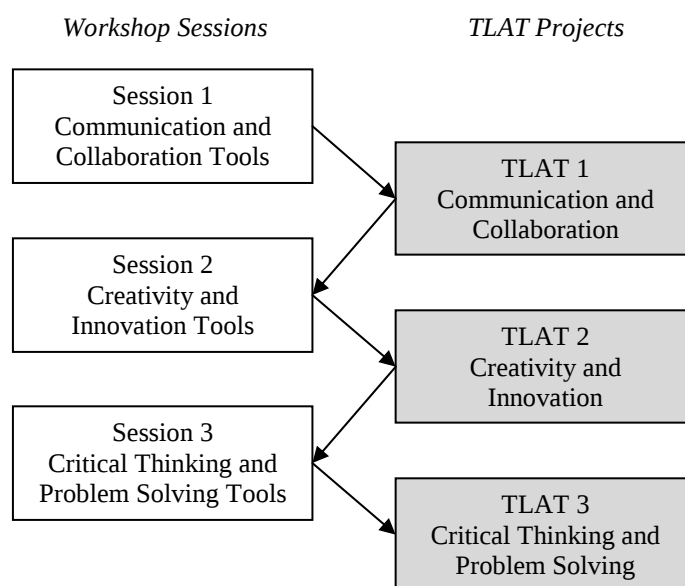


Figure 4.1. Structure of the educational technology course.

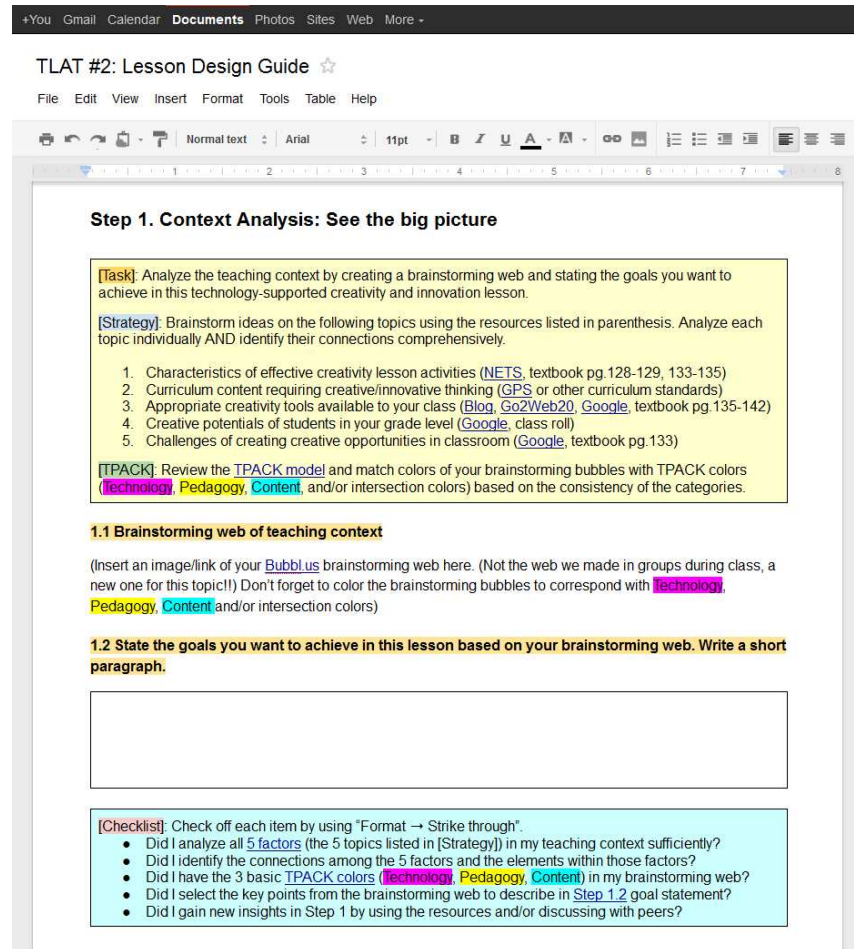


Figure 4.2. Sample screenshot of a lesson design guide in Stage 1.

Scaffolding

The intervention was focused on scaffolding higher-order *analytic*, *generative* and *evaluation* reasoning during ill-structured problem solving (see Figure 4.3), the framework for which had been examined through a series of studies (Shen & Hannafin, 2009, 2011). Our previous findings (Shen & Hannafin, 2011) suggested principles and propositions to facilitate higher-order reasoning during problem solving using *procedural*, *metacognitive*, *conceptual*, and *strategic* scaffolding functions (Hannafin, Land, & Oliver, 1999) and *directive*, *supportive* mechanisms (Silliman & Wilkinson, 1994). *Procedural* scaffolds help to guide learners through

the reasoning steps to solve problems, while integrating *metacognitive*, *conceptual*, and *strategic* scaffolds with *procedural* scaffolds help to enhance reasoning.

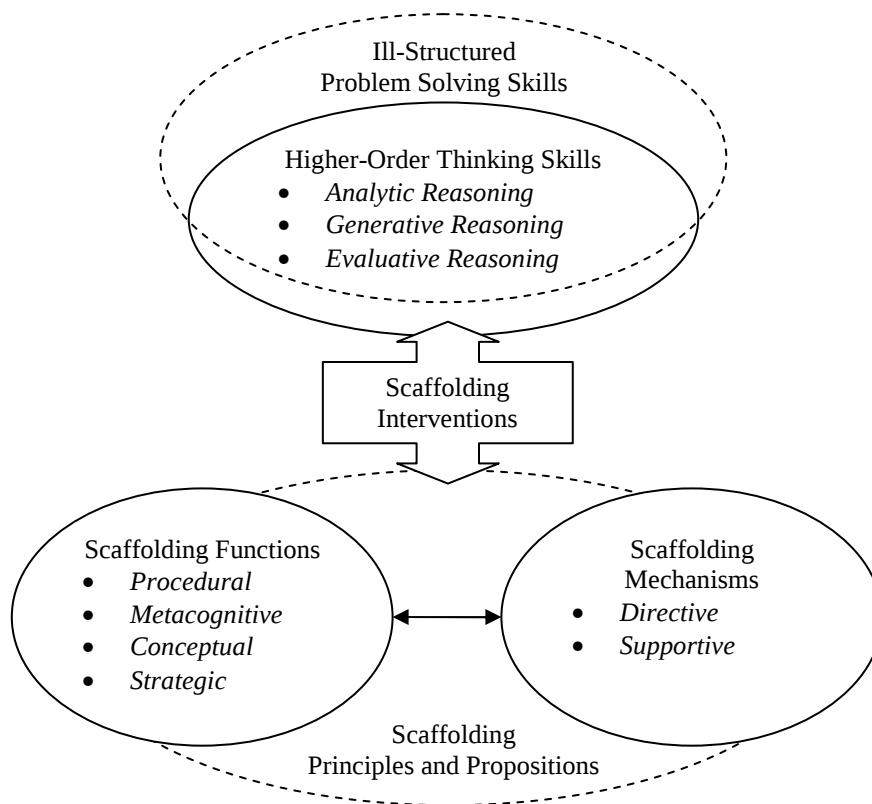


Figure 4.3. Framework for scaffolding higher-order reasoning during problem solving.

As listed in Table 4.1, these principles or propositions were applied in two stages and embedded in lesson design guides. During Stage 1 (TLAT 1&2), directive scaffolds were presented and progressively increased from TLAT 1 to TLAT 2. Stage 2 included TLAT 3 and transferred the regulatory responsibilities to the preservice teachers through supportive scaffolding. The basic scaffolding strategy in both stages provided five procedural steps which guided the preservice teachers in designing a technology-supported lesson: Step 1 Context Analysis: See the big picture, Step 2 Innovation-in-Action: Explore lesson activities, Step 3 Decision Making: Select the best lesson activity, Step 4 Elaboration: Describe the lesson activity, and Step 5 Looking back: Reflect on the lesson design. During Stage 1, directive *Task*, *Strategy*,

TPACK prompts and *Checklists* were embedded in the five steps to provide procedural, metacognitive, conceptual, and strategic scaffolding functions (Figure 4.2). During Stage 2, supportive *Task*, *Strategy*, and *TPACK* prompts were used to engage the preservice teachers in regulating lesson design process (Figure 4.4). They were encouraged to discuss with a partner but were required to complete the steps individually. Specific scaffolds were described below.

Stage 1

Step 1. Context Analysis: The *Task* prompts explained how to analyze the lesson design context, such as “creating a concept map” and “setting instructional goals” in TLAT 2. The *Strategy* prompts gave a list of five factors to analyze—including 1) NETS, 2) curriculum standards, 3) technology tools, 4) student characteristics, and 5) potential challenges—and provided links to related knowledge sources. The description of each factor indicated connections to other factors (e.g., curriculum standards that involve communication and collaboration and would benefit from technology). In TLAT 2, the *TPACK* prompt required color-coding the concept map ideas with technology (pink), pedagogy (yellow), and content (blue) categories. The *Checklist* in TLAT 2 reminded analyzing all five factors, color-coding the concept map, and establishing goals based on analysis.

Step 2 Innovation-in-Action: The *Task* prompts required brainstorming 3-5 brief technology-supported lesson ideas based on context analysis in Step 1. The *Strategy* prompts recommended technology integration websites with lesson plans (e.g., *In-Time*, *Thinkfinity*, and *Quest Garden*) and provided instructions on how to search and use them. In TLAT 2, the *TPACK* prompts required specifying a) curriculum standards, b) technology tools, and c) student activities or tasks in describing each possible lesson idea. The *Checklist* prompted to keep open-minded to all possibilities and clarify the *TPACK* components in description.

Table 4.1

Principle or proposition-based features of two-stage scaffolding

	Stage 1: TLAT 1&2 Directive Scaffolding	Stage 2: TLAT 3 Supportive Scaffolding
Procedural Scaffolds	5 lesson design steps: Step 1. Context Analysis Step 2. Innovation-in-Action Step 3. Decision Making Step 4. Elaboration Step 5. Looking back <i>Task</i> and <i>Strategy</i> prompts explained what to do in each step and provided sub-steps to follow.	5 lesson design steps same as TLAT 1&2. <i>Task</i> prompts briefly described what to do in each step. <i>Strategy</i> prompts suggested referring back to TLAT 1&2 for how to complete each step. - Procedural scaffolds in TLAT 1&2 were available.
Metacognitive Scaffolds	<i>Task</i> prompts in Step 1 required setting instructional goals based on analyses (TLAT 2 only). <i>Strategy</i> and <i>Task</i> prompts in Step 2-4 reminded reviewing and address analyses in Step 1. <i>Task</i> and <i>Strategy</i> prompts in Step 5 required reflection based on analyses in Step 1. <i>Checklists</i> in Step 1-4 reminded monitoring the completion of the guided tasks (TLAT 2 only).	<i>Task</i> prompts required - planning for the sub-steps of Step 1-4, - using the plan as a checklist to monitor completion, and - reflecting on the lesson activity in Step 5. - Metacognitive scaffolds in TLAT 1&2 were available.
Conceptual Scaffolds	<i>Strategy</i> prompts in Step 1 indicated connections among the contextual factors and linked to related knowledge sources. <i>TPACK</i> prompts in Step 1, 3, and 4 required using pink, yellow, and blue to color-code the lesson design ideas into technology, pedagogy, and content categories respectively (TLAT 2 only).	<i>TPACK</i> prompts required showing connections to the TPACK model in each step. - Conceptual scaffolds in TLAT 1&2 were available.
Strategic Scaffolds	<i>Strategy</i> prompts in Step 2 recommended technology integration websites with existing lesson plans and provided instructions on how to search.	Strategic scaffolds in TLAT 1&2 were available.

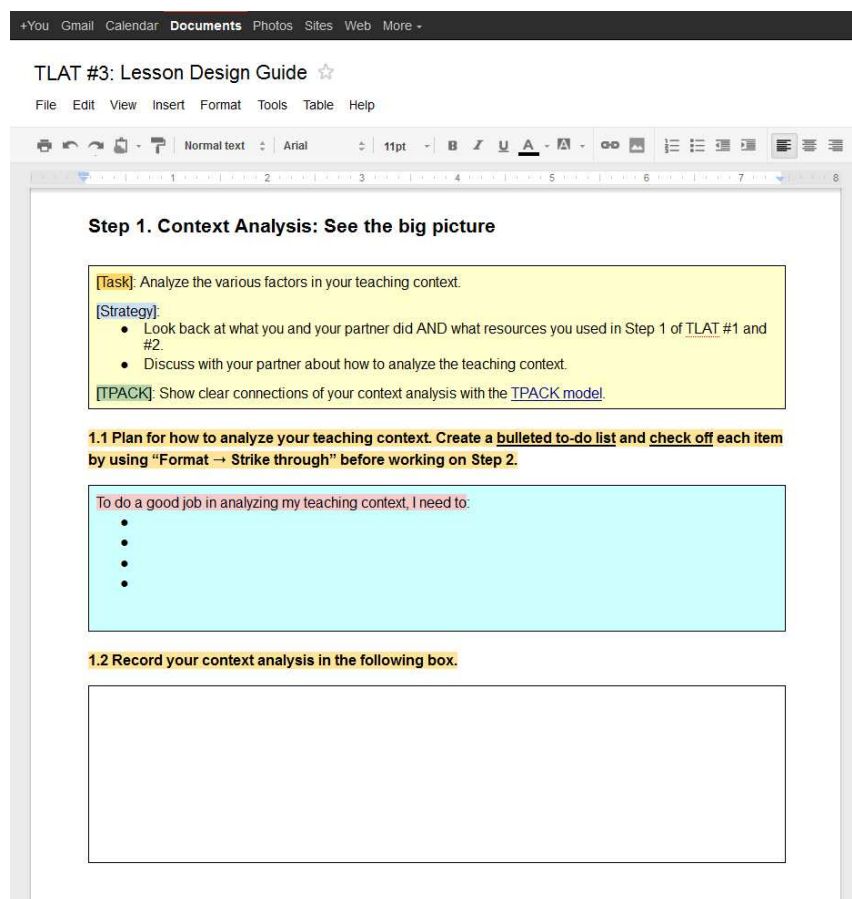


Figure 4.4. Sample screenshot of the lesson design guide in Stage 2.

Step 3 Decision Making: The *Task* prompts presented three sub-steps for decision making, including 1) identifying five evaluation criteria, 2) rating the generated lesson ideas with criteria on a 5-point scale, and 3) selecting the best lesson idea and justifying the decision. An evaluation table was provided for rating and computing total scores of the lesson ideas. The *Strategy* prompts emphasized reviewing context analyses, particularly the instructional goals, when making the decision. In TLAT 2, the *TPACK* prompt required color-coding the evaluation criteria into technology, pedagogy, and content categories. The *Checklist* prompted to remain objective in evaluation, consider a variety of factors, and justify the decision.

Step 4 Elaboration: The *Task* prompts provided the structure for elaborating on the lesson idea selected in Step 3, including introduction of the activity, student participation, teacher

guidance, and evaluation of learning outcomes. In TLAT 2, the *Strategy* prompts suggested reviewing and addressing the concept map and the goal statement when developing the lesson activity. Also, the *TPACK* prompt required color-coding the key sentences or phrases of each paragraph into technology, pedagogy, and content categories. The *Checklist* prompted preservice teachers to accommodate the contextual factors, address the instructional goals, and color-code sentences in each paragraph.

Step 5 Looking Back: The *Task* prompt required reflecting on the lesson activity developed in Step 4 and proposing ways to improve. The *Strategy* prompt suggested evaluating the lesson activity based on analyses and refining accordingly.

Stage 2

Step 1 Context Analysis: The *Task* prompted to analyze various factors in the teaching context. It also required initial planning for how to analyze and documenting the analysis process and ideas using the plan as a checklist. The *Strategy* prompt suggested referring to Step 1 in TLAT 1&2 for how to analyze and what resources to use while discussing with a partner. The *TPACK* prompt requested showing connections to the TPACK model during analysis.

Steps 2-5: Similar as Step 1, the *Task* prompt briefly described what to do in the step and asked the preservice teachers to plan for the sub-steps and document and monitor their reasoning with the plan in Step 2-4. The *Strategy* prompt suggested looking back at the same step in TLAT 1&2 and discussing with a partner about how to complete the step in TLAT 3. The *TPACK* prompt required showing connections of their reasoning with the TPACK model.

Research Questions

1. To what extent did the preservice teachers' reasoning change from Stage 1 to Stage 2?
2. To what extent did the directed and supportive scaffolds influence reasoning?

Research Design

Component mixed methods design (Green, 2008) was used to concurrently collect quantitative and qualitative data on reasoning process during the three TLAT projects in order to triangulate the quantitative reasoning statistics with qualitative reasoning themes to characterize changes influenced by evolving scaffolds. The quantitative component provided repeated measures and descriptive statistics to assess changes in the preservice teachers' reasoning across the three TLAT projects, while the qualitative component applied grounded theory methods by inducing themes of contextualized reasoning skills and scaffold utilization.

Data Collection

A background survey (Appendix N) was conducted at the beginning of the semester to provide demographic information as well as to document interests and experience in teaching, which were subsequently used for sampling purposes. In addition, three online surveys (Appendix O) related to the preservice teachers' reasoning process were implemented during each TLAT project. The surveys were comparable across the three TLAT projects, and comprised of questions related to analytic, generative, and evaluative reasoning skills, which were developed based on our previous research findings (Shen & Hannafin, 2011). Overall, 90% or more undergraduates from the four sections participated in the TLAT 1&2 surveys and 84% participated in the TLAT 3 survey. Since scaffolds were designed to prepare preservice teachers, we eliminated participants who indicated they were not interested in becoming a teacher. Among the remaining participants, a total of 10 preservice teachers were purposefully selected for the qualitative component based on two criteria: 1) In order to focus on participants with a clear intent in becoming a teacher, each indicated they were very interested in becoming a K-12 teacher; and 2) collectively, they represented a balance of prior teaching knowledge and

experience, (See Table 4.2 for profiles). A semi-structured interview (Appendix P) was conducted with participants immediately after they completed each TLAT project, during which they reviewed their lesson design guide and described their reasoning process.

Data Analysis

Quantitative Analysis

The background survey and the three end-of-project surveys were merged using anonymous ID numbers. To compare reasoning skills across projects, we computed analytic, generative, and evaluative reasoning scores for each project by using corresponding survey questions triangulated with qualitative themes and ran repeated measure analyses to identify changes in higher-order reasoning skills. We also ran a descriptive analysis of survey responses to compare higher-order reasoning skills across the TLAT projects.

Qualitative Analysis

The three reasoning skills were used as major coding categories. Codes within categories were initially created by open-coding preservice teachers' reasoning responses (e.g., "analytic thinking: setting goals," "analytic thinking: identifying technology tools," and "generative thinking: exploring lesson ideas"). We also coded perceptions of the utility of scaffolds when preservice teachers reported using specific features while reasoning. Lesson design guides were used to interpret responses and to triangulate with reasoning self-reports. We generated themes of individual preservice teachers' analytic, generative, and evaluative thinking skills and utilization of scaffolds for each TLAT project. The themes were merged across preservice teachers as qualitative evidence of higher-order reasoning skills and scaffolding influences.

Table 4.2

Profiles of interview participants

<i>Preservice teachers</i>	<i>Year</i>	<i>Major</i>	<i>Education Coursework</i>	<i>Field Experience</i>
Brook	3 rd	Early childhood education	Foundational courses, methods courses	Observing elementary classes for 150 hours, helping individual students, and teaching lessons for 1-10 hours.
Carla	3 rd	Early childhood education	Foundational courses, subject matter courses	Observing elementary classes for 21-30 hours, guiding the students, and helping out in an afterschool program.
Ember	3 rd	Early childhood education	Foundational courses, subject matter courses	Volunteering in an elementary school helping the students with homework, and working in an afterschool program.
Emmy	3 rd	Science education	Foundational courses	Observing pre-middle grades classes for 15 hours, and teaching a couple of lessons.
Kristie	4 th	Social studies education	Foundational courses, methods courses	Observing middle school and high school classes for 31-40 hours, and mentoring an elementary school student.
Lauren	3 rd	Science education	N/A	Mentoring low-income students in an afterschool program.
Mellissa	3 rd	Early childhood education	Foundational courses, subject matter courses	Observing elementary classes for 31-40 hours, tutoring the students, and working in summer camps.
Sophia	4 th	Family and consumer sciences education	N/A	Teaching Sunday classes at church.
Scott	3 rd	Science education	Foundational courses	Helping out middle school and high school marching band by teaching them to play instruments.
Tracy	3 rd	Early childhood education	Foundational courses, subject matter courses	Observing elementary classes for 40 or more hours, and teaching lessons for 1-10 hours.

Mixed Analysis

For each TLAT project, the statistics for analytic, generative, and evaluative reasoning were triangulated with the corresponding qualitative themes. Changes in reasoning skills from scaffolding Stage 1 to Stage 2 were identified using repeated measures analyses and the triangulated reasoning skills of each TLAT project. To identify scaffolding influences, we analyzed connections between the preservice teachers' higher-order reasoning skills and qualitative themes of how they used the directive and supportive scaffolds.

Findings and Interpretations

Analytic Reasoning

Analytic reasoning, defined as analysis of problem space operators and their connections (Bloom, 1956), was primarily examined in Step 1 (analyzing interrelated factors in the teaching context). As summarized in Table 4.3, analytic reasoning scores of the three TLAT projects were significantly different ($F(2, 56)=23.222, p=.000$). Table 4.4 showed that TLAT 3 scored lower than TLAT 1 ($F(1, 28)=36.429, p=.000$) and TLAT 2 ($F(1, 28)=26.886, p=.000$), indicating reduced analytic reasoning skills. Qualitative data and descriptive statistics indicated changes in the breadth and depth of the preservice teachers' analyses.

Breadth

During TLAT 1&2, all interviewees analyzed the contextual factors suggested by the *Strategy* prompts and set goals accordingly. For example, in TLAT 2, Kristie referred to the list of five factors that she was "supposed to have" and analyzed "step by step." She created a concept map by using the factors as major branches and identifying elements under each. Although she initially focused on content learning in her instructional goals, the *Checklist* prompt (Did I select the key points from the brainstorming web to describe in Step 1.2 goal

statement?) triggered her to include goals addressing the NETS (Creativity and Innovation). She reported:

When I first wrote my goals, it really had nothing to do with my brainstorm map, so I went back [after using the *Checklist*]... Originally I was just talking about how important it was for them to know the content. I thought creativity should be one of the main goals, [because] it was in the brainstorm map, I didn't realize that.

Table 4.3

Higher-order reasoning scores of the three TLAT projects

N=29	TLAT 1		TLAT 2		TLAT 3		Repeated measure ANOVA	
	M	SD	M	SD	M	SD	F (2, 56)	p
Analytic Thinking ^a	16.97	3.650	16.55	3.670	11.93	4.765	23.222	.000**
Generative Thinking ^a	15.40	2.269	15.48	2.132	14.93	2.712	.714	.494
Evaluative Thinking ^b	12.76	3.158	14.83	2.494	13.31	2.466	5.376	.007*

Notes: ^a Computed with five-question factor scale; ^b Computed with four-question factor scale

During TLAT 3, the preservice teachers also considered many contextual factors from TLAT 1&2. Eight interviewees indicated their analysis was based on the directive scaffolds in previous TLATs. Lauren referred to the prompts and checklist in TLAT 2 “to see what we were supposed to have” and analyzed “what makes a good problem-based lesson,” “curriculum standards,” “possible technology tools,” and “potential challenges.” Two others based their analysis on the TPACK model. For example, Melissa organized her concept map using “the three TPACK concepts”—content, pedagogy, and technology—supported by underlying components. However, 28.6% preservice teachers failed to identify challenges or constraints in their teaching

context; and 11.4% failed to analyze students' aptitudes. None of the interviewees set instructional goals after analysis.

Table 4.4

Follow-up repeated contrast of higher-order reasoning scores

N=29	TLAT 1 vs. 3		TLAT 2 vs. 3	
	F(1, 28)	p	F(1, 28)	p
Analytic Thinking	36.429	.000**	26.886	.000**
Generative Thinking	.817	.374	1.205	.282
Evaluative Thinking	.563	.459	8.084	.008*

Depth

As shown in Table 4.5, during TLAT 1&2, preservice teachers identified on average 3 or more elements for each contextual factor. In TLAT 2, 85.4% integrated knowledge from the provided links or hints to enrich analysis, and classified their identified elements through color-coding. Brook analyzed the characteristics of an effective Creativity and Innovation lesson:

I had the NETS standards [website] open and then these (elements) are right from the book really, like “focus on the content,” “emphasize out of the box thinking,” “design original works”... “Use models and simulations” [and] “identify and explore trends” [are from the NETS website].

She color-coded these ideas on her concept map to indicate the content, pedagogy, and technology categories she assumed they belonged to.

Seven interviewees considered the connections among the factors during analysis. To identify curriculum standards for TLAT 1, Melissa read through the language arts performance standards and “looked for words that relate to communication, collaboration with students.” She then selected technology tools by making sure “they had characteristics of the standards” and were “appropriate for the age.”

Table 4.5

Number of elements identified for contextual factors

	TLAT 1 n=42		TLAT 2 n=41		TLAT 3 n=35	
	M	SD	M	SD	M	SD
NETS	4.17	.986	3.90	.995	3.26	1.379
Technology tools	3.67	1.097	3.56	1.097	2.91	1.401
Students' characteristics	3.88	1.131	3.15	1.295	2.54	1.358
Potential challenges	3.24	1.206	3.32	1.192	1.89	1.694

During TLAT 3, fewer contextual factors were identified. After planning for analysis, five interviewees analyzed superficially without specifying details or considering connections. Emmy noted, “I pretty much just made a sentence or two about each of these (factors).” She discussed the factors in general based on her own understanding, such as “the technology should be user friendly and easy to learn.” Although Melissa created a concept map, she labeled “critical thinking” as an element under the “pedagogy” factor but failed to elaborate. She analyzed the

“content” factor separately, trying to “have anything related to English language arts,” such as “reading,” “writing,” and “comprehension.”

Nevertheless, the remaining interviewees investigated some factors through analytic reasoning. Brook recalled discussing with her partner when planning for analysis, “We started off saying we should define Critical Thinking and Problem Solving, [because] that is something that we did with the other two TLATs.” After researching online, she identified critical thinking as “looking at something from many different viewpoints,” “involving skillful judgments,” “[being] thoughtful and reflective.” Clarifying critical thinking led her to identify curriculum standards compatible with the NETS:

As I read them (performance standards) I just made simple judgments of which ones I thought were going to be easier to do critical thinking lessons on. A lot of the ones I chose already have different perspectives to look at.

She was then able to use “key words from the standards” to search for relevant interactive tools or existing lessons on *Thinkfinity* and *Quest Garden* websites.

Generative Reasoning

According to scholars (Bloom, 1956; Guilford, 1967), generative reasoning synthesizes the relevant factors and elements to create new ideas through divergent and convergent productions. Step 2 (Innovation in Action) involved divergent production of possible lesson ideas based on integrating the contextual factors, while Step 4 (Elaboration) required convergent production to develop lesson details consistent with context analyses. No significant differences were found among the generative reasoning scores of the three TLATs. Qualitative data showed similar divergent production skills but also suggested differences in integration and convergent production skills.

Integration

Preservice teachers' integration in TLAT 1 was characterized by designing learning content and activities for the technology tools they preferred to use. Kristie called her approach "backwards design":

I took the three [technology] tools that I knew the most about, which were *Twitter*, the *Blog*, and *Skype*. And I really tried to mode them into the lesson I wanted it to be... And then eventually you try to make it travel back to a standard.

In TLAT 2, eight interviewees followed the *TPACK* prompts procedurally by starting with curriculum standards and incrementally integrating technology tools and learning activities.

Tracy described how she generated lesson ideas:

I just chose different areas of content... Then I thought of tools that could go with it (the content). I just went step by step... [Then] I thought of the activity that could incorporate the tools and the curriculum standards.

However, despite the technology integration websites and instructions, few preservice teachers incorporated ideas from existing lesson plans. In TLAT 2, 34.1% failed to use any and 43.9% only used 1-2 lesson plans from the provided websites.

To facilitate utilization of technology integration resources in TLAT 3, the instructor demonstrated searching for existing lessons on *Thinkfinity* and *Quest Garden* websites and suggested in class, "Your Step 2 can be 5 ideas from *Thinkfinity* or 5 different ways to use tools found on *Thinkfinity*. (Or) you can find a *WebQuest* and talk about how you would use it in class." As a result, most preservice teachers re-used or adapted rather than generating lesson ideas: 57.1% preservice teachers indicated that the majority of their lesson ideas were not original. Although Kristie copied and pasted the *TPACK* prompts from TLAT 2, she engaged in

little reasoning for integration but responded by simply summarizing existing ideas from *WebQuests* or *Thinkfinity*. When introducing one of her lesson ideas, she explained, “The *WebQuest* generates the activity for you. So I just said they would use the task in the *WebQuest*.” Brook did not use the *TPACK* prompts, but integrated new content, pedagogy, and technology components by modifying to “fit the needs for my lesson.” When adapting the Bill of Rights *WebQuest*, she “took out the first part of the Process” to help students study Bill of Rights and “added them (students) creating a *Glogster* advertising why a specific right is protected in our Constitution, why it is important, and what the world would be like today if it wasn’t in place.” She also added a “mini mock trial” because it was “a lot of critical thinking and problem solving.”

Divergent Production

During TLAT 1&2, preservice teachers brainstormed a minimum of 3 possible lesson ideas as required by the *Task* prompts; 30% or more generated 4-5 ideas. Three interviewees reported that their ideas improved through brainstorming. Kristie recalled that she generated lesson ideas by “taking a step further” of the previous lesson idea and commented, “To create a good technology-supported lesson activity, it is important to list a healthy number of ideas.” Similarly, Carla remarked, “The more I worked on it (generating lesson ideas), the more I understood what the goals were, like using creativity and technology, the better each lesson [idea] became.”

During TLAT 3, all preservice teachers produced 3 or more possible lesson ideas. Brook planned for Step 2 to “Find multiple options that can be used for your lesson.” She indicated that she would use this strategy in future:

I will probably come up with two or three potential lessons for each standard or day that I'm going to do... I even did this in the huge unit project for one of my other classes. We didn't pick our first lesson that we chose... We were throwing ideas back and forth at each other.

Moreover, generating lesson ideas through adaptation appeared to make divergent production easier, with 48.6% reported generating 4-5 lesson ideas. Tracy explained why she was able to generate more lesson ideas in TLAT 3:

Just from looking at *Thinkfinity*, it gave you more [ideas]. With the other two (TLAT 1&2), I always came up with my own ideas. This (TLAT 3) was the first one where I used someone's idea at first and then I extended what they gave me.

Convergent Production

Overall, 90.5% preservice teachers in TLAT 1 looked back at their analyses in Step 1, as suggested by the *Strategy* prompts, when elaborating on the lesson activity in Step 4. Seven interviewees developed lesson details to accommodate the students' aptitudes or to address the potential challenges. Using TLAT 2 *Strategy* prompts and *Checklists*, all preservice teachers referred back to their analyses during elaboration and 75% reported looking back 3 or more times. They incorporated several factors when developing details and reportedly increased attention to their goals. Brook said, "I went back and read them (goals) a lot, just so I would remember what they were and I could make sure I was following them." The *TPACK* prompt facilitated monitoring the lesson details to represent content, pedagogy, and technology aspects. Ember commented, "I had to make sure that I had something to highlight, that I wasn't just writing about pedagogy or just about the technology tool."

Although 91.4% preservice teachers in TLAT 3 referred to their analyses, 57.1% referred back only twice or fewer times. Six interviewees believed that they internalized their analysis results, which had less breadth and depth than previous TLATs, and focused on generating more details beyond their brief lesson idea in Step 2. As Melissa described:

I would just go back to where you (I) briefly describe them (lesson ideas) in step 2, and make sure I'm just explaining it more in-depth than previously. I don't think I looked back at the brainstorming thing (concept map) because at that point I had looked at it so many times before, I kind of knew what was there.

However, in contrast, Lauren commented, "I looked back at Step 1 more when I was doing Step 4... to make sure I was thinking of everything that it (the lesson) was supposed [to have]."

During Step 1 analysis, she incorporated the definition of a problem-based lesson from the course website, which later guided her lesson development. To "emphasize the process," she stated, "The process of them getting the results is like them doing the lab and creating the graph and everything. That's more important than the actual answer they get at the end." In addition, five interviewees continued to color-code the paragraphs, but mostly to meet the requirement of "showing connections to TPACK" rather than to purposefully generate lesson details.

Evaluative Reasoning

Evaluative reasoning, making judgments about the collected information or generated ideas based on criteria (Dewey, 1933; Ennis, 1987), was mainly applied during Step 3 (Decision Making) to evaluate potential lesson ideas using criteria. However, evaluation was also involved in Step 5 of Looking Back over the lesson plan to make improvements. Evaluative reasoning scores differed across the three TLAT projects ($F(2, 56)=5.376, p=.007$). TLAT 3 scores were comparable to TLAT 1 ($F(1, 28)=.563, p=.459$), but lower than TLAT 2 ($F(1, 28)=8.084$,

$p=.008$), indicating that the preservice teachers' evaluative reasoning skills reduced but retained to some extent. Qualitative TLAT 3 analysis indicated diverse evaluative reasoning during decision making but little during reflection.

Decision Making

Overall, 60% or more preservice teachers in TLAT 1&2 selected the lesson idea they considered to be “best” through guided decision making. In TLAT 2, Tracy first identified evaluation criteria reflecting TPACK, such as “use prior knowledge to be creative,” “meet all types of learning styles,” and “use technology to support creativity.” After rereading her lesson ideas in Step 2, she rated them on a 1-5 scale based on those criteria and selected the idea that scored the highest. To evaluate objectively, she said “I put myself as if I didn’t come up with the activity.” Using the *Strategy* prompt, Kristie pointed out that “My goals were [promoting] creativity and content [learning]” and incorporated them in her evaluation criteria and justification of the selected lesson idea:

By using *Bubbl.us* and *iMovie* [in the lesson], my students will be allowed a chance to express their creativity through the medium of film while also displaying their understanding of the Bill of Rights.

During TLAT 3, 54.3% preservice teachers determined their best lesson idea mainly through evaluation rather than preference. Several decision-making patterns emerged. Preservice teachers who frequently referred back to TLAT 1&2 based their decisions on evaluation processes similarly as previously done. For example, Scott used the same evaluation table from TLAT 2 to rate the possible lesson ideas because he believed that “with rating you’re really picking the best activity, not the one that you like best.” Brook recognized her tendency to choose the first lesson idea that she “spent time thinking about” and “liked it the best.”

Therefore, she rated and ranked her lesson ideas based on pros and cons identified using criteria (e.g., “fit for the grade level,” “promote critical thinking or problem solving”) and “tried to do without taking into consideration how much I personally liked the lesson.” In contrast, preservice teachers who rarely referred back to TLAT 1&2 tended to make decisions based on their preference. For example, Ember assumed that she already knew “what was expected” in TLAT 3 and did not refer back. Consequently, rather than evaluating her lesson ideas in Step 3, she believed all of them “could have been good” if she “expanded on each.” Influenced by a class on art immersion in elementary classroom, she finally selected the lesson idea that “included an art project.” Nevertheless, most preservice teachers justified their decision by arguing that their chosen lesson addressed the evaluation criteria; 68.6% mentioned 4-5 criteria in their justification.

Reflection

When reflecting under the *Task* and *Strategy* prompts in Step 5, 95% or more preservice teachers in TLAT 1&2 evaluated the weakness of their lesson and indicated ways to improve. For instance, in TLAT 1, Sophia reviewed her student analysis and noted that she did not consider “mixing between all categories (aptitudes)” when grouping the students for collaboration. She reflected on her lack of knowledge about individual differences and group work:

When I was a high school student, I didn’t think like Oh if I’m in a group with different learners and I might learn differently and I might contribute differently. So looking back that was something that I definitely would like to group them... to mix them well.

As a result, she paid particular attention to grouping students with different motivation levels and learning styles in TLAT 2.

As the preservice teachers were only prompted to “reflect on the lesson activity” in TLAT 3, most emphasized the advantages or benefits of their lesson but not their weakness; 25.7% failed to identify anything to be improved. Melissa stated her lesson would make the students “think in a critical way they have never before,” although she failed to clarify critical thinking during analysis. Tracy admitted that she tended to think “nothing is going to go wrong” with her lesson because “it’s hard for me to put myself in real perspective of what might be challenging [during teaching].” Moreover, many “challenges” or “problems” identified were not related to the instructional design of the lesson thus did not trigger modifications. For example, Kristie mentioned her classroom may have “a small number of computers,” so she needed to reserve the technology room. Emmy was concerned that her students may play with the lab equipments and talked about how she would manage with rules.

General Discussion

The goal of this study was to improve preservice teachers’ analytic, generative, and evaluative reasoning skills when designing technology-supported lessons. We used a two-stage scaffolding approach and multiple scaffolding functions to support preservice teachers’ development and internalization of reasoning. During Stage 1, the five steps and sub-steps provided directive scaffolds that guided preservice teachers through a reasoning process model shown in Figure 4.5. The contextual factors were used sequentially, ensuring the breadth of analytic reasoning. The brainstorming of lesson ideas promoted divergent production; and the TPACK prompts for generating lesson ideas facilitated incremental integration of content, technology, and pedagogy. The evaluation scaffolds guided how to select and support a lesson. Moreover, the conceptual scaffolds deepened analytic reasoning. Descriptions of contextual factors prompted consideration of individual factors and their connections; the resources

encouraged knowledge integration during identifying each factor; and the color-coding of elements amplified key TPACK perspectives. The metacognitive scaffolds supported generative and evaluative reasoning with analyses. As preservice teachers represented analyses with instructional goals and referred back in later steps, they were better able to integrate contextual factors to generate lesson ideas, make and justify decisions based on goals, develop lesson details to address analyzed factors, and reflect on the lesson by comparing to analyses.

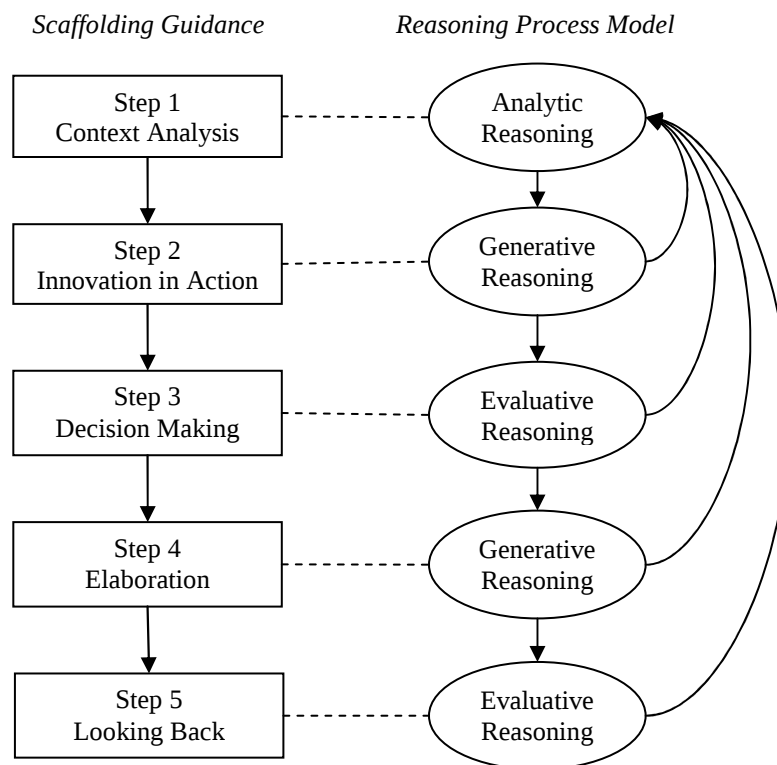


Figure 4.5. Scaffolded reasoning process model during technology integration.

As directive scaffolds were switched into supportive scaffolds, evidence of reasoning processes changed differently across individuals. At least five interviewees began to internalize reasoning skills supported by procedural scaffolds, as they planned and applied all or part of the guided reasoning, such as analyzing the teaching context, generating multiple technology-supported lesson ideas, and selecting ideas through criteria-based evaluation. However, all

interviewees reverted to naïve thinking. In some cases, preservice teachers assumed they had internalized the reasoning skills thus did not review or refer back. As a result, five did not employ evaluative reasoning, instead falling back on personal preference. In other cases, preservice teachers did not internalize the reasoning processes supported by conceptual or metacognitive scaffolds, which were less explicit than the procedural supports. Consequently, they analyzed learning context superficially without integrating knowledge or considering connections, attended less to analyses focus when generating lesson details, or failed to reflect on potential shortcomings of their lesson designs.

Nevertheless, Brook and Lauren retained analytic reasoning from procedural and conceptual scaffolds as they accessed external resources to clarify the NETS (Critical Thinking and Problem Solving), which later enhanced their generative and evaluative reasoning. Brook, for example, integrated new components to promote critical thinking in adapting the existing lesson; Lauren developed lesson details to address the criteria of a good problem-based lesson. Both evaluated the lesson ideas and justified the decision with NETS-related criteria. Although they did not report re-using metacognitive scaffolds, their retained analytic reasoning appeared to serve the similar function of monitoring generative and evaluative reasoning. In both two cases, the directive procedural and conceptual scaffolds during Step 1 may have influenced the development of analytic reasoning and the transfer of generative and evaluative reasoning skills.

The demonstration and recommendation of technology integration websites also provided dynamic strategic scaffolds that influenced generative reasoning. Despite ineffective initial strategic scaffolds, the instructor's dynamic scaffolding promoted utilization of existing lessons, which stimulated divergent lesson ideas for many. Some adapted existing lessons to various extents, whereas others simply copied from previous lessons. Most preservice teachers, however,

did not demonstrate the TPACK attributes while using technology integration resources to support design. Existing lessons integrated factors from particular teaching contexts, which proved incompatible with the *TPACK* prompts to scaffold integration from scratch. The preservice teachers may need further scaffolds on how to use the strategic resources to inform as opposed to simplify their reasoning for integration.

Implications

Our findings indicated the value of several strategies for scaffolding preservice teachers' technology-supported instruction. First, two-stage scaffolding helped preservice teachers develop and internalize the intended reasoning. These findings were consistent with the results from Angeli and Valanides (2005) who prepared preservice science teachers to integrate technology using an explicit design model and reported improvements in preservice teachers' lesson designs. Two-stage scaffolding extended their approach by first embedding the reasoning model in structured design experience and then reducing the structures to elicit self-regulated reasoning. Moreover, it appears to be necessary to increase preservice teachers' metacognition for monitoring their reasoning by sustaining explicit guidance and confirming its impact prior to rapid reductions or withdrawals of prompts.

Second, conceptual and metacognitive scaffolds related to analytic reasoning need to be adjusted cautiously as they transition from directive to supportive mechanisms. Directive conceptual scaffolds can help preservice teachers to consider interconnected contextual factors and integrate knowledge during analysis. Directive metacognitive scaffolds can promote consistency among context analyses and the generation and evaluation of lesson ideas. As these processes were not readily recognized as procedural steps, premature transition to supportive conceptual and metacognitive scaffolds is likely to render them undetected and, as a

consequence, fail to become internalized. Therefore, it is important to monitor and adapt the transitioning process by integrating directive conceptual and metacognitive scaffolds into supportive procedural scaffolds.

Third, additional scaffolds are needed to help preservice teachers apply existing lessons to inform their generative reasoning. Stand-alone technology integration resources may be easily ignored when preservice teachers are unclear how to use them. To promote utilization of strategic scaffolds, instructors may need to demonstrate or individually assist searching for relevant lessons as well as model how such approaches may be adapted versus simply adopted. Case-based reasoning scaffolds (e.g., Kim & Hannafin, 2011) may prove beneficial to help preservice teachers identify technology integration strategies from existing lessons and incorporate them into generative reasoning.

Limitations

A number of limitations should be noted. We assumed that preservice teachers' reasoning performance was shaped by analysis, generation, and evaluation during ill-structured problem solving. While intuitively logical, this may represent more advanced teacher reasoning than novices typically possess. Further research is required to confirm this assumption and to explore preservice teachers' problem-solving reasoning using grounded theory methods (Glaser & Strauss, 1967). While the changes observed in preservice teachers' reasoning were seemingly attributed to the scaffolds, other factors may also have influenced such changes. Further studies need to account prior teaching knowledge and experience, peer interactions, and how they influence preservice teachers' reasoning in particular. Since it could not be determined definitively whether preservice teachers generated multiple lesson ideas via divergent production or trial-and-error of alternatives, additional data collection strategies such as think-aloud

protocols (Ericsson & Simon, 1996) might be used to document preservice teachers' real-time reasoning process. Finally, we evaluated changes in preservice teachers' reasoning skills but did not examine actual classroom implementation of planned technology integration practices. Research is needed to assess the need for and effectiveness of scaffolding preservice teachers reasoning processes and implementations.

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CHAPTER 5

CONCLUSIONS

This dissertation featured a design research inquiry initiated by an educational technology course instructor's goal to stimulate preservice teachers' reasoning while planning technology-supported lessons. Using this course as the local context to scaffold higher-order reasoning during ill-structured problem solving, I collaborated with the course instructor to develop and test scaffolds over a three-year period beginning Spring of 2008. Informed by design research theories and methods (Barab & Squire, 2004; van den Akker, Gravemeijer, McKenney, & Nieveen, 2006), I examined the scaffolding propositions from my theoretical framework (chapter #2) and conducted four iterations (chapter #3 and #4) to evaluate and refine the scaffolds and to generate evidence-based principles to augment the framework. To conclude, I discuss implications for theory, instructional design, and future research.

Evolution of Framework

In this section, I compare the results to the scaffolding propositions to summarize how the framework was extended and which propositions and assumptions require further exploration.

Procedural Scaffolding

Directive procedural scaffolds were designed to guide learners through higher-order reasoning in a step-by-step fashion. Findings from the four iterations confirm this proposition and suggest strategies to support analytic, generative, and evaluative reasoning. During Iterations 3 (chapter #3) and 4 (chapter #4), directive scaffolds assisted preservice teachers during analysis

of technology integration factors while considering connections. The brainstorming of lesson ideas prompted them to defer initial decisions and explore alternatives for teaching with technology. Technological Pedagogical Content Knowledge (TPACK) prompts during Iteration 4 (chapter #4) yielded incremental improvements in integration of curriculum standards, technology tools, and pedagogical activities. The evaluation steps directed preservice teachers to evaluate possible lesson ideas with identified criteria before making and justifying technology integration decisions. Preservice teachers who followed directive procedural scaffolds were more likely to revise an initially naïve reasoning approach to demonstrate higher-order reasoning skills.

Supportive procedural scaffolds were designed to promote self-regulated completion of intended reasoning. During Iteration 2 (chapter #3), preservice teachers continued to explore instructional problems and generate multiple lesson ideas while the initial reasoning steps were reduced and available as optional rather than required. However, without mandatory use, they did not specify how to integrate technology or apply criteria to evaluate lesson ideas. During the supportive scaffolding of Iteration 4 (chapter #4), preservice teachers were advised to refer to previous projects for supportive procedural scaffolds. Findings revealed comparable breadth but reduced depth in analytic reasoning, greater divergent generative reasoning but limited integration, and retained criteria-based evaluative reasoning among preservice teachers who frequently referred back to previous projects. Collectively, while findings indicate that intentional use of supportive procedural scaffolds elicited higher-order, self-regulated reasoning, when directive supports were transitioned, additional scaffolds were needed to influence depth of reasoning.

Metacognitive Scaffolding

Directive metacognitive scaffolds were imposed to facilitate monitoring of higher-order reasoning. During Iteration 4 (chapter #4), checklists provided to monitor completion of reasoning steps served to reinforce analytic reasoning as preservice teachers were prompted to consider multiple factors when stating lesson goals or planning for analysis. In addition to offering explicit guidelines, scaffolds during both Iterations 3 (chapter #3) and 4 (chapter #4) directed preservice teachers to self-monitor their generative and evaluative reasoning. Preservice teachers were better able to generate lesson ideas, develop lesson details, and identify evaluation criteria aligned with analysis focus. During Iteration 4 (chapter #4), two preservice teachers demonstrated internal monitoring during supportive scaffolding. Overall, findings indicate that directive metacognitive scaffolds highlighted intended reasoning skills and facilitated self-regulated reasoning among some preservice teachers.

Supportive metacognitive scaffolds were intended to promote transfer of regulatory responsibilities to learners during reasoning. Two preservice teachers from Iterations 1 and 3 (chapter #3) respectively transitioned from depth-first to breadth-first reasoning strategies through critical reflection on naïve approaches during planning. Moreover, planning for sub-steps during Iteration 4 (chapter #4) prompted some preservice teachers to reinforce newly developed reasoning skills by referring back to previous projects, but did not support others who assumed internalization of intended reasoning. These findings suggest preliminary evidence that supportive metacognitive scaffolds promote self-regulated higher-order reasoning by prompting to review previous and plan for future problem-solving strategies. Yet, learners who fail to reflect before planning may not be able to retain higher-order reasoning upon the transfer of regulatory responsibilities.

Conceptual Scaffolding

Directive conceptual scaffolds were designed to influence analytic reasoning by focusing on concepts underlying the ill-structured problem. During Iterations 2 and 3 (chapter #3), when preservice teachers were prompted to clarify pedagogical concepts of the intended National Educational Technology Standard (NETS) before or during analysis, they retrieved or integrated relevant pedagogical knowledge and differentiated NETS-related standards, problems, and tools. While using directive conceptual scaffolds during Iteration 4 (chapter #4), preservice teachers considered multiple aspects in the problem space and incorporated knowledge or information from available sources. However, most did not access external resources or enrich analysis when scaffolds were switched from directive to supportive. Findings suggest that directive conceptual scaffolds amplified attention to key concepts while highlighting the importance of knowledge sources availability until analytic reasoning skills are internalized.

Supportive conceptual scaffolds were designed to promote self-regulated identification of key aspects in the ill-structured problem space. During supportive scaffolding of Iteration 4 (chapter #4), prompts requesting connections to the TPACK model scaffolded analysis conceptually. Some preservice teachers created a concept map comprising TPACK components (pedagogy, content, and technology) to guide their problem identification and breadth of analysis. However, they specified primarily superficial rather than essential elements and did not seek additional knowledge or information, perhaps due to limited prior teaching knowledge and available resources. This suggests supportive conceptual scaffolds can promote self-regulated analysis but may be insufficient for learners with limited domain knowledge and prior experience.

Strategic Scaffolding

Directive strategic scaffolds were designed to promote consideration and synthesis of multiple perspectives evident in situated problems. In the current dissertation studies, however, problem space attributes (e.g., subject areas and grade levels) varied among preservice teachers; thus we were not able to ensure the relevance of specific directive strategic scaffolds for problem representation or solutions for individual preservice teachers.

Supportive strategic scaffolds were designed to guide in applying or adapting ideas derived from analogous cases to solve the current problem. During Iterations 3 (chapter #3) and 4 (chapter #4), supportive strategic lesson plan scaffolds appeared to limit preservice teachers' higher-order reasoning when they were simply adopted rather than adapted. Preservice teachers produced convergent or divergent lesson ideas when summarizing existing lessons. Use of existing lessons also influenced evaluative reasoning as preservice teachers reported satisfaction with adopted ideas but were unable to distinguish their rationale based on criteria. As noted by Hernandez-Serrano and Jonassen (2003), case libraries alone are insufficient to support reasoning. These results suggest the need for additional supporting structures to scaffold how to use and adapt cases to inform versus simplify problem solving.

Implications for Instructional Design

The refined framework and propositions provide guidelines for scaffolding ill-structured, problem-centered learning in varied contexts. Upon establishing an enabling learning context organized around problems (Hannafin, Land, & Oliver, 1999), educators and designers may first identify intended analytic, generative, and evaluative reasoning skills situated in the learning domain, and relate them to learners' entering knowledge and skills to determine performance gaps (Dick, Carey, & Carey, 2001) and zones of proximal development (Vygotsky, 1978).

Results from this research provided evidence for selecting scaffolding strategies to support reasoning performance based on learner and task analyses. For example, novice learners may need sustained directive procedural and conceptual scaffolds to support step-by-step reasoning process while prompting knowledge retrieval or integration. Incremental directive scaffolds involving reflective prompts may promote understanding and spontaneous internalization of higher-order reasoning processes. As learners demonstrate desired reasoning, directive supports may be transitioned to supportive scaffolds to promote joint regulation of problem solving until executive control is transferred effectively.

Question prompts (King, 1991) have been successfully used as fixed scaffolds in previous studies (e.g., Bulu & Pedersen, 2010; Ge & Land, 2000; Oh & Jonassen, 2007) as well as in the current research to provide diverse scaffolding functions through different mechanisms. They are often provided via technology-enhanced media which may otherwise constrain reasoning with predefined rules and externalize and store reasoning processes (Sharma & Hannafin, 2007). Although dynamic scaffolds are difficult to design and validate in advance and are rarely examined in-depth, educators may consider framework propositions during preplanning and promote interactive activities during implementation to complement the fixed scaffolds (Wang & Hannafin, 2008).

To evaluate reasoning performance, a rubric could be developed to accommodate performance goals associated with domain-specific analytic, generative, and evaluative reasoning. Such a rubric could be applied to assess problem-solving processes or products that reflect reasoning. Formative evaluations could diagnose initial and ongoing reasoning skills and inform decisions on transitioning from directive to supportive scaffolding prior to complete fading of scaffolds.

Next Steps

This dissertation has served as the initial steps toward a long-term research agenda to investigate and advance the proposed theoretical framework. After testing and refining fixed scaffolding propositions in the context of preparing preservice teachers to integrate technology, I plan to examine dynamic scaffolding propositions in similar contexts.

Dynamic scaffolds are inextricable to and mutually beneficial with fixed scaffolds (e.g., Ge & Land, 2003; Saye & Brush, 2002; Wang & Hannafin, 2008). This is a key continuing design research concern, particularly given the increased focus on technology-based support during preservice teacher preparation: *How can we integrate dynamic instructor guidance and peer interactions with fixed scaffolds to develop preservice teachers' higher-order reasoning skills in solving technology-supported lesson design problems?* While we documented the effects of fixed scaffolds, dynamic scaffolds promoted only limited reasoning but were not examined in-depth. The interplay between dynamic and fixed scaffolds may be evaluated and adjusted through iterative applications to better support intended reasoning.

1. *How do dynamic instructor guidance and peer interactions influence preservice teachers' high-order reasoning while designing technology-supported lessons?*

Comparing higher-order reasoning data from conditions with and without dynamic instructor guidance and peer interactions may help determine their impact. Incidences from interactive scaffolding processes may indicate and exemplify dynamic scaffolding effects. Understanding dynamic scaffolds' role in supporting higher-order reasoning is a prerequisite to refining facilitation strategies.

2. *How do dynamic instructor guidance and peer interactions relate to preservice teachers' use of fixed lesson design guides?*

Preservice teachers' interactions with instructor and peers based on their reasoning under fixed scaffolding as well as decisions or changes they made after those interactions may reveal the mutual influences between dynamic and fixed scaffolds. Understanding of such connections can provide evidence for adjusting the two types of scaffolds during integrative applications.

3. *What are the roles of dynamic instructor guidance and peer interactions in sustaining higher-order reasoning during transitioning from fixed lesson design guides?*

Dynamic instructor guidance and peer interactions are integral parts of class instructions and may not be faded intentionally. Dynamic scaffolds' influences on preservice teachers' reasoning when fixed directive scaffolds are switched into supportive scaffolds may prove their effects for sustaining or internalizing higher-order reasoning skills. This understanding may suggest strategies for transitioning from or or fading scaffolds.

Finally, as design research emphasizes the transferability and generalizability of outcomes (van den Akker, Gravemeijer, McKenney, & Nieveen, 2006), my future steps also include testing the refined scaffold design and propositions in new settings and domains.

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APPENDICES

APPENDIX A. PREVIOUS RESEARCH ON SCAFFOLDING PROBLEM SOLVING

References	Context	Scaffolder(s)	Samples or Descriptions
Bulu and Pedersen (2010)	6th graders solving a novel science problem	Alien Rescue	Domain-general question prompts: e.g., What information do you need to find in order to solve this problem? Is your evidence enough to convince someone of your solution? Domain-general modeling: e.g., After understanding the problem, Ashley needs to develop solutions. There may be multiple solutions. She needs to decide and select one of them. Domain-specific question prompts: e.g., What does Akona need to survive? Think about the facts including body, food, habitat, dwellings, communication and technology.
Chen and Bradshaw (2007)	Undergraduate students solving educational measurement problem	Web-based learning environment with question prompts	Knowledge integration prompts: e.g., Explain why reliability and validity are important. Summarize the purpose and the meaning of reliability and validity.
Choi and Lee (2009)	Undergraduate preservice teachers solving classroom management problems	Case-Based Learning Environment for Classroom Management Problem Solving	Problem solving stages: e.g., Analyzing problems, Creating solutions, and Making decisions. Audios of multiple stakeholder's perspectives and solutions to the case problem. Prompts: e.g., Critically examine each stakeholder's perspective by considering ... Considering these constraints of the multiple stakeholders' perspectives, how would you expand your view of the problem(s) in this case?
Davis and Linn (2000)	8th graders solving real-world science problems	Knowledge Integration Environment	Activity prompts: e.g., Your assignment now is to ... My design will be good for the aliens because ... Self-monitoring prompts: e.g., Planning ahead: In thinking about doing our design, we need to ... Looking back: Our design could be better if we ...
Demetriadis et al. (2007)	Undergraduates solving software project management case problems	eCASE	Question prompts: e.g., Observe: What concrete events imply possible problems? Recall: What other case do you recall having similar problems? Conclude: What are the useful implications for the successful development of a project?

			A “case archive” link was provided in addition to the “recall” question prompt.
Ge and Land (2003)	Undergraduate students solving an information system design problem	Electronic and hard copies of question prompts	Question prompts: e.g., What are the technical components? What information do you need for this system? What should the system do? Do I have evidence to support my solution? Are there alternative solutions?
Ge, Chen, and Davis (2005)	Graduate students solving instructional design case problems	Web-based learning environment	Question prompts as a guide: e.g., Is there really a need for Web-based instruction? What might be the major causes for students’ low motivation in learning classical literature? What information do you need to find out ...?
Gillies and Khan (2009)	Primary school students solving problems related to society and environment	Peer questioning	Peers posed questions that challenge and scaffold each other’s high-level thinking: e.g., Collaborative Strategic Reading strategy, Ask to Think-Tel Why strategy, intellectual role approach, and reflective questioning approach.
Greene and Land (2000)	Undergraduate preservice teachers constructing activities integrating web resources	Guiding questions on paper Instructor-student interactions Student-student interactions	Instructor questioning: e.g., That’s basically what it is about, but why that? How does it address learning? Why would you use that? Peer interaction: e.g., Kara: They will know nothing about stocks. So we will either have to teach them or they will look it up on Internet ... Tammy: I don’t think they are just getting their feet wet ... When I bought and sold stocks for [a project in the] 8th grade ... I don’t want to get up there and lecture.
Hernandez-Serrano and Jonassen (2003)	Undergraduate students solving a food product development problem	Web-based case library	A case library of 24 stories told by expert food product developers about how they solved similar problems.
Kim and Hannafin (2011)	Undergraduate preservice teachers designing technology-supported lessons	Web-enhanced Case-Based Activity tool	A case library with stories of experienced teachers’ technology integration practice. Prompts: e.g., Story summary, Technology integration, Critique, Introduction of your scenario, and Ideas from the case.
Lajoie et al. (2001)	9th graders solving	BioWorld	Teacher prompting: e.g., Remember ... we talked about peptic ulcers related to the digestive

	diagnostic problems related to the digestive system	Teacher	system. Teacher questioning: e.g., What is one of the most important things to do when you make a diagnosis?
MacGregor and Lou (2005)	4th graders doing a WebQuest on endangered species	WebQuest	Study guide prompts: e.g., Habitat, description, reasons for endangered status. Concept mapping template specified connections to the major concepts: e.g., characteristics of species, habitat issues, and how these factors contributed to the causes of endangerment.
Ng, Cheung, and Hew (2010)	Graduate students solving an instructional design problem	Blackboard Knowledge Community	Message labels: e.g., Identify problems, Discussion, and Develop solutions.
Oh and Jonassen (2007)	Undergraduate preservice teachers solving student behavior problems	Future Learning Environment 3	Message types: e.g., Problem identification, Hypothesize cause, Solution generation, Verification, Rebuttal, Evidence, and Elaboration.
Oliver and Hannafin (2000)	8th graders solving an earthquake engineering problem	Knowledge Integration Environment	Conceptual question prompts: e.g., What is the problem described by this evidence? Why would this problem be difficult to keep from happening?
Pedersen and Liu (2002)	6th graders solving the problem of finding a new home for an alien specie	Alien Rescue	Expert modeling video: e.g., Session 1: Expert modeled reading for a purpose, identifying pertinent information through self-questioning, and recording that information in the onscreen notebook in a list format.
Saye and Brush (2002)	11th graders solving a problem on civil rights movement	Decision Point	Storyboard template and a model storyboard: e.g., Screen 1: Description of Problem required specifying text on the screen, supporting media, and script.
Uribe, Klein, and Sullivan (2003)	Undergraduate ROTC students solving a military personnel case	Peer collaboration through Blackboard	Peer questioning: e.g., What did you come up with for the definition of the problem? I think the problem can be found with ... What do you think they should do?

Wolf, Brush, and Saye (2000)	8th graders writing newspaper articles related to Selma March	Decision Point	Guides prompts: e.g., People involved, goals of the people involved, causes of this event, description of what happened, opinions in favor of and opposed to this event. Journal prompts: e.g., Progress report: Describe any problems or success; Make a plan for research on the next class meeting day.
Yelland and Masters (2007)	Primary school students solving novel math problems on computer.	Teacher	Modeling: e.g., The aim is to get the turtle to the toy in as few moves as possible and back to the elevator. How can we do that? Prompting: e.g., The dots each represented 10 steps. Questioning: e.g., Is there a better way to do this if we want to save on energy?
Zydney (2010)	10th graders solving pollution problem	Pollution Solution	Video cases of real experts who disagreed about the best way to solve the problem. Organizing template: e.g., Problem: What issue(s) is your client trying to solve? What are your client's objectives and goals for this case?

APPENDIX B. ITERATION 1 CASE STORIES

Project 1 Case Story

Case #1: Creativity and Innovation

You are working with a group of very creative learners. They prefer obtaining information from multi-media sources and learning your course content through hands-on activities. They are visual and kinesthetic learners. However, most of their classes are taught through teacher-centered classroom instruction, during which they learn by passively listening to lectures with few chances to interact in the learning environment. You find that this type of teaching is ineffective for learning because it does not match the students' learning styles. Even worse, you find that the lecture-dominated teaching is stifling the creativity of your students.

From your experiences with technology and learning you know that the integration of technology can benefit students by providing them with multi-media information resources and offering them opportunities to learn by doing. Therefore, you decide to design technology-integrated lessons that can meet students' learning styles and encourage creativity and innovation. You plan to start by designing lessons based on curriculum standards you believe can be mastered through active learning and a focus on creative activities.

Project 2 Case Story

Case #2: Communication and Collaboration

You made careful observations of your students' learning while implementing your first technology integration lesson—focused on creativity and innovation. You were pleased to find students became more motivated to learn when they were given the opportunity to communicate their ideas and products to others. More importantly, your students could help each other with difficulties, piggyback on classmates' ideas to generate more creative thoughts, and negotiate the conflicting opinions which led to deeper understanding.

However, you noticed some problems as well. For example, some students were good at using technology but some had difficulties—and they were frustrated while developing their projects. The high-achieving students performed very well in their task and enjoyed “learning by doing.” Your struggling students had many difficulties in completing their task and learned little from the hands-on activity. When working in groups, some students contributed a lot and even dominated the teamwork, while some students were not very engaged and stayed off-task.

The current curriculum standard you are planning to teach can best be achieved by using teaching strategies that emphasize peer interaction and collaborative learning. You know from the EDIT 2000 class that technology can provide your students with rich learning resources, productivity tools, and communication tools. You decide to learn from your previous technology integration experience and try to maximize the positive effects and address the problems you found.

Project 3 Case Story

Case Three: Research and Critical Thinking

You've just returned from a professional educator's conference and your head is swimming with all of the different teaching ideas and strategies you saw. One particular learning activity that intrigued you was the idea of a WebQuest. You know your students will really respond to this type of learning activity. WebQuests encourage creativity, collaboration, and communication—the three “C’s” that have been a focal point for your class. A WebQuest will allow your students to conduct research using web-based resources and to communicate their findings to an authentic audience. It seems almost too good to be true.

You've decided that creating a WebQuest from scratch might be more work than you can handle at this busy time of the school year, so you decide to modify an existing WebQuest. So—where can you find existing WebQuests and how can you know how/what to modify? For that matter—how will you make sure students are interested in the topic? Where will you find quality resources for them to use for research? And how on earth do you evaluate student work?!?

APPENDIX C. ITERATION 1 SCAFFOLDS

Project 1 Scaffolds

Guidance for Solving Instructional Problems

Investigate the Problem

Step 1: Identify the Challenges

Integrate your teaching scenario with the general case description. **What specific challenges, issues and problems will your students face when they learn the same curriculum content through teacher-centered and lecture dominated classroom instruction?** Focus on TEN challenges that you think are the most important. Write your 10 challenges below. Word them as clearly and thoroughly as possible, and use statements (rather than question). You can refer to your understanding about teaching and learning or your own learning experiences.

Challenge #1:

Challenge #2:

Challenge #3:

Challenge #4:

Challenge #5:

Challenge #6:

Challenge #7:

Challenge #8:

Challenge #9:

Challenge #10:

Step 2: Select an Underlying Instructional Problem

Based on the challenges you listed in Step 1, identify the possible underlying Instructional Problems that are of major importance. Select ONE underlying Instructional Problem that you want to solve in this project. This problem should be relevant to creativity and could benefit from technology integrated teaching and learning. Write it down in question form, beginning with the words, “In what ways might we ...?” or “How might we ... ?” Your problem should clearly explain what you want to do and why it is important. Please also indicate by number the Step 1 Challenge(s) from which your Instructional Problem was developed.

Instructional Problem Statement	My instructional problem is:
	This instructional problem is important because:
Check the related challenge(s) in Step 1	☐ #1 ☐ #2 ☐ #3 ☐ #4 ☐ #5 ☐ #6 ☐ #7 ☐ #8 ☐ #9 ☐ #10

Identify Solutions to the Problem

Step 3: Produce Solution Ideas

How will you incorporate technology in teaching and learning to solve your Instructional Problem? Brainstorm as many solution ideas as you can to the Instructional Problem. You may consider the different technology tools you have learned in EDIT 2000. You can use the following sources of information for references: 1) Chapter 5 in your textbook; 2) Class posts on WIKI; 3) ISTE NETS standards for your grade level. For each solution, you must briefly describe WHO will carry out WHAT action, HOW it will be done, and WHY it will solve the Instructional Problem.

Solution #1:

Solution #2:

Solution #3:

Solution #4:

Solution #5:

Solution #6:

Solution #7:

Solution #8:

Solution #9:

Solution #10:

Select the Most Promising Solution

Step 4: Select Criteria

Your task now is to select the most promising solution from your Step 3 list. Generate criteria that will help you determine the creative potential and appropriateness of your solutions. Select and list FIVE criteria that you think are most relevant and important for evaluating your solution ideas. Each criterion should have a different focus.

List Five Criteria

1	
2	
3	
4	
5	

Step 5: Apply Criteria

Apply the criteria to your solutions for the Instructional Problem. Use each criterion to rank the solutions in an evaluation matrix. Use a scale from 1 (poorest) to 10 (best) and enter the numbers in the appropriate columns. Add the ranks you have given to each solution and enter the sums in the TOTAL column.

	Solution Ideas (List the solution ideas with simple words)	Criteria					Total
		1	2	3	4	5	
#1							
#2							
#3							
#4							
#5							
#6							
#7							
#8							
#9							
#10							

Step 6: Design a Simple Lesson Activity:

Turn your most promising solution into a practical lesson activity. Explain more specifically what the teacher and students will do, how technology will be used to support students' learning styles and creativity, and why this solution will solve the Instructional Problem you are focused on.

You may consider some of these questions as prompts:

- How will the lesson be implemented?
- What will the teacher and students do?
- How will technology be used to support teaching and learning?
- How will this lesson activity solve the instructional problem?
- How will you evaluate your students' learning outcomes?
- What are the potential obstacles of your lesson?
- How might you overcome the potential obstacles?

Step 7: Develop Materials for your Activity:

Write the introduction of your lesson and the description of the task that you will use with your students in class. Provide one or more samples that your students would create with technology.

Project 2 Scaffolds**Reflect on Case One**

Take a moment to reflect on your performance in Case One. This helps you learn from your experience and do a better job in Case Two.

As I worked on Case 1, I did well in ...

1.

2.

3.

As I worked on Case 1, I had difficulties with ...

1.

2.

3.

As I worked on Case 1, I wish I had spent more time on ...

1.

2.

3.

Select Curriculum Standards for Case Two

The theme of case two is communication and collaboration. Read the text in the gray box on page 66 of your handout (read the questions but you do not need to answer them). Try to identify curriculum standards that address communication and/ or collaboration in your subject area. Write down the number and/or simple description of the relevant standards in the following boxes.

Number of Standards	Simple Description

Plan for Case Two

Read the description of case two in your handout and decide on the most appropriate curriculum standard you want to teach. Refer to your experience in case one, and make a plan for how you are going to deal with case two under your teaching situation.

To investigate the instructional problem(s) with my teaching situation, I need to...

1.

2.

3.

To identify effective solution(s) to the instructional problem, I need to...

1.

2.

3.

To integrate technology in a meaningful and purposeful way, I need to...

1.

2.

3.

Evaluation Criteria

Criteria	Point Value	Total Points
Learning activity encourages student communication. List type of communication:		
Learning activity encourages student collaboration.		
	Total	/100

Project 3 Grading Rubric

Criteria	Unsatisfactory	Average	Satisfactory	Total Points
Engaging Introduction	Does not engage students.	Some students may be drawn into the activity, some opportunity for engagement	Draws student into the activity, students will be engaged in project	/10
Authentic Task	Task is not authentic, provides little challenge, will be difficult to complete.	Task is not authentic, provides some challenge for students. May be difficult to complete.	Task is authentic, challenging, and doable. Task is 1-3 sentences with description of task and student deliverables.	/10
Student Collaboration	No opportunity or need to work collaboratively, all work can be completed independently	Students can work in roles, but can complete task independently	Students work together in collaborative roles. Minimum of 3 maximum of 5	/10
Process	The process is unorganized; students are not given any structure for the WebQuest activity. The teacher will have a hard time facilitating the WebQuest.	The process is organized; however, students are not given enough direction to be successful. The students will need guidance when completing the WebQuest.	The process is organized with defined roles. Each role has specific resources to help solve the authentic task. Students will not need assistance when working on the WebQuest.	/15
Appropriate Resources	Less than 5 web resources are provided for students. Resources are not age appropriate. Students will not be able to use resources to complete the task.	Less than 5 web resources are provided for students. Resources may not be age-appropriate or useful for the task. All resources are text-based.	A minimum of 5 web resources are provided for each role. Resources are appropriate for the age level and task. At least 2 resources are interactive.	/15

Relevant Evaluation	There is no link between the required task and the evaluation.	There is some link between the required task and the evaluation.	There is a direct link between the required task and the evaluation.	/10
Teacher Page	Does not give suggestions for teacher use, shows no link to content and technology integration standards	Gives some suggestions for teacher use, shows an indirect link to content and technology integration standards	Gives suggestions for teacher use, shows direct link to content and technology integration standards	/10
Creativity and Effort	New version of WebQuest is the same as the original version. Very few changes are made and organization is poor.	Some changes made to new version of WebQuest; idea could be expanded to engage learners	New version of WebQuest is organized and easy to follow. When comparing the two versions, it is apparent that many changes were made to create an engaging learning activity.	/10
Reflection	Write a short reflection about your Case 3 experience—reflection questions will be provided on Thursday, April 22.			/10
Total Points				/100

APPENDIX D. ITERATION 1 INTERVIEW PROTOCOL

1. Tell me a little bit about yourself: 1) major, 2) years in the university.
2. What educational courses have you taken before EDIT 2000? What did you learn?
3. Do you have any teaching or lesson planning experience? If so, tell me a bit about that.
4. Why do you take EDIT 2000? What was your expectation? What did you learn on this course?
5. Have you experienced similar types of problem-solving projects before? If yes, how do you describe your style (your own way or procedure) in working on such projects?
6. Please briefly describe your experience with the three case projects. What did you do? How did you feel about the tasks?
7. From your experience, what are the differences among the three cases in terms of solving problems?
8. What did you do after we provided you the case description? How did you start?
9. How did you identify the instructional problems in the cases?
10. How did you decide on the curriculum standards for your case?
11. How did you come up with the lesson activities for solving the case problems?
12. How did you decide on the technology tools you want to use with your students?
13. From your experience, what was the relationship between the case problem, the curriculum standards, the lesson activity, and the technology?
14. You used the CPS packet in case one. Tell me your experience in using it. Do you think it is helpful or not? How did it help you? What were the difficulties in using the packet?
15. Did you use it for case two? If yes, how did you use it for case two? Why did you use it? (Why didn't you use it?)
16. You did some reflection and planning at the beginning of case two. Tell me your experience in doing that. What did you learn?
17. What were the differences between using the case one packet and the case two packet?
18. How did you decide on the three criteria for evaluating your solutions and grading your project? Tell me your experience of using the criteria for your project. Do you think that is helpful to you? Why?
19. What was the difference between using your own criteria and the teacher's rubric, like case 3?
20. What resources did you use in solving the case problems? How did you use them? Are they helpful or not? Why? (*e.g., Web resources, reading, peer discussion, instructor, class activities*)
21. What difficulties did you meet in the three projects? How did you deal with the difficulties?

APPENDIX E. ITERATION 2 CASE STORIES

Project 1 Case Story

Case One: Communication and Collaboration

The grant your school applied for was awarded and you have access to several new computers in your classroom. You are excited about the computers and want to use them to support students' communication and collaboration, which are important skills for your students to have. From your previous experience, you know that students are more motivated to learn when they are given the opportunity to collaborate in groups and communicate their ideas to a "real audience". More importantly, they can help each other with difficulties and negotiate conflicting opinions through collaboration, which leads to deeper understanding of course content.

However, you remember that things don't always go smoothly when your class does collaborative projects. You remember that during the last collaborative learning project, students seemed to be actively talking to each other, but not everyone learned as much as they were expected to due to a number of problems. For example, some students contributed a lot and even dominated the teamwork, while some students were not truly engaged and kept talking about irrelevant things. Some groups of students really seemed to respond well from the activity, while others seemed to learn very little. While negotiating different ideas, some students failed to listen to each other carefully before they gave responses, which resulted in unpleasant collaboration that ended up with conflicts, disagreements, and even quarrels.

The current curriculum standard you are planning to teach can best be achieved by using teaching strategies that emphasize peer interaction and collaborative learning. You know from your EDIT 2000 class that technology can provide your students with rich learning resources, productivity tools, and communication tools. You decide to integrate technology with teaching strategies to address the problems you have experienced with communication and collaboration.

Project 2 Case Story

Case Two: Creativity and Innovation

Things went pretty well with your last learning activity. The principal even stuck her head in to see what was going on - collaboration and communication can be pretty noisy at times! You really feel like your students were engaged in their learning. You stepped out of your comfort zone and created a learning environment that met the needs of your digital learners. You talked with some students after the project and these are some of the things they said:

"I really enjoyed working with a group, it was nice not having to make decisions on my own."

"It was really interesting to get a chance to work with people who aren't in our class. I hope we get the chance to do that again!"

"I actually understand why we were supposed to learn this!"

You're glad that students enjoyed the activity and can see how they are able to apply what they have learned. However, during the activity you sometimes heard things like this within student groups:

"I can't think of anything else, let's just go with our first idea."

"We did something like this in my afterschool program, I'll show you what we did and we can just copy it."

"Okay, we've finished everything on the checklist, I guess we're done."

"I'm really good at using *insert technology here *, so this should be easy!"

"Did she say how much we were supposed to write?"

You want your students to push themselves to think. You want your students to be creative. You don't want them to just learn the material for the test. You want them to understand it, apply it, and think about it in new ways. You've read a bit about creativity and you know that anyone can be creative when given the right scaffolding or support. You decide that the next curriculum standard you are teaching is perfect for stretching your student's creative muscles - and you know of some really useful technology tools that can support their creativity. So, on with your next lesson - where students will use technology to promote creativity AND learn your curriculum standard.

Project 3 Case Story

Case Three: Research and Problem Solving

You are amazed at your students' creativity! You feel a little guilty that you haven't given them opportunities to do this kind of work before. It's not that you didn't think they were capable - you just didn't realize how capable they were.

However, you find there is still something to be improved because many students failed to think critically which was crucial to in-depth understanding. Although the students had been busy with collecting information and developing products during the hands-on activities, many of them simply compiled all the information they got into a product, without carefully analyzing, synthesizing and evaluating the resources. Even though they generated some creative thoughts based on the materials or information they collected, they did not do much critical reasoning with their ideas to distinguish the appropriate and inappropriate ones. You also notice that your students usually placed more emphasis on the end product of their project rather than the learning process, which was intended to help them construct meaningful knowledge and develop critical thinking, problem-solving, and inquiry skills. There is a danger that the students may just learn something superficial if they fail to understand what they are doing and why.

The third curriculum standard you are going to teach involves critical thinking and problem-solving skills. Based on your technology integration experience and the problems you have noticed, you believe that it is time to develop a lesson to engage your students in research and problem-solving activities by using technological tools and resources. Your goal is to promote students' critical reasoning and doing with understanding.

APPENDIX F. ITERATION 2 SCAFFOLDS

Project 1 Scaffolds**Case One: Communication and Collaboration**

Step 1: Select Curriculum Standard

Select a curriculum standard from your subject/grade level that involves or requires communication and collaboration.

1) What curriculum standard will you address in this lesson?

2) Why did you choose this curriculum standard?

Step 2: Identify the Challenges

Situate your the standard that you are going to teach into the case scenario and think about what specific challenges, in terms of communication and collaboration, you might meet in teaching this standard. List your challenges in the following area (**Number each challenge**).

Step 3: Frame the Instructional Problem

Based on the challenges you listed in Step 2, which one is the biggest issue? This will be your instructional problem. Describe the problem that you want to solve in this case project. Make sure your instructional problem is relevant to communication and collaboration and could benefit from technology integrated teaching and learning.

1) What is your instructional problem?

2) Why is this instructional problem important?

Step 4: Generate Solutions

Think about how you might incorporate technology into teaching and learning to solve your instructional problem. Review Chapter 3 in your textbook to learn about communication and collaboration and the sample lessons while you are working on this step. Consider the different technological tools you have learned either in EDIT 2000 or by yourself and brainstorm as many solution ideas as you can. List your solutions in the following area **(Number each solution)**.

Step 5: Select Criteria

Your task now is to select the most promising solutions from your Step 4. Generate criteria that will help you determine the appropriateness of your solutions. Select and list FIVE criteria that you think are most relevant and important for evaluating your solutions. Each criterion should have a different focus.

List Five Criteria

- 1)
- 2)
- 3)
- 4)
- 5)

Step 6: Apply Criteria

Apply the criteria to your solutions for the Instructional Problem. Use each criterion to rank the solutions in an evaluation matrix. Use a scale from 1 (poorest) to 10 (best) and enter the numbers in the appropriate columns. Add the ranks you have given to each solution and enter the sums of the TOTAL column.

	Solutions (Summarize your solutions)	Criteria					Total
		1	2	3	4	5	
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Step 7: Design your Lesson

Turn your most promising solution into a practical lesson plan. Explain more specifically how you will implement your lesson, how you will use technology to support communication and collaboration, and why your lesson activity will solve your the instructional problem. Here is the information you should include:

Lesson Title

Grade/Content Area

Lesson Duration

*State Objectives (these will come directly from the Georgia Performance Standards)

*Select Tools, Materials, and Teaching Methods (what will you use to accomplish this learning activity?)

*List Student Task/Product (what is the specific task you want students to complete? This should be no more than 3 sentences).

*Describe Learner Participation (describe the steps of the learning activity. How will students be divided into groups with specific responsibilities, how will the lesson be introduced, how will you monitor student learning during the activity, what will students be doing during the activity?)

*Evaluate Learner Outcomes (describe how you will know students have achieved your stated learning objectives).

*Create a Student Sample (Provide one sample that you expect your students would create in this lesson.)

Project 2 Scaffolds

Case Two: Creativity and Innovation

Before reading Case Two scenario, respond to the following questions:

1. In my opinion, a good lesson designer is ...
2. How can I help my target audiences learn? How important is my role as a lesson designer?

Step 1: Select Curriculum Standard (required!!)

Select a curriculum standard that is relevant to creativity and innovation in your subject area and grade level.

1) What curriculum standard that you will address in this lesson?

2) Why do you choose this curriculum standard?

Step 2: Identify the Challenges

Situate your curriculum standard in the case scenario and think about what specific challenges, in terms of creativity and innovation, you might meet in teaching this standard. List your challenges in the following area **(Number each challenge)**.

Step 3: Frame the Instructional Problem (required!!)

Based on the challenges you listed in Step 2, identify the underlying instructional problem that is of major importance. Describe the problem that you want to solve in this

case project. Make sure your instructional problem is relevant to creativity and innovation and could benefit from technology integrated teaching and learning.

1) What is your instructional problem?

2) Why is this instructional problem important?

Step 4: Generate Solutions

Think about how you might incorporate technology in teaching and learning to solve your instructional problem. Read Chapter 3 in your textbook to learn about creativity and innovation and the sample lessons while you are working on this step. Consider the different technological tools you have learned either in EDIT 2000 or by yourself and brainstorm as many solution ideas as you can. List your solutions in the following area **(Number each solution)**.

Step 5: Select Criteria (required!!)

Your task now is to select the most promising solutions from your Step 4. Generate criteria that will help you determine the appropriateness of your solutions. Select and list FIVE criteria that you think are most relevant and important for evaluating your solutions. Each criterion should have a different focus.

Step 6: Apply Criteria

Apply the criteria to your solutions for the Instructional Problem. Use each criterion to rank the solutions in an evaluation matrix. Use a scale from 1 (poorest) to 10 (best) and enter the numbers in the appropriate columns. Add the ranks you have given to each solution and enter the sums of the TOTAL column.

Step 7: Design your Lesson (required!!)

Turn your most promising solution into a practical lesson plan. Explain more specifically how you will implement your lesson, how you will use technology to support creativity and innovation, and why your lesson activity will solve your the instructional problem. Here is the information you should include:

Lesson Title

Grade/Content Area

Lesson Duration

*State Objectives (these will come directly from the Georgia Performance Standards)

*Select Tools, Materials, and Teaching Methods (what will you use to accomplish this learning activity?)

*List Student Task/Product (what is the specific task you want students to complete? This should be no more than 3 sentences).

*Describe Learner Participation (describe the steps of the learning activity. How will students be divided into groups with specific responsibilities, how will the lesson be introduced, how will you monitor student learning during the activity, what will students be doing during the activity?)

*Evaluate Learner Outcomes (describe how you will know students have achieved your stated learning objectives).

*Create a Student Sample (Provide one sample that you expect your students would create in this lesson.)

Project 3 Scaffolds

Case Two: Critical Thinking and Problem Solving

Before reading Case Three scenario, respond to the following questions:

1. Self-evaluate your own understanding on "critical thinking" and "problem-solving" skills?
2. Think back your previous experiences that you applied critical thinking or problem-solving skills. How did you learn these skills?

Step 1: Select Curriculum Standard (required!!)

Select a curriculum standard that is relevant to research and problem solving in your subject area and grade level.

1) What curriculum standard that you will address in this lesson?

2) Why do you choose this curriculum standard?

Step 2: Identify the Challenges

Situate your curriculum standard in the case scenario and think about what specific challenges, in terms of research and problem solving, you might meet in teaching this standard. List your challenges in the following area **(Number each challenge)**.

Step 3: Frame the Instructional Problem (required!!)

Based on the challenges you listed in Step 2, identify the underlying instructional problem that is of major importance. Describe the problem that you want to solve in this case project. Make sure your instructional problem is relevant to research and problem solving and could benefit from technology integrated teaching and learning.

1) What is your instructional problem?

2) Why is this instructional problem important?

Step 4: Generate Solutions

Think about how you might incorporate technology in teaching and learning to solve your instructional problem. Read Chapter 3 in your textbook to learn about research and problem solving and the sample lessons while you are working on this step. Consider the different technological tools you have learned either in EDIT 2000 or by yourself and brainstorm as many solution ideas as you can. List your solutions in the following area **(Number each solution)**.

Step 5: Select Criteria (required!!)

Your task now is to select the most promising solutions from your Step 4. Generate criteria that will help you determine the appropriateness of your solutions. Select and list FIVE criteria that you think are most relevant and important for evaluating your solutions. Each criterion should have a different focus.

Step 6: Apply Criteria

Apply the criteria to your solutions for the Instructional Problem. Use each criterion to rank the solutions in an evaluation matrix. Use a scale from 1 (poorest) to 10 (best) and enter the numbers in the appropriate columns. Add the ranks you have given to each solution and enter the sums of the TOTAL column.

Step 7: Design your Lesson (required!!)

Turn your most promising solution into a practical lesson plan. Explain more specifically how you will implement your lesson, how you will use technology to support communication and collaboration, and why your lesson activity will solve your the instructional problem. Here is the information you should include:

Lesson Title

Grade/Content Area

Lesson Duration

*State Objectives (these will come directly from the Georgia Performance Standards)

*List Student Task/Product (what is the specific task you want students to complete? This should be no more than 3 sentences).

*Describe Learner Participation (describe the steps of the learning activity. How will students be divided into groups with specific responsibilities, how will the lesson be introduced, how will you monitor student learning during the activity, what will students be doing during the activity?)

*Evaluate Learner Outcomes (describe how you will know students have achieved your stated learning objectives).

APPENDIX G. ITERATION 2 INTERVIEW PROTOCOL

Tell me your major and year in the university. Previous educational courses? Teaching and lesson planning experience? Technology skills? Why EDIT 2000, what appeals to you?

Recall the moment when you are provided with the case stories, how did you get started?

- Select curriculum standards
- Identify the challenges
- Define the instructional problem you want to address
- How did you use the steps/questions on the Google Document when you get started? (step 1-3)
- Do you think it's important to do so? How do you think it helped with problem-solving?

After identifying the instructional problem, what did you do?

- Select technology tools
- Design learning activities
- What resources did you use from identifying problems to coming up with solutions? (Internet, book, peer, and instructor)
- How did you do brainstorming and decision-making (picking solutions)?
- Do you think it's important to do so? How do you think it helped with problem-solving?

Tell me your experience of selecting and applying your own criteria.

- How did you make your own criteria?
- How did you use the criteria, both yours and the teachers'?
- What was it like for you when using your own criteria?
- How did you use the number chart?
- Do you think it's important to do so? How do you think it helped with problem-solving?

Tell me your experience of developing your solution idea into a full lesson plan.

- What did you do?
- How did you elaborate on your solution idea? Give example
- What resources did you use to develop your lesson plan? (Internet, book, peer, and instructor)

Tell me your experience of reflection after a case was done (or during the case).

- How did you reflect? Give example.
- How did you use the reflection questions?
- What did you learn from reflection?
- What did you do differently in the following case?
- Do you think it's important to do so? How do you think it helped with problem-solving?

Given what you said about your problem-solving experience, as a preservice teacher

- What does it mean to you by solving case problems like this?
- What do you think you got/learned out of the three case projects?
- How do you make sense of the guidance we provided?
- What do you think you got/learned out of using the guidance?

- How do you describe yourself in terms of approaching the problematic teaching situations?
How is it different from your previous understanding?
- How will this experience affect how you approach such situations in future?
- Suppose I am a teacher who is thinking about using technology in teaching but hasn't done that before, what are the key issues that you think I should be aware of?
- How do you think this course will affect you as you continue your professional development as a teacher?

APPENDIX H. ITERATION 3 SIMULATED TEACHING SCENARIOS

New Teacher Welcome Letter

The Aderhold School
"Supporting 21st Century Learners"

January 15, 2010

Dear New Teacher,

Welcome to The Aderhold School. We have so many exciting things planned for our students this year! I know you will be an asset to our community as we work diligently to meet the needs of all of our students.

Our challenge this year is ensure that all students have an opportunity to become proficient as 21st century learners. We want our students to have opportunities to communicate with peers and experts outside of our school walls. We want students to collaborate with one another and to have opportunities to be creative in their learning. It is important for our students to use critical thinking skills to solve real-world problems.

In order to meet this challenge, I have scheduled several professional development opportunities for all classroom and resource teachers. In these workshops you'll learn how to use technology to provide opportunities for your students to: communicate and collaborate, create and innovate, think critically, and solve problems. I expect that you will also find that the tools you learn will help you in your own personal and professional lives.

In addition, I have invited experienced teachers to work with you as you prepare these 21st century learning activities for your students. These mentors will be available online as you are working on your projects. Your professional development instructors will give you more information about contacting your mentor teachers.

This year our teachers are encouraged to apply for technology grants, work with resource teachers to develop student activities, and participate in a district-wide project to support student critical thinking. I think you will find many ways to use what you've learned in your technology workshops as you participate in these opportunities.

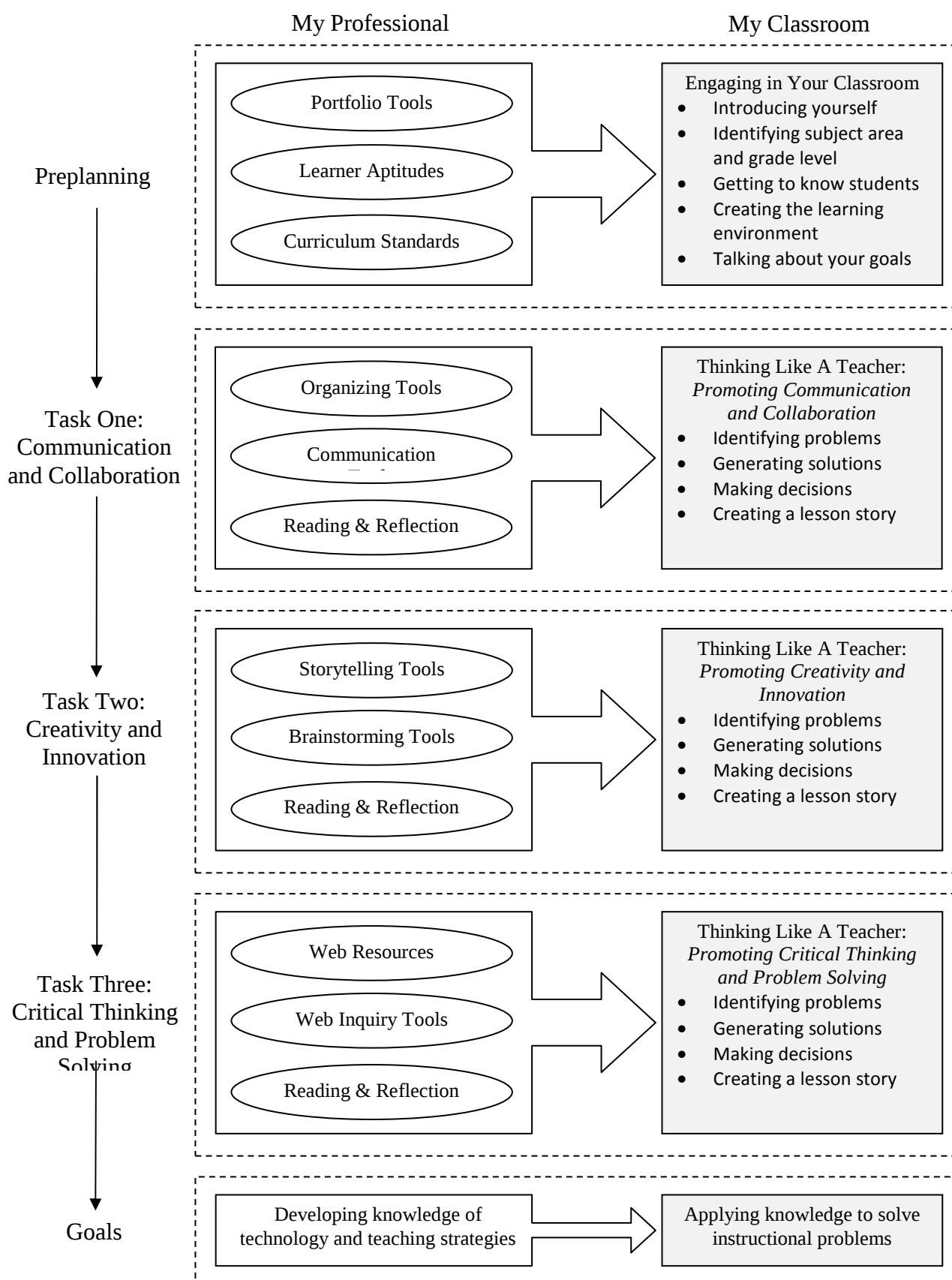
I'm looking forward to a great school year!

Dr. Ima Learner
Principal
The Aderhold School

Sample Class Rolls

Last Name	First Name	Gender	Socioeconomic Status	Learning Styles	Learning Abilities	Learning Attitudes
Bourdeau	Danyanita	Female	free/reduced lunch	visual		low motivation
Dixon	Anita	Female		auditory		medium motivation
Emerson	Daniel	Male	free/reduced lunch	visual	resource class	low motivation
Gabbitas	Tomas	Male		auditory	gifted program	high motivation
Kabala	Ethan	Male	free/reduced lunch	kinesthetic	gifted program	high motivation
Gonzalez	Matthew	Male	free/reduced lunch	kinesthetic		medium motivation
Kim	Eunjung	Female		auditory	gifted program	medium motivation
Kim	Sangchul	Male	free/reduced lunch	auditory	resource class	low motivation
O'Kain	Mari	Female		auditory	resource class	medium motivation
Sullivan	William	Male		visual		high motivation
Schultz	Lila	Female		kinesthetic		medium motivation
Sullivan	Jennifer	Female		kinesthetic		medium motivation
Tejada	Reagan	Female		visual		high motivation
Wang	Miranda	Female		kinesthetic		medium motivation
Wang	Guoqin	Male		kinesthetic		high motivation
Zhao	Jonathan	Male		kinesthetic	resource class	medium motivation

Spring 2010 School Improvement Plan: New Teacher Professional Development



Project 1 Scenario

Foundation for 21st Century Learning

"Funding the communication and collaboration of 21st Century Learners"

The Foundation for 21st Century Learning is calling for project proposals to develop K12 learning activities, whose objective would be to use technology to improve the opportunities for communication and/or collaboration among K-12 learners. Topics covered may include: any standard listed in the Georgia Performance Standards document.

This initiative is in response to growing concern over lack of meaningful opportunities for K12 students to communicate and collaborate in and outside of traditional learning environments. Communication and collaboration skills, especially related to the use of technology, are essential to succeed in the 21st century. The Foundation believes we should prepare students by embedding these skills in their content learning. Communication and collaboration activities also enhance content learning by creating an authentic social environment.

While the Foundation for 21st Century Learning will consider all proposals dealing with the integration of technology to support communication and collaboration, it particularly prefers proposals based on the National Educational Technology Standards (NETS) which encourage students to use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Specifically, the Foundation seeks lessons that encourage students to:

- Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
- Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
- Develop cultural understanding and global awareness by engaging with learners of other cultures.
- Contribute to project teams to produce original works or solve problems.

All applications should be clearly marked "**GRANT PROPOSAL**". All complete applications will be considered on a merit basis either by the trustees of the Foundation or by an advisory committee appointed by it. All applications become the property of the Foundation. **Deadline for submission is Tuesday, February 23 at 5 pm.** Awards will be made on a merit basis, judged on the importance of the project to the Foundation's mission, and also upon the availability of funds. All decisions made by the Foundation will be final.

The Foundation for 21st Century Learning is a non-profit, charitable foundation.

Dr. Lotsa Qian
Executive Director
Foundation for 21st Century Learning

Project 2 Scenario

Good afternoon,

Congratulations on your successful grant proposal. Now that you have all of these new tools in your classroom I think you might be able to help out some of the gifted children in your class. You have several gifted students in your classroom and I want to make sure that they (and all students at our school) have as many opportunities as possible to be creative. But I need some help from you.

I attended a conference on gifted education last week and I went to a session where we learned about many different types of technology tools. I have a really hard time figuring out which ones would be the best to use with your students. I'm getting together a group of teachers today and Thursday to look at the tools with me and to brainstorm ways that we can use the tools to promote student creativity and innovation. Since you've already done such a great job using technology to support communication and collaboration - I was hoping you might help me to do the same with creativity and innovation.

This is the ISTE standard that I'm working from. I hope you'll be able to select some of the tools from this meeting and give me some ideas for learning activities that could be conducted with them.

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students:

- a. apply existing knowledge to generate new ideas, products, or processes.
- b. create original works as a means of personal or group expression.
- c. use models and simulations to explore complex systems and issues.
- d. identify trends and forecast possibilities.

Thanks in advance for all of your help,

Mrs. Eno Vate
Gifted Teacher
The Aderhold School

APPENDIX I. ITERATION 3 SCAFFOLDS

Project 1 Scaffolds**Think Like A Teacher #1
Supporting Communication and Collaboration**

Teacher Name:

Activity Name: (do this last)

Grade/Subject:

Curriculum Standard:

NETS Standard:

Step 1: Planning Ahead

In order to do a good job in this grant application, what are the important things that you need to consider as a teacher (e.g., your goals)? It is important for you to think about the big picture before worrying about details.

Step 2: Challenge Quest

- 1) What are the potential instructional problems or challenges that you would encounter?
- 2) Why are they important or not?

Explore and evaluate the possible challenges.

Step 3: Innovation-in-Action

What communication and collaboration activities and technology tools could you use to address the challenges you believed to be important? Explore possible instructional strategies using the resources such as the links on the blog, your mentor teacher, and examples in the textbook (indicate the sources of your ideas).

Step 4: Decision Making

Among the possible instructional strategies you generated above,

- 1) Which one(s) would be the best for your lesson?
- 2) Why do you think so?

Explain the reason behind your decision.

Step 5: Storytelling

Tell a story of how you implemented the lesson. Make sure you address the following questions:

- 1) How did you introduce the activity to engage your students?
- 2) What did students do during the activity? How well did they perform?
- 3) What did you do during the activity to facilitate student learning?
- 4) How did you know that your students met your curriculum goals or not?

Appendix**1) Student Sample**

The student sample should show how the lesson activity impacted student content learning and engaged them in communication and collaboration opportunities.

2) Budget Estimate

The budget estimate should include all hardware and software needed to provide 21st century learning opportunities for your students.

Project 2 Scaffolds

Think Like A Teacher #2

Supporting Creativity and Innovation

Step 1: Challenge Quest

Brainstorm ideas about the positives and negatives of promoting creativity in school. Use Bubbl.us or Inspiration to create a brainstorming map.

List the challenges you identified in your brainstorming map.

- 1.
- 2.
- 3.
- 4.
- 5.

Step 2: Innovation-in-Action

Brainstorm ideas for mini-lesson activities and align them with the challenges they could address. Multiple tools can be used in the same activity and the same tool can be used in multiple ways.

Tools	Lesson Activities (brief ideas)	Challenges (numbers)

Step 3: Decision Making

Using the Characteristics of Effective Creativity Tasks listed on p. 129 in your textbook, give each of your possible lessons a "yes", "no", or "maybe". Then, select the lesson activity rated the most "yes" responses.

Criteria	Activity #1	Activity #2	Activity #3	Activity #4	Activity #5
Focuses on content					
Emphasizes divergent thinking					
Incorporates creativity strategies					
Provides informational feedback					

Write an argument to justify your selection of the lesson activity.

Step 4: Lesson Activity

Elaborate on the lesson activity you selected in step 3. Remember, you're helping the gifted teacher select activities to use with your gifted students.

Project 3 Scaffolds

Think Like A Teacher #3 Supporting Critical Thinking and Problem Solving

Teacher Name:

Grade/Subject:

Step 1: Planning Ahead

Based on your experience in TLAT #1 and TLAT #2,

1) What thinking strategies would you keep using in TLAT #3?

2) What do you expect to do differently in TLAT #3?

Step 2: Situation Analysis

1. Before designing your lesson, it is important to analyze the context from Content, Pedagogy, and Technology perspectives and to clarify their relationships. Create a brainstorming web to help you do the analysis and use the following questions as a guide.

- 1) What are the goals of supporting critical thinking/problem solving in content learning?
- 2) What are the characteristics of a good critical thinking/problem solving lesson?
- 3) How can technology integration promote critical thinking/problem solving skills?
- 4) What are the challenges of developing critical thinking/problem solving skills in your class?

2. Write a short paragraph based on your brainstorming web to describe what you would like to achieve in designing the critical thinking/problem solving lesson.

3. What curriculum standards would be relevant to the ideas on your brainstorming web and your goals of designing this lesson? Identify 2-3 curriculum standards and number them.

Step 3: Innovation-in-Action

What possible lesson activities and technology tools could address the ideas you identified in section 2? Brainstorm ideas of technology tools and lesson activities while keeping in mind what you would like to achieve. Align the tools and lesson activities with the number of curriculum standards.

Tools	Lesson Activities (brief ideas)	Curriculum Standards

Step 4: Decision Making

Identify 3-4 criteria based on section 2 Situation Analysis to evaluate the problem solving/critical thinking lesson activities. Rate your possible lesson activities on a scale of 1-4 as to how well they meet the criteria (1=not met, 2=somewhat met, 3=met, 4=met adequately).

Criteria	Activity #1	Activity #2	Activity #3	Activity #4	Activity #5

Make a decision on which lesson activity you would like to use. Write an argument to justify your decision.

Step 5: Lesson Development

Briefly describe the procedure of implementing the lesson you selected. Make sure you include

1) introduction, 2) teacher activities, 3) student activities, and 4) evaluation.

APPENDIX J. ITERATION 3 SURVEY INSTRUMENTS

Project 1 Survey

The purpose of this interview is to let us know your experience in the first Think Like A Teacher project. The information you provide will help us improve this activity in future EDIT 2000 classes.

Class section: 8:00 / 9:30 / 11:00 / 12:30

ID Number:

We want to know more about your background.

Are you interested in becoming a teacher?

- ☐ Not interested at all
- ☐ Not so interested
- ☐ Somewhat interested
- ☐ Interested
- ☐ Very interested

Prior to EDIT 2000, how many teaching related courses have you taken (e.g., Educational Psychology, Method courses, etc.)?

- ☐ None
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How many hours have you been interacting with students similar to those in your project?

- ☐ None
- ☐ 1-10
- ☐ 11-20
- ☐ 21-30
- ☐ 31-40
- ☐ 41 or more

How many hours have you been teaching students similar to those in your project?

- ☐ None
- ☐ 1-10
- ☐ 11-20
- ☐ 21-30
- ☐ 31-40
- ☐ 41 or more

We want to know your process in completing the project.

How much time did you spend on Challenge Quest to explore the potential instructional problems?

- ☐ 10 minutes in class
- ☐ 10 minutes in class plus less than 30 minutes after class
- ☐ 10 minutes in class plus about 30 minutes after class
- ☐ 10 minutes in class plus more than 30 minutes after class

- ☐ 10 minutes in class plus one hour or more after class

How many potential instructional problems did you explore?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How much time did you spend on Innovation-in-Action to explore possible tools and lesson activities?

- ☐ Less than 30 minutes
- ☐ Between 30 minutes to one hour
- ☐ About one hour
- ☐ Between one to two hours
- ☐ Two hours or more

How many possible communication and collaboration tools did you consider?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How many possible lesson activities did you generate?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

What resources helped you identify instructional problems and generate lesson activities (multiple)?

- ☐ My learning experience
- ☐ My teaching experience
- ☐ Knowledge from education courses
- ☐ Textbook
- ☐ Links on the course blog

- ☐ Online mentor
- ☐ Instructor
- ☐ Peers in the class
- ☐ Other:

How much time did you spend on Decision Making to decide which tool(s) and lesson activity to use?

- ☐ 10 minutes in class
- ☐ 10 minutes in class plus less than 30 minutes after class
- ☐ 10 minutes in class plus about 30 minutes after class
- ☐ 10 minutes in class plus more than 30 minutes after class
- ☐ 10 minutes in class plus one hour or more after class

What helped you make your decision on which tool(s) and lesson activity to use (multiple)?

- ☐ My initial preference
- ☐ My goals/ideas in Planning Ahead
- ☐ The instructional problems identified in Challenge Quest
- ☐ The Characteristics of effective technology-supported communication and collaboration task
- ☐ listed in the textbook and discussed in class
- ☐ Other:

We want to know your thinking strategies during the project.

I considered the things I planned ahead in section 1 when working on the other sections.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I reflected on what I already knew and what I needed to know as a beginning teacher.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I was clear about what instructional problems to address before exploring them in Challenge Quest.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I decided which technology tool(s) and lesson activity to use early in this project.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

After exploring possible lesson activities, I felt all the ideas I considered were great.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I designed the lesson activity based on my prior knowledge and experience.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I designed the lesson activity using the teaching resources I found or were provided in this class.

- ☐ Strongly disagree
- ☐ Disagree

- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I referred to the Grant Proposal Guide to guide my thinking process.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I referred to the rubric to guide my thinking process.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

By working on this project, I gained new ideas about designing communication and collaboration activities.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

After this project, I recognize strengths and limitations in how I think like a teacher.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

Here are some tentative advices for future EDIT 2000 students. We want to know your opinions based on your experience in this project.

You need to analyze potential instructional problems from different perspectives.

- ☐ Not important at all

- ☐ Not so important
- ☐ Somewhat important
- ☐ Important

- ☐ Very important

You need to synthesize the different perspectives to identify the instructional problem.

- ☐ Not important at all
☐ Not so important
☐ Somewhat important
☐ Important
☐ Very important

You need to determine the most important instructional problem to focus on.

- ☐ Not important at all
☐ Not so important
☐ Somewhat important
☐ Important
☐ Very important

You need to consider multiple lesson activities you could possibly use.

- ☐ Not important at all

- ☐ Not so important
☐ Somewhat important
☐ Important
☐ Very important

You need to explore the details of the lesson activities you consider.

- ☐ Not important at all
☐ Not so important
☐ Somewhat important
☐ Important
☐ Very important

You need to compare and contrast possible lesson activities before making a decision.

- ☐ Not important at all
☐ Not so important
☐ Somewhat important
☐ Important
☐ Very important

We want to know your suggestions about the guidance we provided (e.g., Grant proposal guide, rubric, class activities).

What guidance was helpful for you to complete this project?

What guidance was confusing or not helpful for you to complete this project?

What additional guidance would help you do a better job in this project?

Project 2 Survey

The purpose of this interview is to let us know your experience in the second Think Like A Teacher project. The information you provide will help us improve this activity in future EDIT 2000 classes.

Class section: 8:00 / 9:30 / 11:00 / 12:30

ID Number:

We want to know your process in completing the project.

How much time did you spend on brainstorming challenges (section 1) of promoting creativity in curriculum?

- ☐ 10 minutes in class
- ☐ 10 minutes in class plus less than 30 minutes after class
- ☐ 10 minutes in class plus about 30 minutes after class
- ☐ 10 minutes in class plus more than 30 minutes after class
- ☐ 10 minutes in class plus one hour or more after class

How many potential challenges did you explore?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How much time did you spend on Innovation-in-Action (section 2) to explore possible tools and mini-lesson activities?

- ☐ Less than 30 minutes
- ☐ Between 30 minutes to one hour
- ☐ About one hour
- ☐ Between one to two hours
- ☐ Two hours or more

How many possible creativity and innovation tools did you consider?

- ☐ 1
- ☐ 2
- ☐ 3

- ☐ 4
- ☐ 5 or more

How many possible mini-lesson activities did you generate?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

What resources helped you identify challenges and generate mini-lesson activities?

- ☐ My learning experience
- ☐ My teaching experience
- ☐ Knowledge from education courses
- ☐ Textbook
- ☐ Links on the course blog
- ☐ Online mentor
- ☐ Instructor
- ☐ Peers in the class
- ☐ Other:

How much time did you spend on Decision Making (section 3) to decide which tools and mini-lesson activities to recommend to the gifted teacher?

- ☐ 10 minutes in class
- ☐ 10 minutes in class plus less than 30 minutes after class
- ☐ 10 minutes in class plus about 30 minutes after class
- ☐ 10 minutes in class plus more than 30 minutes after class

- ☐ 10 minutes in class plus one hour or more after class

What helped you make your decision on which tools and mini-lesson activities to recommend?

- ☐ My initial preference
- ☐ My goals of promoting creativity in curriculum

- ☐ The potential challenges of promoting creativity in curriculum I brainstormed in Challenge Quest
- ☐ The criteria of effective creativity task listed in the textbook and in the TLAT #2 guide
- ☐ Other:

We want to know your thinking strategies during the project.

I analyzed different challenges of promoting creativity in curriculum and their relationships.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I was clear about what instructional challenges to address before exploring them in Challenge Quest (section 1).

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I decided which technology tools and mini-lesson activity to recommend early in this project.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I was engaged in generating multiple, alternative ideas of mini-lesson activities in Innovation-in-Action (section 2).

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral

- ☐ Agree
- ☐ Strongly agree

After evaluating the possible mini-lesson activities with criteria in Decision Making (section 3), I felt all the ideas I considered were great.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I generated ideas for the mini-lesson activities based on my prior knowledge and experience.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I generated ideas for the mini-lesson activities using the teaching resources I found or were provided in this class.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

By working on this project, I gained new ideas about designing creativity and innovation activities.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I followed the steps on the TLAT #2 guide in completing this project.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I identified the challenges I listed (section 1) from creating the brainstorming map.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I could generate the same list of challenges without creating the brainstorming map.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I used the table in Innovation-in-Action (section 2) to generate multiple mini-lesson activities.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral

- ☐ Agree
- ☐ Strongly agree

I would still consider multiple mini-lesson activities even if I was not provided with that table in Innovation-in-Action (section 2).

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I used the table in Decision Making (section 3) to select the appropriate ideas for mini-lesson activities.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I ended up selecting mini-lesson activities different from my initial preference.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

TLAT #2 guide was helpful for designing mini-lesson activities.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

Here are some tentative advices for future EDIT 2000 students. We want to know your opinions based on your experience in this project.

You need to analyze potential instructional problems or challenges from different perspectives.

- ☐ Not important at all
- ☐ Not so important
- ☐ Somewhat important
- ☐ Important
- ☐ Very important

You need to synthesize the different perspectives to identify the instructional problems or challenges.

- ☐ Not important at all
- ☐ Not so important
- ☐ Somewhat important
- ☐ Important
- ☐ Very important

You need to determine the most important instructional problems or challenges to focus on.

- ☐ Not important at all
- ☐ Not so important
- ☐ Somewhat important
- ☐ Important
- ☐ Very important

You need to consider multiple lesson activities you could possibly use.

- ☐ Not important at all
- ☐ Not so important
- ☐ Somewhat important
- ☐ Important
- ☐ Very important

You need to explore the details of the lesson activities you consider.

- ☐ Not important at all
- ☐ Not so important
- ☐ Somewhat important
- ☐ Important
- ☐ Very important

You need to compare and contrast possible lesson activities before making a decision.

- ☐ Not important at all
- ☐ Not so important
- ☐ Somewhat important
- ☐ Important
- ☐ Very important

We want to know your suggestions about the guidance we provided (e.g., Grant proposal guide, rubric, class activities).

What guidance was helpful for you to complete this project?

What guidance was confusing or not helpful for you to complete this project?

What additional guidance would help you do a better job in this project?

Project 3 Survey

The purpose of this interview is to let us know your experience in the third Think Like A Teacher project. The information you provide will help us improve this activity in future EDIT 2000 classes.

Class section: 8:00 / 9:30 / 11:00 / 12:30

ID Number:

We want to know your process in completing the project.

How much time did you spend on Situation Analysis (section 1) in designing the critical thinking/problem solving lesson?

- ☐ 10 minutes in class
- ☐ 10 minutes in class plus less than 30 minutes after class
- ☐ 10 minutes in class plus about 30 minutes after class
- ☐ 10 minutes in class plus more than 30 minutes after class
- ☐ 10 minutes in class plus one hour or more after class

How many important ideas (goals, characteristics, challenges, etc.) did you identify?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How much time did you spend on Innovation-in-Action (section 2) to explore possible tools and lesson activities?

- ☐ Less than 30 minutes
- ☐ Between 30 minutes to one hour
- ☐ About one hour
- ☐ Between one to two hours
- ☐ Two hours or more

How many critical thinking/problem solving tools did you consider?

- ☐ 1
- ☐ 2

- ☐ 3
- ☐ 4
- ☐ 5 or more

How many possible lesson activities did you generate?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

What resources helped you analyze the situation and generate lesson activities?

- ☐ My learning experience
- ☐ My teaching experience
- ☐ Knowledge from education courses
- ☐ Textbook
- ☐ Links on the course blog
- ☐ Online mentor
- ☐ Instructor
- ☐ Peers in the class
- ☐ Other:

How much time did you spend on Decision Making (section 3) to decide which tools and lesson activities to use?

- ☐ 10 minutes in class
- ☐ 10 minutes in class plus less than 30 minutes after class
- ☐ 10 minutes in class plus about 30 minutes after class
- ☐ 10 minutes in class plus more than 30 minutes after class

- ☐ 10 minutes in class plus one hour or more after class

What helped you make your decision on which tools and lesson activities to use?

- ☐ My initial preference
- ☐ My goals of promoting critical thinking and problem solving in curriculum

- ☐ The potential challenges of promoting critical thinking/problem solving in curriculum
- ☐ The criteria of an effective critical thinking/problem solving task
- ☐ Other:

We want to know your thinking strategies during the project.

I analyzed the lesson design situation (section 2) from Technology, Pedagogy, and Content perspectives.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I was clear about what instructional goals and challenges to address before Situation Analysis (section 2).

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I decided which technology tool and lesson activity to use early in this project.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I was engaged in generating multiple, alternative lesson activities in Innovation-in-Action (section 3).

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree

- ☐ Strongly agree

The criteria I generated in Decision Making (section 4) were effective for evaluating the appropriateness of possible lesson activities.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

After evaluating the possible lesson activities with my criteria (section 4), I felt all the ideas I considered were great.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I generated ideas for the lesson activities using the teaching resources I found or were provided in this class.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

By working on this project, I gained new ideas about designing critical thinking and problem solving activities.

- ☐ Strongly disagree

- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I followed the steps on the TLAT #3 guide in completing this project.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I used the thinking strategies I planned ahead (section 1) when working on section 2-5.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I referred to the lesson design checklist to monitor my thinking process in section 2-5.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I followed the four guiding questions in Situation Analysis (section 1) to create the brainstorming web.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I identified goals of designing a critical thinking/problem solving lesson from creating the brainstorming web.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral

- ☐ Agree
- ☐ Strongly agree

I used the table in Innovation-in-Action (section 3) to generate multiple possible lesson activities.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

Exploring multiple tools and lesson activities helped me generate more appropriate ideas.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

I applied the criteria I generated in Decision Making (section 4) to select the most appropriate lesson activity.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

My initial preference of the lesson activity influenced my decision making process.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

TLAT #3 guide was helpful for designing critical thinking/problem solving activities.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

You need to analyze potential instructional problems or challenges from different perspectives.

- ☐ Not important at all

- ☐ Not so important
☐ Somewhat important
☐ Important
☐ Very important

Here are some tentative advices for future EDIT 2000 students. We want to know your opinions based on your experience in this project.

You need to synthesize the different perspectives to identify the instructional problems or challenges.

- ☐ Not important at all
☐ Not so important
☐ Somewhat important
☐ Important
☐ Very important

You need to consider multiple lesson activities you could possibly use.

- ☐ Not important at all
☐ Not so important
☐ Somewhat important
☐ Important
☐ Very important

You need to determine the most important instructional problems or challenges to focus on.

- ☐ Not important at all
☐ Not so important
☐ Somewhat important
☐ Important
☐ Very important

You need to explore the details of the lesson activities you consider.

- ☐ Not important at all
☐ Not so important
☐ Somewhat important
☐ Important
☐ Very important

You need to compare and contrast possible lesson activities before making a decision.

- ☐ Not important at all
☐ Not so important
☐ Somewhat important
☐ Important
☐ Very important

We want to know your suggestions about the guidance we provided (e.g., Grant proposal guide, rubric, class activities).

What guidance was helpful for you to complete this project?

What guidance was confusing or not helpful for you to complete this project?

What additional guidance would help you do a better job in this project?

APPENDIX K. ITERATION 3 INTERVIEW PROTOCOLS

Project 1 Interview Protocol

1. Can you tell me your background as an education major student?
 - a. Education courses
 - b. Lesson planning projects
 - c. Teaching experience
2. Briefly introduce your project
 - a. What is your project about?
 - b. What do you like about this project?
3. Recall your thinking process, what did you do after reading the Call for Grant Proposal?
 - a. Planning
 - i. What did you plan?
 - ii. How did you use it?
 - b. Instructional problem
 - i. How did you explore? What problems did you explore?
 - ii. How did you find them?
 - c. Lesson activity
 - i. What tools did you consider?
 - ii. What possible activities did you think about?
 - iii. How did you explore the alternatives?
 - iv. How did you find them?
 - d. Make decision
 - i. How do you think about the ideas you generated?
 - ii. How did you decide which tool and lesson activity to use?
 - iii. What was your reason? Did you consider the characteristics, student roll?
 - e. Create the lesson story
 - i. How did you use your ideas?
 - f. Looking back
 - i. How did you look back?
 - ii. What did you learn?
 - iii. What would you do differently?
4. What resources did you use? How did you use them?
 - a. The textbook
 - b. Links on the course blog
 - c. Instructor / online mentor / peers in the class
5. What was your impression of the guidance?
 - a. How did you use them? How did they help you? Give example
 - b. What did you like/dislike about the guidance?
 - c. What additional guidance would help you do better?
6. What advice would you give to future students who will work on this project?
 - a. What strategies can they use?
 - b. How will these strategies help them? How did they help you?

Project 2 Interview Protocol

1. Briefly introduce your project
 - a. What mini-lesson activities did you recommend to the gifted teacher?
 - b. What do you like about this project?
2. Recall your thinking process, what did you do after reading the letter from the gifted teacher?
 - a. Planning
 - i. Did you do any planning? What did you plan?
 - ii. How did you use your experience in TLAT #1?
 - b. Challenge Quest
 - i. How did you brainstorm challenges of promoting creativity?
 - ii. How did you find them?
 - iii. How did you address them?
 - c. Innovation-in-Action:
 - i. What tools did you consider?
 - ii. What possible activities did you think about?
 - iii. How did you explore the alternative?
 - iv. How did you find them?
 - v. When did you decide what tool/activity to use?
 - d. Make decision:
 - i. How do you think about the ideas you generated?
 - ii. How did you decide which tool and lesson activities to recommend?
 - iii. What was your reason? Did you consider the characteristics, student roll?
3. What were the differences in your thinking strategies or process between TLAT #1 and TLAT #2?
 - a. Challenge Quest
 - b. Innovation-in-Action
 - c. Decision Making
4. How did you use resources?
 - a. The textbook
 - b. Links on the course blog
 - c. Instructor / online mentor / peers in the class
5. What was your impression of the guidance?
 - a. How did you use them (concept mapping, brainstorming table, evaluative table)?
 - b. How did they help you?
 - c. What did you like/dislike about the guidance?
 - d. What difficulties did you experience?
 - e. What additional guidance would help you do better?
6. What advice would you give to future students who will work on this project?
 - a. What strategies can they use?
 - b. How will these strategies help them? How did they help you?

Project 3 Interview Protocol

1. Briefly introduce your project
 - a. What was your project about?
 - b. What do you like about this project?
2. Recall your thinking process, what did you do after reading the letter from the principal?
 - a. Planning Ahead
 - i. What did you plan?
 - ii. How did you use the ideas you planned?
 - b. Situation Analysis
 - i. How did you create the brainstorming map?
 - ii. What important ideas did you get from brainstorming?
 - iii. How did you pick curriculum standards?
 - c. Innovation-in-Action
 - i. How did you explore multiple tools and lesson activities?
 - ii. How did you align the tools, lesson activities, and curriculum standards?
 - iii. How did you relate the lesson activities to your ideas in Situation Analysis?
 - d. Decision Making
 - i. How did you identify the criteria for evaluating lesson activities?
 - ii. How did you apply those criteria to select lesson activities?
 - iii. How did you justify your decision?
 - e. Monitoring
 - i. How did you use the lesson design checklist?
 - f. Looking Back
 - i. What thinking strategies did you learn from designing this lesson activity?
 - ii. How would you apply those thinking strategies in future?
3. How did you use resources?
 - a. The textbook
 - b. Links on the course blog
 - c. Instructor / online mentor / peers in the class
4. What was your impression of the guidance?
 - a. How did you use them?
 - b. What did you like/dislike about the guidance?
 - c. How helpful was it to
 - i. Analyze the situation by creating a concept map
 - ii. Explore multiple tools and lesson activities
 - iii. Create criteria to evaluate the lesson activities
 - d. What difficulties did you experience?
 - e. What additional guidance would help you do better?
5. What advice would you give to future students who will work on this project?
 - a. What strategies can they use?
 - b. How will these strategies help them? How did they help you?
6. After working on the three TLAT projects, what are the differences in
 - a. Your ways of thinking like a teacher
 - b. Strategies of designing technology integration lessons
 - c. Knowledge of integrating technology

APPENDIX L. ITERATION 4 SIMULATED TEACHING SCENARIOS

New Teacher Welcome Letter*The Aderhold School**"Supporting 21st Century Learners"*

August 24, 2010

Dear New Teacher,

Welcome to The Aderhold School. We have so many exciting things planned for our students this year! I know you will be an asset to our community as we work diligently to meet the needs of all of our students.

Our challenge this year is ensure that all students have an opportunity to become proficient as 21st century learners. We want our students to have opportunities to communicate with peers and experts outside of our school walls. We want students to collaborate with one another and to have opportunities to be creative in their learning. It is important for our students to use critical thinking skills to solve real-world problems.

In order to meet this challenge, I have scheduled several professional development opportunities for all classroom and resource teachers. In these workshops, you'll learn some Technological Pedagogical Content Knowledge (TPACK) that help you use technology to provide opportunities for your students to: communicate and collaborate, create and innovate, think critically, and solve problems. I expect that you will also find that the tools you learn will help you in your own personal and professional lives.

This year our teachers are encouraged to propose lessons to apply for technology grants, work with resource teachers to develop student activities, and participate in a school-wide inquiry learning project to support student critical thinking. I think you will find many ways to use what you've learned in your technology workshops as you participate in these opportunities. Please see the attached New Teacher Professional Development Road Map for details.

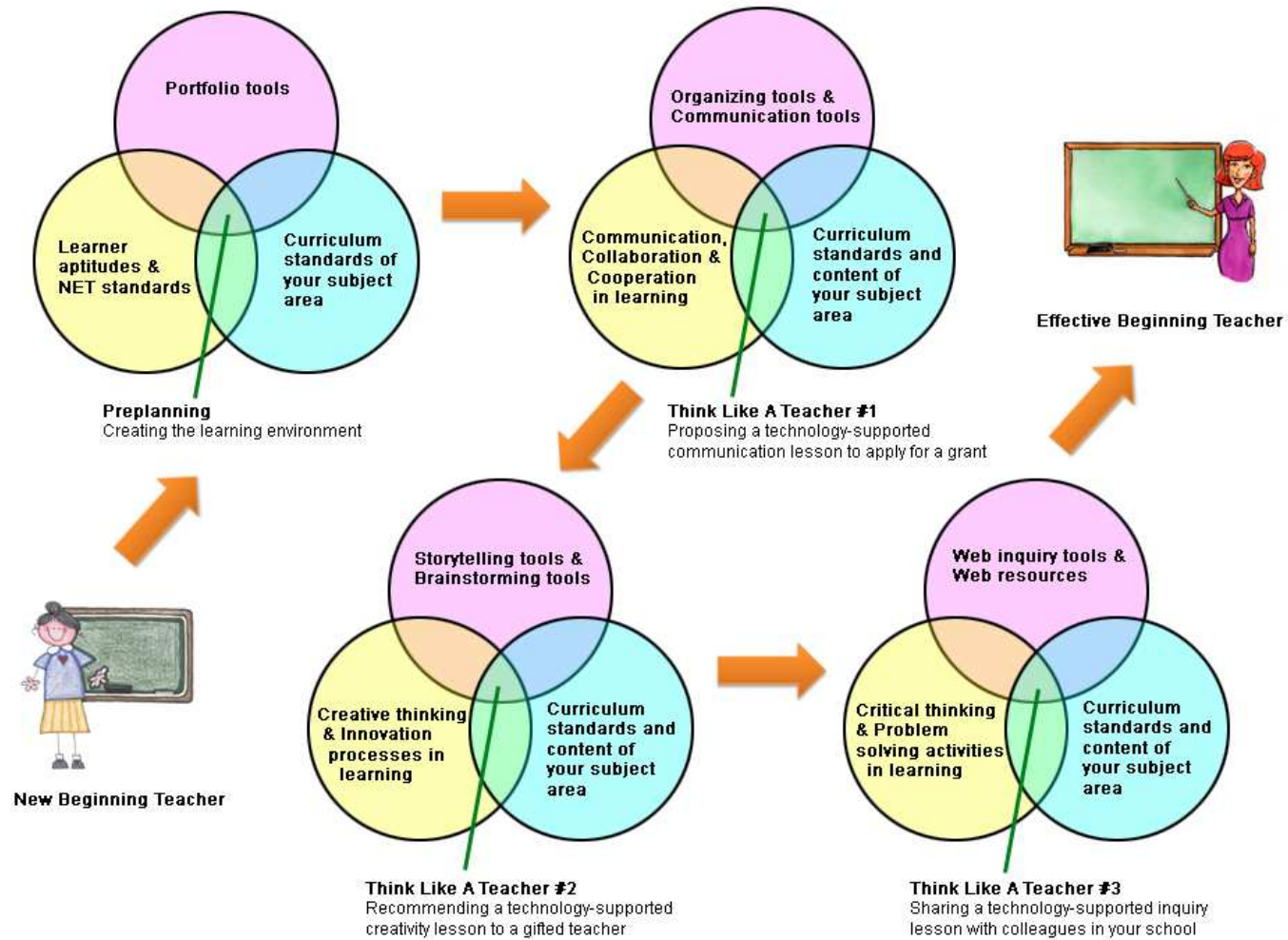
I'm looking forward to a great school year!

Dr. Ima Learner
Principal
The Aderhold School

Attachment

Fall 2010 Aderhold School New Teacher Professional Development Road Map

Fall 2010 Aderhold School New Teacher Professional Development Road Map



Fall 2010 Aderhold School New Teacher Professional Development Road Map

TLAT 1 Scenario

Foundation for 21st Century Learning

"Funding the communication and collaboration of 21st Century Learners"

The Foundation for 21st Century Learning is calling for project proposals to do develop K12 learning activities, whose objective would be to use technology to improve the opportunities for communication and/or collaboration among K-12 learners. Topics covered may include: any standard listed in the Georgia Performance Standards document.

This initiative is in response to growing concern over lack of meaningful opportunities for K12 students to communicate and collaborate in and outside of traditional learning environments. Communication and collaboration skills, especially related to the use of technology, are essential to succeed in the 21st century. The Foundation believes we should prepare students by embedding these skills in their content learning. Communication and collaboration activities also enhance content learning by creating an authentic social environment.

While the Foundation for 21st Century Learning will consider all proposals dealing with the integration of technology to support communication and collaboration, it particularly prefers proposals based on the National Educational Technology Standards (NETS) which encourage students to use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Specifically, the Foundation seeks lessons that encourage students to:

- a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
- b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
- c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
- d. Contribute to project teams to produce original works or solve problems.

Selection Process

All grant applications must follow the lesson design guide shared via Google docs and provide an expected student project sample. The following criteria will be followed in the grant evaluation process:

1. The lesson activity should engage students in content learning by addressing Georgia Performance Standards or other learning standards.
2. Technology should be used to promote one or more types of communication and/or collaboration described by the National Educational Technology Standards.
3. The lesson activity should allow every student to participate in and contribute to their group work with clearly defined roles.

4. The grant application should address all questions posed and reflect clarity of thinking as the lesson activity is developed.
5. The student sample should show how the lesson activity impacted student content learning and engaged them in communication and collaboration opportunities.

All complete applications will be considered on a merit basis either by the trustees of the Foundation or by an advisory committee appointed by it. All applications become the property of the Foundation. Deadline for submission is Tuesday, September 28 at 8am. Awards will be made on a merit basis, judged on the importance of the project to the Foundation's mission, and also upon the availability of funds. All decisions made by the Foundation will be final. The Foundation for 21st Century Learning is a non-profit, charitable foundation.

Dr. Lotsa Qian
Executive Director
Foundation for 21st Century Learning

TLAT 1 Class Rolls

Last Name	First Name	Gender	Socioeconomic Status	Learning Styles	Learning Abilities	Learning Attitudes
Rauscher	Melina	Female		auditory		high motivation
Dougherty	Ethan	Male		kinesthetic	resource class	high motivation
Kabala	Anna	Female		visual	gifted program	high motivation
Sullivan	Mari	Female		visual	gifted program	high motivation
Zgambo	Anita	Female		visual	gifted program	high motivation
Chiles	Masi	Male		auditory		low motivation
Dixon	Andrew	Male	free/reduced lunch	auditory	resource class	low motivation
Stalcup	Daniel	Male		auditory	resource class	low motivation
Thomas	William	Male		kinesthetic		low motivation
O'Kain	Matthew	Male	free/reduced lunch	auditory	gifted program	medium motivation
Gabbitas	John	Male	free/reduced lunch	kinesthetic	resource class	medium motivation
Gonzalez	Reagan	Female		kinesthetic	gifted program	medium motivation
Rauscher	Danyanita	Female	free/reduced lunch	kinesthetic		medium motivation
Tejada	Lila	Female	free/reduced lunch	kinesthetic		medium motivation
Choi	Emma	Female	free/reduced lunch	visual		medium motivation
Quilliams	Mike	Male		visual		medium motivation
Wang	Shujuan	Female		visual		medium motivation
Zhao	Guoqin	Male	free/reduced lunch	visual		medium motivation

TLAT 2 Scenario

Letter from a Gifted Teacher

Good afternoon,

I am Eno Vate, the gifted teacher in the Aderhold School. I became very interested in using technology to promote student creativity after attending a conference on gifted education weeks ago. A few sessions I went to talked about the idea of incorporating technology tools to inspire students' creativity in content learning. I'm passionate about that idea and hope to apply it by collaborating with teachers in different subject areas. I know strategies to stimulate students' creative thinking and innovation process, however, I don't have much knowledge or experience about using technology in classroom. The principal suggested I contact you because you are participating in the EDIT2000 Computers for Teachers workshop and have just proposed a technology-supported lesson for developing students' communication and collaboration skills. I think we can be great collaborators with complementary expertise.

Your EDIT2000 instructor and I have planned a Creativity Workshop together for this Thursday, in which you will learn and experience some creativity strategies. Since you know more about technology and content learning than me, I hope to get your input on how to use technology tools to facilitate those creativity strategies in your subject area. My goal is to develop lesson activities meeting the NETS Creativity and Innovation Standard (see below). I also believe that addressing the curriculum standards should be equally important. I hope you'll be able to share a lesson activity with me that you would use in your class to support student creativity and innovation.

NETS Creativity and Innovation Standard:

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students:

- a. Apply existing knowledge to generate new ideas, products, or processes.
- b. Create original works as a means of personal or group expression.
- c. Use models and simulations to explore complex systems and issues.
- d. Identify trends and forecast possibilities.

Please use the second version of Aderhold School lesson design guide that your EDIT 2000 workshop instructor will share with you. I would like to look at your lesson activity as well as your design process, so that I can understand your ideas better. Could you share your complete lesson design guide with me by Tuesday, November 2 at 8 am? Then I would have time to read it and meet with you that week.

Thanks in advance for all of your help,

Eno Vate
Gifted Teacher
The Aderhold School

TLAT 2 Class Rolls

Last Name	First Name	Gender	Socioeconomic Status	Learning Styles	Learning Abilities	Learning Attitudes
Rauscher	Melina	Female		auditory	gifted program	high motivation
Dixon	Andrew	Male	free/reduced lunch	auditory	resource class	low motivation
Stalcup	Daniel	Male		auditory	resource class	low motivation
Chiles	Masi	Male		kinesthetic		high motivation
Dougherty	Ethan	Male		kinesthetic	resource class	high motivation
Kabala	Anna	Female		kinesthetic	gifted program	high motivation
Rauscher	Danyanita	Female	free/reduced lunch	kinesthetic		low motivation
Thomas	William	Male		kinesthetic	gifted program	low motivation
Gabbitas	John	Male		kinesthetic	resource class	medium motivation
Gonzalez	Reagan	Female		kinesthetic	gifted program	medium motivation
Tejada	Lila	Female		kinesthetic	gifted program	medium motivation
Sullivan	Mari	Female		visual	gifted program	high motivation
Wang	Shujuan	Female		visual		high motivation
Zgambo	Anita	Female		visual	gifted program	high motivation
Choi	Emma	Female	free/reduced lunch	visual		medium motivation
O'Kain	Matthew	Male		visual	gifted program	medium motivation
Quilliams	Mike	Male		visual		medium motivation
Zhao	Guoqin	Male		visual	gifted program	medium motivation

TLAT 3 Scenario

Fall 2010 Lesson Activity Design Contest Announcement

Using Technology to Support Critical Thinking and Problem Solving

Congratulations on completing two TLAT projects! If you look at the New Teacher Professional Development Road Map, there is only one step remaining before you become an effective beginning teacher. To encourage you to complete the last step, the Aderhold School is pleased to announce the Fall 2010 Lesson Activity Design Contest for all new teachers participating in the EDIT2000 Computers for Teachers workshop. In each EDIT2000 section, prizes will be awarded to the best design process and product in creating a technology-supported critical thinking and problem solving lesson activity. Prize winners will be decided from online evaluation by the new teachers in the EDIT2000 workshop based on a rubric created by all four sections. The winners' TLAT #3 projects will be used as exemplars in Spring 2011 EDIT2000 workshop.

Enter the Contest

All new teachers in the Fall 2010 EDIT2000 workshop are invited to participate in the contest. Every lesson designer is required to work with a partner teaching similar subject areas and/or grade levels in order to serve as a consultant to each other. Prizes will be awarded to both the lesson designer and the consultant in the same group. Contestants are expected to follow the third version of Aderhold School lesson design guide and to design lesson activities for students on the provided class roll. After completing the TLAT #3 project, please fill out this form to register for the contest.

Contest Rules

- 1) The lesson activity should be designed to address the National Educational Technology Standards on using technology to support Critical Thinking, Problem Solving, and Decision Making:
- 2) Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.
Students:
 - a. Identify and define authentic problems and significant questions for investigation.
 - b. Plan and manage activities to develop a solution or complete a project.
 - c. Collect and analyze data to identify solutions and/or make informed decisions.
 - d. Use multiple processes and diverse perspectives to explore alternative solutions.
- 3) There should be evidence in the design process and/or product that the lesson activity is designed for the students on the class roll.
- 4) Contestants should follow the prompts on the Aderhold School lesson design guide v3.0 to complete the TLAT #3 project.
- 5) Contestants should create or describe a sample of student work that would result from conducting this activity.

- 6) Contestants should show evidence of learning from their experience in TLAT #1 and #2 (e.g., using the design/thinking strategies they learned).
- 7) Each lesson designer should have a consultant for his or her project AND serve as a consultant to his or her partner's project. Input from the consultant should be evident in the design process (e.g., providing ideas and/or comments using a different color.).
- 8) Contestants should register for the contest and publish their TLAT #3 project online by Thursday, 11/18 at 8am.

Online Evaluation

An evaluation rubric will be created with ideas from all four EDIT2000 sections after the submission of the TLAT #3 projects. The criteria will evaluate both the lesson design process and product. Every new teacher will be responsible for evaluating at least 5 TLAT #3 projects teaching similar grade levels or subject areas, excluding lessons designed by themselves or their partners. The evaluation process includes rating each project based on the rubric and giving comments to the lesson designer. The link to online evaluation will be available around 11/18.

Contest Dates

11/9-11/17: Designing TLAT #3 lesson activities
 11/18 before 8am: Registering for the contest and publishing TLAT #3 online
 11/18 during class: Collecting criteria to create the evaluation rubric
 11/19-11/30 before 8am: Evaluating at least 5 TLAT #3 projects
 12/2: Announcing winners

TLAT 3 Class Rolls

Last Name	First Name	Gender	Socioeconomic Status	Learning Styles	Learning Abilities	Learning Attitudes
Quilliams	Shujuan	Female		auditory	gifted program	high motivation
Stalcup	William	Female		auditory		high motivation
Thomas	Mike	Male		kinesthetic		high motivation
Zhao	Reagan	Male		kinesthetic		high motivation
Rauscher	Lila	Male		visual		high motivation
Rauscher	John	Male		visual		high motivation
Choi	Masi	Female		visual		high motivation
Dixon	Matthew	Female		visual		high motivation
Gonzalez	Melina	Female		visual	gifted program	high motivation
Zgambo	Mari	Female	free/reduced lunch	visual		high motivation
Kabala	Ethan	Male		auditory	resource class	low motivation
Wang	Guoqin	Male	free/reduced lunch	auditory	resource class	low motivation
Dougherty	Danyanita	Male		kinesthetic		low motivation
O'Kain	Emma	Female	free/reduced lunch	kinesthetic		low motivation
Tejada	Daniel	Male		kinesthetic	resource class	medium motivation
Gabbitas	Anita	Female		kinesthetic		medium motivation
Sullivan	Anna	Female		kinesthetic		medium motivation
Chiles	Andrew	Male		visual	gifted program	medium motivation

APPENDIX M. ITERATION 4 SCAFFOLDS

TLAT 1 Scaffolds

Think Like A Teacher #1
Supporting Communication and Collaboration
 Lesson Design Guide

Overview**Design Procedure**

- [Step 1. Context Analysis: See the big picture](#)
- [Step 2. Innovation-in-Action: Explore lesson activities](#)
- [Step 3. Decision Making: Select the best lesson activity](#)
- [Step 4. Elaboration: Describe the lesson activity](#)
- [Step 5. Looking Back: Reflect on lesson design](#)

Guidance Explanations

- [Task]** is what you need to do in designing this lesson.
- [Purpose]** tells you why you are working on this particular **[Task]**.
- [Strategy]** provides you tactics and resources for completing this **[Task]**.
- [TPACK]** indicates the types of knowledge you will learn and apply during this **[Task]**.

Step 1. Context Analysis: See the big picture

- [Task]**: Answer the five questions below using the provided strategies. List your ideas in bullet points. Think about the connections among your ideas.
- [Purpose]**: Step 1 helps you understand context of designing the technology-supported communication and collaboration lesson, which is the basis for Steps 2-5.

1.1 What makes a good technology-supported communication and collaboration lesson?

- [Purpose]**: To set goals for your lesson.
- [Strategy]**: Review the [grant evaluation criteria](#), [NETS standards](#), and read pg. 67-68 in the textbook.
- [TPACK]**: Learn and apply [PK](#), [TPK](#), [PCK](#), [TPCK](#)

1.2 What curriculum standards in your area involve communication and/or collaboration activities that would benefit from technology? List several standards, include the prefix of each standard.

[Purpose]: To identify appropriate curriculum standards to address in your lesson.

[Strategy]: Explore [Georgia Performance Standards](#) or other learning standards in your area.

[TPACK]: Learn and apply [CK](#), [PCK](#), [TCK](#), [TPCK](#)

1.3 What are the characteristics of the students in your grade level and subject area?

[Purpose]: To identify learner characteristics and learning needs.

[Strategy]: Analyze your class roll, use your prior knowledge and experience, and refer to the [Teacher Boot Camp](#) website for concepts.

[TPACK]: Learn and apply [PK](#), [TPK](#), [PCK](#), [TPCK](#)

1.4 What communication and collaboration tools would be appropriate for your students and subject area? List several tools you may consider to use.

[Purpose]: To explore available technology tools appropriate for your class.

[Strategy]: Look at [tools learned in class](#), tools listed the textbook (pg. 75-80), or other [communication tools](#) and [collaboration tools](#) from the [Go 2 Web 2.0](#) website.

[TPACK]: Learn and apply [TK](#), [TPK](#), [TCK](#), [TPCK](#)

1.5 What challenges are you likely to encounter in implementing a technology-supported communication and collaboration lesson with your students?

[Purpose]: To foresee potential problems and constraints in the classroom.

[Strategy]: Read pg. 70-75 in the textbook, use your prior knowledge and experience, and discuss with peers or the instructor.

[TPACK]: Apply [CK](#), [PK](#), [TK](#) in identifying the challenges

Step 2. Innovation-in-Action: Explore lesson activities

[Task]: Based on your analysis, brainstorm 3-5 possible lesson activities that are related to or could address your ideas listed in Step 1. Describe each lesson activity briefly with 2-3 sentences. Indicate the curriculum standards prefix at the beginning of your description.

[Purpose]: Step 2 engages you in exploring various ways of using technology to support communication and collaboration in your teaching context, which you have analyzed in Step 1.

[Strategy]: 1) Use lesson activities on [these websites](#) and sample lessons in the textbook (pg. 83-88, 92-94) to collect ideas that can be adapted to your class. 2) Discuss with peers about possible lesson activities to bounce ideas off each other. 3) Use your prior experience in learning and teaching.

[TPACK]: Apply [CK, PK, TK](#) in brainstorming possible lesson activities: 1) **Content** - What content will your students learn? 2) **Pedagogy**: What major activities/tasks will they do? 3) **Technology** - What communication/collaboration tool(s) will be used? Apply [PCK, TCK, TPK, TPCK](#) in describing them.

2.1 Possible Lesson Activity #1 (Required)

2.2 Possible Lesson Activity #2 (Required)

2.3 Possible Lesson Activity #3 (Required)

2.4 Possible Lesson Activity #4

2.5 Possible Lesson Activity #5

Step 3. Decision Making: Select the best lesson activity

[Task]: Evaluate the possible lesson activities you have generated in Step 2 to choose the best one for further development. Use the three criteria from the [Call for Grant Application](#) letter and identify two additional criteria to guide your evaluation. Rate the possible lesson activities on a scale of 1-4 as to how well they meet the criteria (1=Not met, 2=Somewhat met, 3=Met, 4=Met adequately). Make your decision and justify it at the end.

[Purpose]: Step 3 helps you compare and contrast the possible lesson activities based on important criteria, which would lead you to a decision most beneficial for your class.

[Strategy]: 1) Review Step 1 Context Analysis to identify two additional criteria. 2) Ask peers to review your evaluation to make sure that your decision is objective.

[TPACK]: Understand and apply the [storm of TPACK](#) in selecting and justifying the best lesson activity.

3.1 Evaluate the possible lesson activities

Decision Making Criteria	Activity #1	Activity #2	Activity #3	Activity #4	Activity #5
Engage students in content learning by addressing curriculum standards.					
Use technology to promote communication or collaboration described by NETS.					
Allow students to participate in and contribute to group work with clearly defined roles.					
Total Score					

3.2 Which lesson activity do you decide to choose?

3.3 How might the selected lesson activity address the decision making criteria?

Step 4. Elaboration: Describe the lesson activity

[Task]: Describe the procedure of your lesson activity in more detail, including 1) introducing the activity to students, 2) teacher and student activities, 3) evaluation of learning outcomes.

[Purpose]: Step 4 provides you the opportunity to elaborate on the lesson activity in a way that could be implemented in a real classroom.

[Strategy]: 1) Look back at your ideas in previous steps to guide the development of

your lesson activity. 2) Read pg. 85-89 of the textbook for evaluation strategies. 3) Click [here](#) to see the style of a lesson activity.
 [TPACK]: Apply [PCK](#), [TCK](#), [TPK](#), [TPCK](#) in developing your lesson activity.

4.1 Background Information

Activity Name:

Grade/Subject:

Curriculum Standard:

NETS Standard:

Technology Tools:

4.2 Technology-Supported Communication and Collaboration Lesson Activity

Step 5. Looking Back: Reflect on lesson design

[Task]: Reflect on the lesson you have designed and your design process by answering the following questions with bullet points.

[Purpose]: Reflection helps you refine your lesson activity before implementation and,

more importantly, learn new knowledge and strategies from your lesson design experience.

5.1 Suppose you have implemented this lesson activity, what would you and your students think about it? What needs to be improved?

[Purpose]: To evaluate the lesson activity and make refinements.

[Strategy]: Look back at the ideas you listed in Step 1, the learner aptitudes on the class roll, and the [TPACK model](#) to identify the aspects to evaluate and improve.

5.2 What new insights did you gain about teaching with technology through designing this lesson activity?

[Purpose]: To develop Technological Pedagogical Content Knowledge from lesson design experience.

[Strategy]: Look back at your responses to Steps 1-4 and highlight the ideas that are new to you. Compare the new ideas to the [TPACK model](#).

5.3 After following this lesson design guide, what design strategies did you learn for creating a good technology-supported lesson activity?

[Purpose]: To identify lesson design strategies that can be applied in future.

[Strategy]: Look back at the [Task], [Purpose], [Strategy], and [TPACK] of each step and think about how they helped or could help you.



Attachment: Student project sample

(Link your student sample here)

TLAT 2 Scaffolds

Think Like A Teacher #2 Supporting Creativity and Innovation Lesson Design Guide v2.0

Overview

Design Procedure

[Step 1. Context Analysis: See the big picture](#)

[Step 2. Innovation-in-Action: Explore lesson activities](#)

[Step 3. Decision Making: Select the best lesson activity](#)

[Step 4. Elaboration: Describe the lesson activity](#)

[Step 5. Looking Back: Reflect on lesson design](#)

Guidance Explanations

[Task] is what you need to do in each step to design this lesson activity.

[Strategy] provides you thinking strategies and resources for completing each **[Task]**.

[TPACK] helps you apply and reinforce your TPACK brain in completing each **[Task]**.

[Checklist] reminds you to monitor and adjust your thinking process during each **[Task]**.

Bookmark indicates an important step or strategy which will be revisited at a later stage.

Technology, **Pedagogy**, **Content** represent basic TPACK colors for highlighting responses.

Step 1. Context Analysis: See the big picture

[Task]: Analyze the teaching context by creating a brainstorming web and stating the goals you want to achieve in this technology-supported creativity and innovation lesson.

[Strategy]: Brainstorm ideas on the following topics using the resources listed in parenthesis. Analyze each topic individually AND identify their connections comprehensively.

1. Characteristics of effective creativity lesson activities ([NETS](#), textbook pg.128-129, 133-135)
2. Curriculum content requiring creative/innovative thinking ([GPS](#) or other curriculum standards)
3. Appropriate creativity tools available to your class ([Blog](#), [Go2Web20](#), [Google](#), textbook pg.135-142)
4. Creative potentials of students in your grade level ([Google](#), class roll)
5. Challenges of creating creative opportunities in classroom ([Google](#), textbook pg.133)

[TPACK]: Review the [TPACK model](#) and match colors of your brainstorming bubbles with TPACK colors (**Technology**, **Pedagogy**, **Content**, and/or intersection colors) based on the consistency of the categories.

1.1 Brainstorming web of teaching context

(Insert an image/link of your [Bubbl.us](https://bubbl.us) brainstorming web here. (Not the web we made in groups during class, a new one for this topic!!) Don't forget to color the brainstorming bubbles to correspond with **Technology**, **Pedagogy**, **Content** and/or intersection colors)

1.2 State the goals you want to achieve in this lesson based on your brainstorming web. Write a short paragraph.

[Checklist]: Check off each item by using "Format → Strike through".

- Did I analyze all [5 factors](#) (the 5 topics listed in [Strategy]) in my teaching context sufficiently?
- Did I identify the connections among the 5 factors and the elements within those factors?
- Did I have the 3 basic [TPACK colors](#) (**Technology**, **Pedagogy**, **Content**) in my brainstorming web?
- Did I select the key points from the brainstorming web to describe in [Step 1.2](#) goal statement?
- Did I gain new insights in Step 1 by using the resources and/or discussing with peers?

Step 2. Innovation-in-Action: Explore lesson activities

[Task]: Explore ways to use technology to support creativity and innovation in content learning. Brainstorm 3-5 brief ideas of possible lesson activities based on your brainstorming web and goal statement in [Step 1](#).

[Strategy]: Search [lesson activity websites](#), use the following strategies, read textbook pg.142-147, and discuss with peers. (P=Pedagogy, C=Content, T=Technology)

- **P→C→T Strategy:** Review the characteristics of creativity lessons in [Step 1](#), identify curriculum content that could be learned in ways embracing those characteristics, and look for supporting technology tools.
- **C→T→P Strategy:** Review the curriculum content in [Step 1](#), look for creativity tools that could be used in learning certain content, and generate lesson activities of using creativity tool for content learning.
- **T→P→C Strategy:** Review the creativity tools in [Step 1](#), generate creativity and innovation activities that use certain tools, and make connections between the activities and the learning content.

[TPACK]: Consider the [TPACK components](#) in generating possible lesson activities by responding to the TPACK-color-coded labels in the boxes below.

2.1 Possible Lesson Activity #1 (Required)

Curriculum Standard: (copy and paste from [Georgia Performance Standards](#))

Technology Tool(s):

Activities/Tasks:

Potential Challenges:

2.2 Possible Lesson Activity #2 (Required)

Curriculum Standard:

Technology Tool(s):

Activities/Tasks:

Potential Challenges:

2.3 Possible Lesson Activity #3 (Required)

Curriculum Standard:

Technology Tool(s):

Activities/Tasks:

Potential Challenges:

2.4 Possible Lesson Activity #4

Curriculum Standard:

Technology Tool(s):

Activities/Tasks:

Potential Challenges:

2.5 Possible Lesson Activity #5

Curriculum Standard:

Technology Tool(s):

Activities/Tasks:

Potential Challenges:

[Checklist]: Check off each item by using “Format → Strike through”.

- Did I keep my mind open to all possible lesson activities and defer final decision on what to do?
- Did I consider a variety of different student tasks, learning contents, and/or creativity tools?
- Did I use my ideas and goals in Step 1 to guide the generation of possible lesson activities?
- Did I describe each possible lesson activity from TPACK components?
- Did I gain new insights in Step 2 by exploring sample lessons and/or discussing with peers?

Step 3. Decision Making: Select the best lesson activity

[Task]: Make a good decision on what to do with your students by a) identifying criteria of a good creativity lesson, b) rating the possible lesson activities using a 1-5 scale (**1=Not met, 2=Somewhat met, 3=Moderately met, 4=Met, 5=Met adequately**), and c) justifying your decision with strong arguments.

[Strategy]: Use the following strategies to complete Step 3.

- **Criteria:** Review [Step 1](#) to identify criteria of a good creativity and innovation lesson from the different factors/goals you have analyzed (e.g., The creativity tool is necessary to the lesson activity.).
- **Evaluation:** Share your lesson activities and criteria with peer(s). Ask one peer to evaluate your lesson activities for you before you evaluate by yourself. Consider your peer’s feedback during evaluation.
- **Decision:** Consider a variety of factors (e.g., weights of each criterion, goals in [Step 1.2](#), etc) in making your final decision. Go back to modify your possible lesson activities, criteria, or ratings, if necessary.
- **Justification:** To make a strong argument for the lesson activity you chose, provide evidence to explain how it addresses your decision making criteria, your goals stated in [Step 1.2](#), and the storm of TPACK.

[TPACK]: Highlight your decision making criteria with the TPACK colors (**Technology**, **Pedagogy**, **Content**, and/or intersection colors) based on the category they belong to.

3.1.1 Peer Evaluation

Decision Making Criteria	Activity #1	Activity #2	Activity #3	Activity #4	Activity #5
Total Score					

3.1.2 Self Evaluation

Decision Making Criteria	Activity #1	Activity #2	Activity #3	Activity #4	Activity #5
Total Score					

3.2 Which lesson activity do you decide to use in class? (Read the [decision making strategy](#) first)

3.3 Why do you choose this lesson activity? (Read the [justification strategy](#) first)

[Checklist]: Check off each item by using “Format → Strike through”.

- Did my decision making criteria represent the factors/goals I analyzed in [Step 1](#)?
- Was I objective in rating each possible lesson activity based on criteria?
- Was it necessary for me to go back to modify my [possible lesson activities, criteria, or ratings](#)?
- Did I make my decision by considering a variety of factors, not simply the highest score?
- Did I provide persuasive evidence to justify my decision on what lesson activity to choose?

Step 4. Elaboration: Describe the lesson activity

[Task]: Create a 4-paragraph “action plan” for the lesson activity you chose, 100-150 words per paragraph (use “Tools → Word count”):

- Paragraph #1: How will you introduce the activity to your class?
- Paragraph #2: How will the students participate in the activity?
- Paragraph #3: How will you provide guidance for the students?
- Paragraph #4: How will the students be evaluated regarding your goals?

[Strategy]: Use the following strategies to complete Step 4.

- **To begin with:** Work from your brief ideas of the selected lesson activity in [Step 2](#) and your justification for it in [Step 3.3](#), which may give you a blue print of your entire lesson activity.
- **To elaborate:** Review your brainstorming map in [Step 1.1](#), generate lesson details that can accommodate the essential elements you identified for the five factors.
- **To elaborate or refine:** Review your goal statement in [Step 1.2](#) and decision making criteria in [Step 3.1.2](#), make sure the details of your lesson activity can address the goals and criteria.

[TPACK]: Within each paragraph, highlight three most important phrases/sentences with the three TPACK colors ([Technology](#), [Pedagogy](#), [Content](#)) respectively.

4.1 Background Information

Activity Name:

Grade/Subject:

Curriculum Standard:

NETS Standard:

Technology Tools:

4.2 Technology-Supported Creativity and Innovation Lesson Activity

[Checklist]: Check off each item by using “Format → Strike through”.

- Did I generate enough details for [introduction, participation, guidance, and evaluation](#)?
- Did I accommodate the [five factors](#) and their essential elements identified in Step 1?
- Did I provide details to show how my lesson activity address my [goals](#) and [criteria](#)?
- Did I have the three TPACK colors ([Technology](#), [Pedagogy](#), [Content](#)) in each paragraph?
- Did I make any modifications to refine my lesson activity after using this checklist?

Step 5. Looking Back: Reflect on lesson design

[Task]: Reflect on your lesson activity and design process to take away strategies to TLAT #3.

5.1 Reflect on your lesson activity

[Strategy]: Envision the real-world setting where you will be implementing this lesson activity. Think about the potential challenges that could prevent you from reaching your goals in [Step 1.2](#). Suggest ways to reduce or combat those challenges.

5.2 Reflect on TPACK knowledge you gained during the design process

[Strategy]: Look back at your color-coded responses in Steps 1-4. Identify ideas that are new to your TPACK brain, especially those regarding **Technology**, **Pedagogy**, **Content**, and/or their intersections.

Technology (TK, TPK, TCK, TPCK):

Pedagogy (PK, PCK, TPK, TPCK):

Content (CK, TCK, PCK, TPCK):

5.3 Reflect on thinking strategies you gained during the design process

[Strategy]: Look back at [Task], [Strategy], [TPACK], and [Checklist] of Step 1-5. Think about how they helped you in each step and write down what you learned that can be reused in TLAT #3.

Step 1:

Step 2:

Step 3:

Step 4:

Step 5:



Attachment: Student project sample
(Link your student sample here)

TLAT 3 Scaffolds

Think Like A Teacher #3 Supporting Critical Thinking and Problem Solving Lesson Design Guide v3.0

Contestants

Lesson designer:
Consultant:

Overview

Design Procedure

- [Step 1. Context Analysis: See the big picture](#)
- [Step 2. Innovation-in-Action: Explore lesson activities](#)
- [Step 3. Decision Making: Select the best lesson activity](#)
- [Step 4. Elaboration: Describe the lesson activity](#)
- [Step 5. Looking Back: Reflect on lesson design](#)

Guidance Explanations

- [Task] is the major activity you need to complete in each step.
- [Strategy] prompts you to look for ways to approach each [Task].
- [TPACK] reminds you to use your TPACK brain in completing each [Task].

Step 1. Context Analysis: See the big picture

[Task]: Analyze the various factors in your teaching context.

[Strategy]:

6. Look back at what you and your partner did AND what resources you used in Step 1 of TLAT #1 and #2.
7. Review your reflections on the relevant design/thinking strategies in Step 5.3 of TLAT #1 and #2.
8. Discuss with your partner about how to analyze the teaching context.

[TPACK]: Show clear connections of your context analysis with the [TPACK model](#).

1.1 Plan for how to analyze your teaching context. Create a bulleted to-do list and check off each item by using “Format → Strike through” before working on Step 2.

To do a good job in analyzing my teaching context, I need to:

- Read and follow the yellow box.
-

1.2 Record your context analysis in the following box.

Step 2. Innovation-in-Action: Explore lesson activities

[Task]: Explore possible technology-supported critical thinking and problem solving lesson activities.

[Strategy]:

- Look back at how you and your partner explored AND described possible lesson activities in Step 2 of TLAT #1 and #2.
- Review your reflections on the relevant design/thinking strategies in Step 5.3 of TLAT #1 and #2.
- Discuss with your partner about the strategies for generating possible lesson activities.

[TPACK]: Show clear connections of your possible lesson activities with the [TPACK model](#).

2.1 Plan for how to explore possible lesson activities. Create a bulleted to-do list and check off each item by using “Format → Strike through” before working on Step 3.

To do a good job in exploring possible lesson activities, I need to:

- Read and follow the yellow box.
-

2.2 Record possible lesson activities in the following boxes.

Step 3. Decision Making: Select the best lesson activity

[Task]: Decide on the most appropriate critical thinking and problem solving lesson activity to develop.

[Strategy]:

- Look back at what helped you and your partner pick the best lesson activity in TLAT #1 and #2.
- Review your reflection on the design/thinking strategies in Step 5.3 of TLAT #1 and #2.
- Discuss with your partner about how to make a valid decision in selecting the best lesson activity.

[TPACK]: Show clear connections of your decision making process with the [TPACK model](#).

3.1 Plan for how to make a decision on which lesson activity to choose. Create a bulleted to-do list and check off each item by using “Format → Strike through” before working on Step4.

To do a good job in selecting the most appropriate lesson activity, I need to:

- Read and follow the yellow box.
-

3.2 Record your decision making process in the following box.

Step 4. Elaboration: Describe the lesson activity

[Task]: Create an elaborate “action plan” for the lesson activity you selected.

[Strategy]:

- Look back at how you and your partner elaborated on the lesson activities in TLAT #1 and #2.
- Review your reflection on the design/thinking strategies in Step 5.3 of TLAT #1 and #2.
- Discuss with your partner about how to elaborate on the details of your lesson activity.

[TPACK]: Show clear connections of your lesson activity with the [TPACK model](#).

4.1 Plan for how to elaborate on the selected lesson activity. Create a bulleted to-do list and check off each item by using “Format → Strike through” before moving to the next step.

To do a good job in elaborating on my lesson activity, I need to:

- Read and follow the yellow box.
-

4.2 Background Information

Activity Name:

Grade/Subject:

Curriculum Standard:

NETS Standard:

Technology Tools:

4.3 Technology-Supported Critical Thinking and Problem Solving Lesson Activity

Step 5. Looking Back: Reflect on lesson design

[Task]: Reflect on your lesson activity AND design process.

[Strategy]:

- Look back at how you and your partner reflected on the lesson activities and the design processes in TLAT #1 and #2.
- Discuss with your partner about what and how to reflect on the lesson activities and the design process in TLAT #3.

[TPACK]: Show clear connections of your reflection with the [TPACK model](#).

5.1 Record your reflection on the lesson activity in the following box**5.2 Record your reflection on the design process in the following box**

Attachment: Student project sample
(Link your student sample here)

APPENDIX N. ITERATION 4 BACKGROUND SURVEY

Aderhold School New Teacher Background Survey

Welcome to the Aderhold School! We would like to know more about your background as a new teacher.

Professional development section
(EDIT2000 class section)

- ☐ 8:00
- ☐ 9:30
- ☐ 11:00
- ☐ 12:30

ID Number:

Name:

Preferred email to contact:

Are you

- ☐ Male
- ☐ Female

At your last birthday, were you

- ☐ 20 or less
- ☐ 21-24
- ☐ 25-29
- ☐ 30 or more

What is your professional field (major)?

How long have you been in this field
(major)?

- ☐ 1 year or less
- ☐ 2 years
- ☐ 3 years
- ☐ 4 years
- ☐ 5 years or more

Are you interested in becoming a teacher?

- ☐ Not interested at all
- ☐ Not so interested
- ☐ Somewhat interested
- ☐ Interested
- ☐ Very interested

What grade level(s) do you intend to teach?

What subject area(s) do you intend to teach?

How many hours have you been interacting
with students in the grade levels and subject
areas you intend to teach? e.g., tutoring
homework, assisting students individually

- ☐ None
- ☐ 1-10hrs
- ☐ 11-20hrs
- ☐ 21-30
- ☐ 31-40
- ☐ 41 or more

How many hours have you been observing
classes of the grade levels and subject areas
you intend to teach?

- ☐ None
- ☐ 1-10hrs
- ☐ 11-20hrs
- ☐ 21-30
- ☐ 31-40
- ☐ 41 or more

How many hours have you been teaching classes of the grade levels and subject areas you intend to teach?

- ☐ None
- ☐ 1-10hrs
- ☐ 11-20hrs
- ☐ 21-30
- ☐ 31-40
- ☐ 41 or more

When did you gain experience of interacting, observing, and/or teaching students in the grade levels and subject areas you intend to teach?

- ☐ Not applicable
- ☐ In high school
- ☐ Mostly in high school and some in college
- ☐ Some in high school and mostly in college
- ☐ In college
- ☐ Other:

List the names of the education-related courses you have taken prior to this semester. If the course involves lesson planning or field teaching, please indicate in parenthesis.

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APPENDIX O. ITERATION 4 SURVEY INSTRUMENTS

TLAT 1 Survey

Think Like A Teacher #1 Reflective Survey

Recall how you used the [Task], [Purpose], [Strategy], and [TPACK] on the lesson design guide.

How often did you read the [Task] of each step on the lesson design guide?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

How often did you follow the [Task] of each step while working on this project?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

How often did you read the [Purpose] of each step on the lesson design guide?

- ☐ Never
- ☐ 1-2 time
- ☐ 3-4 times
- ☐ 5-6 times
- ☐ 7 times or more

Check the step(s) that you can recall their name(s) and [Purpose](s) OR select I cannot remember. (DO NOT go back to look at the lesson design guide for this question. It's OK if you cannot remember.)

- ☐ Step 1
- ☐ Step 2
- ☐ Step 3
- ☐ Step 4
- ☐ Step 5
- ☐ I cannot remember the name and purpose of any step.

How often did you read the [Strategy] of each step on the lesson design guide?

- ☐ Never
- ☐ 1-2 time
- ☐ 3-4 times
- ☐ 5-6 times
- ☐ 7 times or more

How often did you use the [Strategy] of each step while working on this project?

- ☐ Never
- ☐ 1-2 time
- ☐ 3-4 times
- ☐ 5-6 times
- ☐ 7 times or more

How often did you click on the links to the TPACK diagrams following the [TPACK] labels?

- ☐ Never
- ☐ 1-2 time
- ☐ 3-4 times
- ☐ 5-6 times
- ☐ 7 times or more

How often did you reflect on what types of TPACK knowledge you were using while working on this project?

- ☐ Never
- ☐ 1-2 time
- ☐ 3-4 times
- ☐ 5-6 times
- ☐ 7 times or more

Recall how you analyzed your teaching context.

How much time did you spend on Step 1 Context Analysis?

- ☐ Less than 0.5 hour
- ☐ 0.5-1 hour
- ☐ 1-1.5 hours
- ☐ 1.5-2 hours
- ☐ More than 2 hours

How many ideas did you list in Step 1.1 "What makes a good technology-supported communication and collaboration lesson"?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

What percent of the ideas listed in Step 1 Context Analysis did you use (consider or look back at) when working on Step 2-5 (Innovation-in-Action, Decision Making, Elaboration, and Looking Back)?

- ☐ Did not use
- ☐ 1-25%
- ☐ 26-50%
- ☐ 51-75%
- ☐ 76%-100%

How many characteristics did you list in Step 1.3 "What are the characteristics of the students in your grade level and subject area"?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How many tools did you list in Step 1.4 "What communication and collaboration tools would be appropriate for your students and subject area"?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How many potential challenges did you list in Step 1.5 "What challenges are you likely to encounter in implementing a technology-supported communication and collaboration lesson with your students"?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

When working on Step 1.1-1.5, how often did your ideas for one question help you identify ideas for another question?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

When answering the questions in Step 1 Context Analysis, how often did you pause and weigh the importance (or value) of an idea before listing it?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

When working on Step 1.1 "what makes a good communication/collaboration lesson", Step 1.3 "student characteristics", and Step 1.5 "potential challenges", how many ideas did you get from external sources (e.g., textbook, Internet, peers)? (NOT from your own mind)

- ☐ None
- ☐ 1-2
- ☐ 3-4
- ☐ 5-6
- ☐ 7 or more

Recall how you explored possible lesson activities.

How much time did you spend on summarizing (or synthesizing) your ideas in Step 1 Context Analysis before or during working on Step 2 Innovation-in-Action?

- ☐ None
- ☐ 5 minutes
- ☐ 6-10 minutes
- ☐ 11-15 minutes
- ☐ More than 15 minutes

How much time did you spend on Step 2 Innovation-in-Action?

- ☐ Less than 1 hour
- ☐ 1-1.5 hours
- ☐ 1.5-2 hours
- ☐ 2-3 hours
- ☐ More than 3 hours

How many possible lesson activities did you brainstorm in Step 2 Innovation-in-Action?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How different are the possible lesson activities you generated on each of the following aspects:

Curriculum standards

- ☐ All of them are similar
- ☐ More than half of them are similar
- ☐ Half of them are different
- ☐ More than half of them are different
- ☐ All of them are different

Activities/tasks

- ☐ All of them are similar
- ☐ More than half of them are similar
- ☐ Half of them are different
- ☐ More than half of them are different
- ☐ All of them are different

Technology tools

- ☐ All of them are similar
- ☐ More than half of them are similar
- ☐ Half of them are different
- ☐ More than half of them are different
- ☐ All of them are different

What percent of the ideas for possible lesson activities in Step 2 Innovation-in-Action were your own ideas? (It is OK to borrow ideas from existing lessons, although they are NOT considered as your own ideas.)

- ☐ 0-20%
- ☐ 21-40%
- ☐ 41-60%
- ☐ 61-80%
- ☐ 81-100%

When brainstorming lesson activities in Step 2 Innovation-in-Action, how often did you use the ideas in Step 1 Context Analysis to monitor the quality of the possible lesson activities?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

When working on Step 2 Innovation-in-Action, how much time did you spend on reviewing existing lesson activities developed by school teachers?

- ☐ Less than 1 hour
- ☐ 1-1.5 hours
- ☐ 1.5-2 hours
- ☐ 2-3 hours
- ☐ More than 3 hours

How many existing lesson activities helped you come up with ideas for your possible lesson activities in Step 2 Innovation-in-Action?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How many ideas did you get from peers while brainstorming possible lesson activities in Step 2 Innovation-in-Action?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

Recall how you decided, elaborated, and reflected on your lesson activity.

To what extent was your decision on which lesson activity to use based on the rating table in Step 3.1 "Evaluate the possible lesson activities"?

- ☐ Not based on Step 3.1
- ☐ 1-25% based on Step 3.1
- ☐ 26-50% based on Step 3.1
- ☐ 51-75% based on Step 3.1
- ☐ 76-100% based on Step 3.1

How many decision making criteria did you mention in Step 3.2 "How might the selected lesson activity address the decision making criteria?"

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How much time did you spend on Step 4 Elaboration to develop the lesson activity?

- ☐ Less than 1 hour
- ☐ 1-2 hours
- ☐ 2-3 hours
- ☐ 3-4 hours
- ☐ More than 4 hours

How often did you go back to review your ideas in Step 1 Context Analysis when developing the lesson activity in Step 4 Elaboration?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

How much time did you spend on Step 5.1 “Suppose you have implemented this lesson activity, what would you and your students think about it? What needs to be improved”?

- ☐ 5 minutes or less
- ☐ 6-10 minutes
- ☐ 11-15 minutes
- ☐ 16-20 minutes
- ☐ More than 20 minutes

How many improvements did you list in Step 5.1 “Suppose you have implemented this lesson activity, what would you and your students think about it? What needs to be improved”?

- ☐ None
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4 or more

How much time did you spend on Step 5.2 “What new insights did you gain about teaching with technology through designing this lesson activity”?

- ☐ 5 minutes or less
- ☐ 6-10 minutes
- ☐ 11-15 minutes
- ☐ 16-20 minutes
- ☐ More than 20 minutes

How many new insights did you identify in Step 5.2 “What new insights did you gain about teaching with technology through designing this lesson activity”?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How much time did you spend on Step 5.3 “After following this lesson design guide, what design strategies did you learn for creating a good technology-supported lesson activity”?

- ☐ 5 minutes or less
- ☐ 6-10 minutes
- ☐ 11-15 minutes
- ☐ 16-20 minutes
- ☐ More than 20 minutes

How many design strategies did you identify in Step 5.3 “After following this lesson design guide, what design strategies did you learn for creating a good technology-supported lesson activity”?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

Background information

Overall, how much time did you spend on this Think Like A Teacher project?

- ☐ Less than 2 hours
- ☐ 2-4 hours
- ☐ 5-7 hours
- ☐ 8-10 hours
- ☐ More than 10 hours

How many hours have you been participating in communication and collaboration activities in the past 3 years?

- ☐ None
- ☐ 1-10
- ☐ 11-20
- ☐ 21-30
- ☐ 31 or more

How many hours have you been observing communication and collaboration lesson activities?

- ☐ None
- ☐ 1-10
- ☐ 11-20
- ☐ 21-30
- ☐ 31 or more

How many hours have you been teaching communication and collaboration lesson activities?

- ☐ None
- ☐ 1-10
- ☐ 11-20
- ☐ 21-30
- ☐ 31 or more

Check the class sessions you attended during this Think Like A Teacher project.

- ☐ Day one, Thursday, 9/16/2010
- ☐ Day two, Tuesday, 9/21/2010
- ☐ Day three, Thursday, 9/23/2010

Last 4 digits of your 810 number (This number will be used to align your responses to the three reflective surveys. You will not be identified individually from this number.):

Thank you for completing this survey! We appreciate your input.

TLAT 2 Survey

Think Like A Teacher #2 Reflective Survey

Recall how you used the lesson design guide.

How often did you read the [Task] of each step on the lesson design guide?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

How often did you follow the [Task] of each step while working on this project?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

How often did you read the [Strategy] of each step on the lesson design guide?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

How often did you use the [Strategy] of each step while working on this project?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

How often did you read the [TPACK] of each step on the lesson design guide?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3 times
- ☐ 4 times or more

How often did you reflect on what types of TPACK knowledge you were using while working on this project?

- ☐ Never
- ☐ 1-2 time
- ☐ 3-4 times
- ☐ 5-6 times
- ☐ 7 times or more

How often did you read the [Checklist] (blue box) of each step on the lesson design guide?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

How often did you check whether you did the things listed in the [Checklist] (blue box) of each step?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

On average, how much time did you spend on reading the yellow box (containing [Task], [Strategy], and [TPACK]) of each step?

- ☐ 0-2 minutes
- ☐ 2-4 minutes
- ☐ 4-6 minutes
- ☐ 6-8 minutes
- ☐ More than 8 minutes

On average, how much time did you spend on using the blue box (containing [Checklist]) of each step?

- ☐ 0-2 minutes
- ☐ 2-4 minutes
- ☐ 4-6 minutes
- ☐ 6-8 minutes
- ☐ More than 8 minutes

Recall how you analyzed your teaching context.

How much time did you spend on Step 1 Context Analysis?

- ☐ Less than 0.5 hour
- ☐ 0.5-1 hour
- ☐ 1-1.5 hours
- ☐ 1.5-2 hours
- ☐ More than 2 hours

How many ideas did you have for “1. Characteristics of effective creativity lesson activities” in Step 1 Context Analysis?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How many ideas did you have for “3. Appropriate creativity tools available to your class” in Step 1 Context Analysis?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How many ideas did you have for “4. Creative potentials of students in your grade level” in Step 1 Context Analysis?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How many ideas did you have for “5. Challenges of creating creative opportunities in classroom” in Step 1 Context Analysis?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

When creating the brainstorming web in Step 1 Context Analysis, how often did your ideas for one topic help you identify ideas for another topic?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

When working on Step 1 Context Analysis, how often did you pause and weigh the importance (or value) of an idea before putting it in a bubble OR including it in your goal statement?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

When brainstorming ideas for “1. Characteristics of effective creativity lesson activities”, “4. Creative potentials of students in your grade level”, and “5. Challenges of creating creative opportunities in classroom”, how many ideas did you get from external sources (e.g., textbook, Internet, peers)? (NOT from your own mind)

- ☐ None
- ☐ 1-2
- ☐ 3-4
- ☐ 5-6
- ☐ 7 or more

What percent of the ideas in Step 1 Context Analysis (including ideas in your brainstorming web and goal statement) did you use (consider or look back at) when working on Step 2-5?

- ☐ Did not use
- ☐ 1-25%
- ☐ 26-50%
- ☐ 51-75%
- ☐ 76%-100%

Recall how you explored possible lesson activities.

How much time did you spend on reviewing your ideas in the brainstorming web and synthesizing them in Step 1.2 “State the goals you want to achieve in this lesson based on your brainstorming web”?

- ☐ None
- ☐ 1- 5 minutes
- ☐ 6-10 minutes
- ☐ 11-15 minutes
- ☐ More than 15 minutes

How much time did you spend on Step 2 Innovation-in-Action?

- ☐ Less than 0.5 hour
- ☐ 0.5-1 hour
- ☐ 1-1.5 hours
- ☐ 1.5-2 hours
- ☐ 2-3 hours
- ☐ More than 3 hours

How many possible lesson activities did you brainstorm in Step 2 Innovation-in-Action?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How different are the possible lesson activities you generated on each of the following aspects:

Curriculum standards

- ☐ All of them are similar
- ☐ More than half of them are similar
- ☐ Half of them are different
- ☐ More than half of them are different
- ☐ All of them are different

Activities/tasks

- ☐ All of them are similar
- ☐ More than half of them are similar
- ☐ Half of them are different
- ☐ More than half of them are different
- ☐ All of them are different

Technology tools

- ☐ All of them are similar
- ☐ More than half of them are similar
- ☐ Half of them are different
- ☐ More than half of them are different
- ☐ All of them are different

What percent of the ideas for possible lesson activities in Step 2 Innovation-in-Action were your own ideas? (It is OK to borrow ideas from existing lessons, although they are NOT considered as your own ideas.)

- ☐ 0-20%
- ☐ 21-40%
- ☐ 41-60%
- ☐ 61-80%
- ☐ 81-100%

When brainstorming lesson activities in Step 2 Innovation-in-Action, how often did you use the ideas in Step 1 Context Analysis to monitor the quality of the possible lesson activities?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

When working on Step 2 Innovation-in-Action, how much time did you spend on reviewing existing lesson activities developed by school teachers?

- ☐ Less than 0.5 hour
- ☐ 0.5-1 hour
- ☐ 1-1.5 hours
- ☐ 1.5-2 hours
- ☐ 2-3 hours
- ☐ More than 3 hours

How many existing lesson activities helped you come up with ideas for your possible lesson activities in Step 2 Innovation-in-Action?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How many ideas did you get from peers while brainstorming possible lesson activities in Step 2 Innovation-in-Action?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

Recall how you decided, elaborated, and reflected on your lesson activity.

To what extent was your decision on which lesson activity to use based on Peer Evaluation in Step 3 Decision Making?

- ☐ Not based on Peer Evaluation
- ☐ 1-25% based on Peer Evaluation
- ☐ 26-50% based on Peer Evaluation
- ☐ 51-75% based on Peer Evaluation
- ☐ 76-100% based on Peer Evaluation

To what extent was your decision on which lesson activity to use based on Self Evaluation in Step 3 Decision Making?

- ☐ Not based on Self Evaluation
- ☐ 1-25% based on Self Evaluation
- ☐ 26-50% based on Self Evaluation
- ☐ 51-75% based on Self Evaluation
- ☐ 76-100% based on Self Evaluation

How many decision making criteria did you mention in Step 3.3 “Why do you choose this lesson activity?”

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How much time did you spend on Step 4 Elaboration to develop the lesson activity?

- ☐ Less than 1 hour
- ☐ 1-2 hours
- ☐ 2-3 hours
- ☐ 3-4 hours
- ☐ More than 4 hours

How often did you go back to review your ideas in Step 1 Context Analysis when developing the lesson activity in Step 4 Elaboration?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

How much time did you spend on Step 5.1 “Reflect on your lesson activity”?

- ☐ 5 minutes or less
- ☐ 6-10 minutes
- ☐ 11-15 minutes
- ☐ 16-20 minutes
- ☐ More than 20 minutes

How many ideas did you list in Step 5.1 “Reflect on your lesson activity” regarding the ways to reduce or combat the potential challenges?

- ☐ None
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4 or more

How much time did you spend on Step 5.2 “Reflect on TPACK knowledge you gained during the design process”?

- ☐ 5 minutes or less
- ☐ 6-10 minutes
- ☐ 11-15 minutes
- ☐ 16-20 minutes
- ☐ More than 20 minutes

How many new ideas or insights did you identify in Step 5.2 “Reflect on TPACK knowledge you gained during the design process”?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How much time did you spend on Step 5.3 “Reflect on thinking strategies you gained during the design process”?

- ☐ 5 minutes or less
- ☐ 6-10 minutes
- ☐ 11-15 minutes
- ☐ 16-20 minutes
- ☐ More than 20 minutes

How many thinking strategies did you identify in Step 5.3 “Reflect on thinking strategies you gained during the design process”?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

Additional information

Overall, how much time did you spend on this Think Like A Teacher project?

- ☐ 1 hour or less
- ☐ 2 hours
- ☐ 3 hours
- ☐ 4 hours
- ☐ 5 hours
- ☐ 6 hours
- ☐ 7 hours
- ☐ 8 hours
- ☐ 9 hours
- ☐ 10 hours or more

Check the class sessions you attended during this Think Like A Teacher project.

- ☐ Day one, Thursday, 10/21/2010
- ☐ Day two, Tuesday, 10/26/2010
- ☐ Day three, Thursday, 10/28/2010

Open your TLAT #1 and TLAT #2 Google docs and COMPARE your lesson design performance, are there any differences?

If YES, tell us 1) what are the major differences and 2) what do you think is causing those differences. If NO, explain why do you think there is no difference.

Thank you for completing this survey! We appreciate your input.

TLAT 3 Survey

Think Like A Teacher #3 Reflective Survey

Recall how you used the lesson design guide.

Look at the blue boxes of Step 1-4. How many ideas did YOU list in each blue box? (EXCLUDING the first one: “Read and follow the yellow box”.)

Step 1 Context Analysis

- ☐ 1 or less
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

Step 2 Innovation-in-Action

- ☐ 1 or less
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

Step 3 Decision Making

- ☐ 1 or less
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

Step 4 Elaboration

- ☐ 1 or less
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How often did you check whether you did the things listed in the blue box of each step?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

How often did you go back to look at your TLAT #1 or #2 lesson design guide?

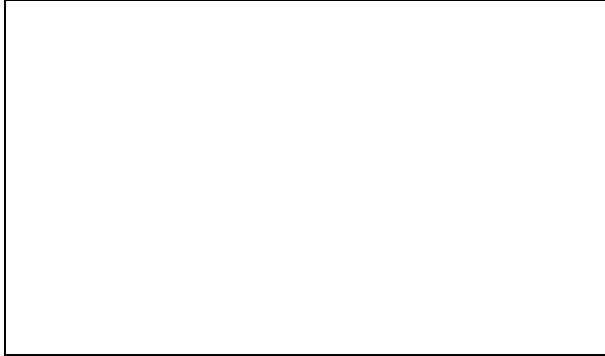
- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

If you looked back at TLAT #1 or #2, what were the things that you continued to do in TLAT #3? If you did not look back, please put N/A.

How often did you discuss with your partner(s) while working on this project?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

If you discussed with your partner(s), what were the things that your partner(s) reminded or suggested you to do? If you did not discuss with partner, please put N/A.



Which steps did you show connections of your ideas to the TPACK model? (Check all that apply)

- ☐ Step 1 Context Analysis
- ☐ Step 2 Innovation-in-Action
- ☐ Step 3 Decision Making
- ☐ Step 4 Elaboration
- ☐ Step 5 Looking Back
- ☐ None of the steps

How often did you reflect on what types of TPACK knowledge you were using while working on this project?

- ☐ Never
- ☐ 1-2 time
- ☐ 3-4 times
- ☐ 5-6 times
- ☐ 7 times or more

Recall how you analyzed your teaching context.

How much time did you spend on Step 1 Context Analysis?

- ☐ Less than 0.5 hour
- ☐ 0.5-1 hour
- ☐ 1-1.5 hours
- ☐ 1.5-2 hours
- ☐ More than 2 hours

How many ideas did you identify for characteristics of effective critical thinking/problem solving lessons in Step 1.2 “Record your context analysis in the following box”?

- ☐ N/A
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How many ideas did you identify for critical thinking/problem solving technology tools in Step 1.2 “Record your context analysis in the following box”?

- ☐ N/A
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How many ideas did you identify for characteristics of your students in Step 1.2 “Record your context analysis in the following box”?

- ☐ N/A
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How many ideas did you identify for challenges of technology-supported critical thinking/problem solving lessons in Step 1.2 “Record your context analysis in the following box”?

- ☐ N/A
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

When analyzing the various factors in Step 1 Context Analysis, how often did your ideas for one factor help you identify ideas for another factor?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

When working on Step 1 Context Analysis, how often did you pause and weigh the importance (or value) of an idea before putting it in Step 1.2 “Record your context analysis in the following box”?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

When working on Step 1.2 “Record your context analysis in the following box”, how many ideas did you get from external sources (e.g., textbook, Internet, peers)? (NOT from your own mind)

- ☐ None
- ☐ 1-2
- ☐ 3-4
- ☐ 5-6
- ☐ 7 or more

What percent of your ideas in Step 1 Context Analysis did you use (consider or look back at) when working on Step 2-5?

- ☐ Did not use
- ☐ 1-25%
- ☐ 26-50%
- ☐ 51-75%
- ☐ 76%-100%

Recall how you explored possible lesson activities.

How much time did you spend on reviewing (or synthesizing) your ideas in Step 1 Context Analysis before or during working on Step 2 Innovation-in-Action?

- ☐ None
- ☐ 1- 5 minutes
- ☐ 6-10 minutes
- ☐ 11-15 minutes
- ☐ More than 15 minutes

How much time did you spend on Step 2 Innovation-in-Action?

- ☐ Less than 0.5 hour
- ☐ 0.5-1 hour
- ☐ 1-1.5 hours
- ☐ 1.5-2 hours
- ☐ 2-3 hours
- ☐ More than 3 hours

How many possible lesson activities did you brainstorm in Step 2 Innovation-in-Action?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How different are the possible lesson activities you generated on each of the following aspects:

Curriculum standards

- ☐ All of them are similar
- ☐ More than half of them are similar
- ☐ Half of them are different
- ☐ More than half of them are different
- ☐ All of them are different

Activities/tasks

- ☐ All of them are similar
- ☐ More than half of them are similar
- ☐ Half of them are different
- ☐ More than half of them are different
- ☐ All of them are different

Technology tools

- ☐ All of them are similar
- ☐ More than half of them are similar
- ☐ Half of them are different
- ☐ More than half of them are different
- ☐ All of them are different

What percent of the ideas for possible lesson activities in Step 2 Innovation-in-Action were your own ideas? (It is OK to borrow ideas from existing lessons, although they are NOT considered as your own ideas.)

- ☐ 0-20%
- ☐ 21-40%
- ☐ 41-60%
- ☐ 61-80%
- ☐ 81-100%

When brainstorming lesson activities in Step 2 Innovation-in-Action, how often did you use the ideas in Step 1 Context Analysis to monitor the quality of the possible lesson activities?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

When working on Step 2 Innovation-in-Action, how much time did you spend on reviewing existing lesson activities developed by school teachers?

- ☐ Less than 0.5 hour
- ☐ 0.5-1 hour
- ☐ 1-1.5 hours
- ☐ 1.5-2 hours
- ☐ 2-3 hours
- ☐ More than 3 hours

How many existing lesson activities helped you come up with ideas for your possible lesson activities in Step 2 Innovation-in-Action?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How many ideas did you get from peers while brainstorming possible lesson activities in Step 2 Innovation-in-Action?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

Recall how you decided, elaborated, and reflected on your lesson activity.

To what extent was your decision on which lesson activity to use based on peer evaluation in Step 3 Decision Making (NOT your initial preference)?

- ☐ Not based on Peer Evaluation
- ☐ 1-25% based on Peer Evaluation
- ☐ 26-50% based on Peer Evaluation
- ☐ 51-75% based on Peer Evaluation
- ☐ 76-100% based on Peer Evaluation

To what extent was your decision on which lesson activity to use based on Self Evaluation in Step 3 Decision Making (NOT your initial preference)?

- ☐ Not based on Self Evaluation
- ☐ 1-25% based on Self Evaluation
- ☐ 26-50% based on Self Evaluation
- ☐ 51-75% based on Self Evaluation
- ☐ 76-100% based on Self Evaluation

How many decision making criteria did you think about in selecting the best lesson activity in Step 3 Decision Making?

- ☐ N/A
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How much time did you spend on Step 4 Elaboration to develop the lesson activity?

- ☐ Less than 1 hour
- ☐ 1-2 hours
- ☐ 2-3 hours
- ☐ 3-4 hours
- ☐ More than 4 hours

How often did you go back to review your ideas in Step 1 Context Analysis when developing the lesson activity in Step 4 Elaboration?

- ☐ Never
- ☐ 1 time
- ☐ 2 times
- ☐ 3-4 times
- ☐ 5 times or more

How much time did you spend on Step 5.1 “Record your reflection on the lesson activity in the following box”?

- ☐ 5 minutes or less
- ☐ 6-10 minutes
- ☐ 11-15 minutes
- ☐ 16-20 minutes
- ☐ More than 20 minutes

How many ideas did you identify for improving your lesson activity in Step 5.1 “Record your reflection on the lesson activity in the following box”?

- ☐ N/A
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4 or more

How much time did you spend on Step 5.2 “Record your reflection on the design process in the following box”?

- ☐ 5 minutes or less
- ☐ 6-10 minutes
- ☐ 11-15 minutes
- ☐ 16-20 minutes
- ☐ More than 20 minutes

How many of the ideas you identified in Step 5.2 “Record your reflection on the design process in the following box” are related to the TPACK model?

- ☐ N/A
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

How many of the ideas you identified in Step 5.2 “Record your reflection on the design process in the following box” are related to thinking/design strategies that you could use in future lesson planning?

- ☐ N/A
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

Additional information

Overall, how much time did you spend on this Think Like A Teacher project?

- ☐ 1 hour or less
- ☐ 2 hours
- ☐ 3 hours
- ☐ 4 hours
- ☐ 5 hours
- ☐ 6 hours
- ☐ 7 hours
- ☐ 8 hours
- ☐ 9 hours
- ☐ 10 hours or more

Check the class sessions you attended during this Think Like A Teacher project.

- ☐ Day one, Tuesday, 11/9/2010
- ☐ Day two, Thursday, 11/11/2010
- ☐ Day three, Tuesday, 11/16/2010

Open your TLAT #1, TLAT #2, and TLAT #3 Google docs and COMPARE your lesson design process, are there any differences? If YES, tell us what are the major differences. If NO, explain why do you think there is no difference.

What did you learn from doing the three Think Like A Teacher projects?

Thank you for completing this survey! We appreciate your input.

APPENDIX P. ITERATION 4 INTERVIEW PROTOCOLS

TLAT 1 Interview Protocol

1. Please briefly introduce yourself.
 - a. Name, program, progress
 - b. What job do you want to do?
 - c. What experience do you have with the students you intend to teach?
 - d. What experience do you have regarding learning/teaching with technology?
 - e. What experience do you have regarding communication and collaboration lessons?
2. Please briefly introduce the lesson activity you designed.
 - a. How is technology-supported communication and collaboration involved in your lesson activity?

Instructions: Please recall and talk-aloud your original thinking process during each of the design steps. I'm going to ask questions about 1) what you think the guide was asking you to do and 2) what you actually did.

3. On Day One, we gave you the letter, the class roll, and the lesson design guide and showed you the video, how did you get started on this project?
4. Before you started on Step x, what did you think it was asking you to do?
5. What did you do in Step x?
 - Step 1. Context Analysis*
 - How did you come up with the ideas you listed?
 - What helped you come up with these ideas? (Use of resources)
 - Step 2. Innovation-in-Action*
 - How did you come up with each of the lesson activities? No need to describe in detail.
 - What helped you generate these lesson activities? (Use of resources)
 - Step 3. Decision Making*
 - How did you identify the additional two criteria?
 - How did you go through the process of selecting from the lesson activities?
 - Why did you choose that particular lesson activity?
 - Step 4. Elaboration*
 - What helped you elaborate on the details of your lesson?
 - How did your ideas in Steps 1-3 help you in developing your lesson?
 - Step 5. Looking Back*
 - How did you look back at the lesson activity you designed?
 - What new insights did you gain?
 - o How did you gain the new insights?
 - What did you think Step 5.3 was asking you to do?
 - o What does “design strategy” mean to you?
 - o What design strategies did you identify?
6. You have done a lot of thinking so far, what thought processes did you find important/helpful?
 - a. What thought process would you continue to use in your next TLAT?

- b. What thought process do you wish you have done differently in this TLAT?
- 7. What was helpful in the lesson design guide?
 - a. How did you use the four different labels [Task], [Purpose], [Strategy], [TPACK]?
 - b. What steps of the lesson design guide were difficult for you?
 - c. What was not so helpful or redundant/unnecessary?
- 8. Anything else would you like to add about your experience or thoughts of this TLAT project?

TLAT 2 Interview Protocol

1. What experience do you have regarding lessons that promote creativity in learning?
2. Please briefly introduce the lesson activity you designed.
 - a. How is technology-supported creativity/innovation involved in your lesson activity?

Instructions: Please recall and talk-aloud your original thinking process during each of the design steps.

3. On Day One, we gave you the letter, the class roll, and the lesson design guide, how did you get started on this project?
4. As you started Step x,
 - a. How did you use the yellow box? [Task], [Strategy], and [TPACK]
 - b. What did you think it was asking you to do?
5. What did you do in Step x?

Step 1. Context Analysis

- How did you create the brainstorming web? Tell me the process.
- What helped you create the brainstorming web? (Use of resources)
- How did you identify the goals you wanted to achieve in Step 1.2?
- How did you use the checklist?

Step 2. Innovation-in-Action

- How did you come up with your possible lesson activities? Tell me the process.
- What helped you generate these lesson activities? (Use of resources)
- How did you describe your possible lesson activities? (4 labels in each box)
- How did you use the checklist?

Step 3. Decision Making

- How did you do peer review with your partner? What feedback did you get?
- How did you do self evaluation? (Identifying criteria, rating)
- How did you decide which lesson activity to use?
- How did you justify why you chose a particular lesson activity?
- How did you use the checklist?

Step 4. Elaboration

- How did you elaborate on your lesson activity? Tell me the process not lesson details.
- What helped you elaborate on the details of your lesson?
- How did your ideas in Steps 1-3 help you in developing your lesson?
- How did you use the checklist?

Step 5. Looking Back

- How did you reflect on your lesson activity?
- How did you reflect on the TPACK knowledge you gained?
- How did you reflect on the thinking strategies you gained?
 - o What does “thinking strategies” mean to you?
 - o What thinking strategies would you continue to use in TLAT #3?

6. How was your thought process in TLAT #2 similar or different from TLAT #1?
7. What was your impression of the lesson design guide for TLAT #2?

- a. What was helpful? What was not helpful/redundant? What was difficult?
8. What do you wish you have done differently in this TLAT project?
9. Anything else would you like to add about your experience or thoughts regarding this TLAT project?

TLAT 3 Interview Protocol

1. What experience do you have regarding critical thinking and problem solving, as a teacher or a student?
2. Please briefly introduce the lesson activity you designed.
 - a. How is technology-supported critical thinking/problem solving involved in your lesson activity?
3. You read the lesson design contest announcement and received the class roll on day one.
 - a. What were you thinking after reading it?
 - b. Did it make a difference in the way you designed your lesson activity?
4. When you were working on Step x,
 - a. How did you and your partner planned for what to do in that step?
 - b. Why did you planned to do so and so?
 - c. **After creating the list in the blue box, how did you use it?**
 - Step 1. Context Analysis*
 - What factors in your teaching context did you analyze?
 - What helped you analyze the factors in your teaching context? (Use of resources)
 - Step 2. Innovation-in-Action*
 - How did you come up with your possible lesson activities? Tell me the process.
 - What helped you generate these lesson activities? (Use of resources)
 - How did you describe your possible lesson activities?
 - Step 3. Decision Making*
 - What feedback did you get from your partner?
 - How did you decide which lesson activity to use?
 - o What criteria did you think about?
 - How did you justify why you chose a particular lesson activity?
 - Step 4. Elaboration*
 - How did you elaborate on your lesson activity? Tell me the process not lesson details.
 - What helped you elaborate on the details of your lesson?
 - Did you go back to revisit Steps 1-3 while developing your lesson activity?
 - Step 5. Looking Back*
 - How did you reflect on your lesson activity?
 - o Anything need to be improved?
 - How did you reflect on the design process?
 - o Anything about TPACK
 - o Anything about design/thinking strategies?
 - d. How did you show connections to TPACK?
 - e. How did you cross off your list in the blue box?
5. You have completed all three TLAT projects. What are some differences or similarities in your experience of designing technology-supported lesson activities across the three TLATs?
6. What did you learn from the three TLAT projects?
 - a. What did you learn from using the lesson design guide?
 - b. What lesson design strategies did you learn?

- c. What lesson design strategies would you continue to use in future?
 - d. What advice would you give to future EDIT2000 students?
- 7. Anything else would you like to add about your experience or thoughts regarding this TLAT project?