Enhancing Elementary Teacher Practice
Through
Technological/Engineering Design Based Learning

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ABSTRACT

As widespread as Science, Technology, Engineering, and Math (STEM) initiatives and reforms are today in education, a rudimentary problem with these endeavors is being overlooked. In general, education programs and school districts are failing to ensure that elementary teachers who provide children's early academic experiences have the appropriate knowledge of and proclivity toward STEM subjects. This issue is further compounded by the focus centered on mathematics due to accountability requirements leaving very little emphasis on science, and most often, the exclusion of technology and engineering instruction from the curriculum (Blank, 2012; Cunningham, 2009; Lederman & Lederman, 2013; Lewis, Harshbarger, & Dema, 2014; Walker, 2014). At the elementary level, the lack of science instruction and professional development generates a weakness for both pre- and in-service teachers and prompts elevated concerns about teaching science (Goodrum, Cousins, & Kinnear, 1992; Anderson, 2002). Research (Lewis, 1999/2006; Wells, 2014) suggests that one way to address this weakness is through the technological/engineering designed-based approach within the context of integrative STEM education.

The purpose of the study was to gain an understanding of change in science instructional content and practice through professional development that educates elementary teachers to implement Technological/Engineering Design Based Learning (T/E DBL) as part of teaching science. The research design was a multiple case study which adhered to a concurrent mixed method approach (Teddlie, & Tashakkori, 2006; Yin, 2003),with four participants who were recruited because of their availability and their grade level teaching assignment that correlated to an analysis of the 2013 science state accountability test, Standards of Learning (Pyle, 2015). Data collected from surveys were analyzed using descriptive and inferential statistics. These data were corroborated with a sweep instrument and assessment rubric analyses, and interview responses to validate the results.

Findings from this study revealed that professional development model used in this study was clearly effective in getting elementary teachers to implement T/E DBL. The participants were better able to integrate T/E DBL when planning and designing instructional units and had an improved understanding of the science concepts they were teaching.

DEDICATION

This dissertation is dedicated to my husband, Robert, who has been a part of my educational journey from the beginning. You have been a constant source of support and encouragement during the challenges of both school and life. Together we celebrate the triumph of hard work, determination, and endurance. What an adventure it has been!

The road of life twists and turns and no two directions are ever the same. Yet our lessons come from the journey, not the destination" (Williams, 2004).

"Even a snail will eventually reach its destination" (Tsukiyama, 2007).

ACKNOWLEDGMENTS

It takes a village to produce a dissertation. Only my name appears on the cover of this dissertation as the author, however, a great many people have contributed to its production. I owe my gratitude to all those people who have made this dissertation possible, and because of them my experience has been one that I will always treasure.

My deepest gratitude is to my advisor, Dr. John Wells. I have been amazingly fortunate to have an advisor who was truly interested in my success and provided the guidance to undertake such a monumental task. Through continued prompting, Dr. Wells taught me how to question thoughts and express ideas. His patience and support helped me overcome many situations and finish this dissertation.

My committee, Dr. Deborah Wells, Dr. Jeremy Ernst, and Dr. Kelly Parkes has been always available to listen and provide advice. I am deeply grateful to them for the discussions that assisted me in addressing the technical details of my work and for providing resources that illuminated my study.

I am indebted to the friends who have helped me stay sane through these challenging years. Their support and encouragement aided me in overcoming setbacks and stay focused on my work and completion of my dissertation. I greatly value their friendship and I deeply appreciate their belief in me.

Most importantly, none of this would have been possible without the love and patience of my family. My daughters have been a constant source of love, support and strength all these years. I would like to express my heart-felt gratitude to Catherine, Desiree, and Sonya.

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CHAPTER ONE: INTRODUCTION

Nature of Problem

As widespread as Science, Technology, Engineering, and Math (STEM) initiatives and reforms are today in education, a rudimentary problem with these endeavors is being overlooked. In general, education programs and school districts are failing to ensure that elementary teachers who provide children's early academic experiences have the appropriate knowledge of and proclivity toward STEM subjects. This issue is further compounded by the focus centered on mathematics due to accountability requirements leaving very little emphasis on science, and most often, the exclusion of technology and engineering instruction from the curriculum (Blank, 2012; Cunningham, 2009; Lederman & Lederman, 2013; Lewis, Harshbarger, & Dema, 2014; Walker, 2014).

Recent reforms in science, A Framework for K-12 Science Education (National Research Council, 2011) and Next Generation Science Standards (Next Generation Lead States, 2013), call for a new vision for engaging students in more complex, relevant, and authentic ways as they conduct investigations within the scope of science and engineering practices. The new standards derived from the framework require that elementary teachers integrate engineering concepts and practices within their science teaching. However, many elementary teachers have a negative attitude toward science, do not understand it, tend to be anxious about teaching it, and rely heavily on recitation, worksheets, and textbooks to provide the instruction (Allen, 2006; Mintzes, Marcum, Messerschmidt-Yates, and Mark, 2012).

Teachers with knowledge deficiencies in particular subject areas will often neglect to cover the subject of engineering due to the fear that they will be unable to answer questions or deal with situations encountered while teaching that subject (Brophy, Klein, Portsmore, & Rogers, 2008, Capobianco, Diefes-Dux, Mena, & Weller, 2011; Yoon, Dyehouse, Lucietto, Diefes-Dux, & Capobianco, 2014). Frykholm and Glasson (2005) found that secondary teachers felt unprepared to connect their area of expertise (e.g., mathematics) with another discipline (e.g., biology). Therefore, it is highly likely those elementary generalists who feel unprepared to teach science, a core curriculum subject, will also feel unprepared to make those connections with engineering content and practices.

Elementary Teachers and Science Instruction

In 2002, the National Science Teachers Association called for the elementary science program to provide opportunities for students to develop understandings and skills necessary to function productively as problem-solvers in a scientific and technological world, but research indicates that these opportunities are not often presented. Science instructional time is being usurped by time spent on other subjects. Blank's (2012) analysis of NAEP data for grades 4-6 revealed that science is taught an average of 2.3 hours per week, the lowest level since 1988 when trend data on the measure began. In comparison, teachers at the same grade levels were teaching mathematics and English/language arts an average of 5.3 and 10 hours a week, respectively (Blank & Toye, 2012).

Research suggested that teachers' confidence about teaching science was as important as content knowledge in shaping their classroom practice (Munby, Russell, & Martin, 2001). If teachers were uncertain about their ability to teach science, the resulting quality of science instruction in their classrooms would be significantly reduced. Such reduced outcomes included lower quality and quantity of science instruction (Hodson, 2003), over-dependence on textbook based activities, use of overly narrow instructional strategies, and feelings of inadequacy (Hanson & Akerson, 2006).

Several studies carried out during the 1990s found that many in-service elementary teachers had elevated concerns for teaching science (Carré & Carter, 1990; Ramey-Gassert, Shroyer, & Staver, 1996) and higher concerns substantially reduced the quantity and quality of science taught (Anderson, 2002; Goodrum, Cousins, & Kinnear, 1992). More recently, large scale studies found that teacher concerns were still problematic in elementary science (Banilower et al., 2013; Murphy, Neil, and Beggs, 2007). Although these studies were conducted several years apart, their results point to a continuing problem.

Elementary Teachers and Science Preparation

Pre-service teachers can typically obtain a license to teach elementary school without taking a rigorous college-level STEM class such as calculus, statistics, or chemistry, and without demonstrating a solid grasp of mathematics knowledge, scientific knowledge, engineering design practices, or the nature of scientific inquiry (Epstein & Miller, 2011). Gunning and Mensah (2010) pointed to the absence of science knowledge and experiences as a vicious cycle—students from kindergarten through college lack understanding of the content and rich experiences that should be learned at these levels, which affects students entering the teaching profession. As a result, future elementary teachers enter teacher preparation programs with inadequate understanding of scientific concepts and theories and the experiences that provide context, (Krall, Christopher, & Atwood, 2009; Smith, & Anderson, 1999, p. 756) and exit with only a perfunctory knowledge of science and the practices for teaching it.

Elementary Teachers and Science Professional Development

If elementary teachers are unable to achieve higher levels of understanding in science and encounter positive experiences in their preparatory programs, they may not have much opportunity once they enter the workforce. In the Report of the 2012 National Survey of Science and Mathematics Education (Banilower et al., 2013), only 39% of educators surveyed felt very well prepared to teach science. The U. S. National Research Council (NRC) asserts ‘‘…teachers need science-specific pedagogical content knowledge'' (2012, p. 256) and, for practicing teachers, the chief method employed to enhance their pedagogical knowledge is through professional development (PD). In many states, budget constraints have significantly limited professional development, especially in science where 85% of teachers surveyed by Dorph, Shields, Tiffany-Morales, Hartry, & McCaffrey (2011, p. 40) reported not receiving science PD within the previous three years.

Professional development opportunities typically concentrate on those subjects that are the focus of state accountability tests (Miller, Curwen, White-Smith, & Calfee, 2015), thus, contributing to their cursory knowledge of science content and practices. When professional developers in science education do focus on the need for teachers to increase their science content knowledge and experience they do so by only using inquiry in the classroom (Johnson, 2006). This lack of professional development focused on science is a recipe for ensuring that elementary teachers do not have successful experiences with teaching science.

Technological/engineering professional development has been less well explored (Compton & Jones, 1998; Daugherty, 2009). With recent reforms such as the Next Generation Science Standards which require teachers to implement engineering design into their science instruction, it is critical that professional development move toward more comprehensive designs to account for the minimal teacher preparation in engineering (Bybee and Loucks-Horsley, 2000; Daugherty, 2009).

Technological/Engineering Design Based Learning and Teaching Science

Design-based learning can enable acquisition of scientific inquiry and real world problem-solving skills (Kolodner et al., 2003; Silk, Schunn, & Strand-Cary, 2009), and improve discipline-specific content knowledge and critical thinking skills (Hmelo, Holton, & Kolodner, 2000; Doppelt, Mehalik, Schunn, & Krysinski, 2008). Engineering design encourages construction of solutions to real problems using inquiry and cooperative learning processes that facilitate development of new understandings and connections to other concepts such as science (Lehman, Kim, & Harris, 2014: Mooney & Laubach, 2002). Teaching through engineering design has the potential to facilitate integrated instruction that meets the requirements of the new science education standards (Lehman, Kim, & Harris, 2014).

According to Wells (2014), technological/engineering design based learning is an instructional approach as well as pedagogy for teaching core understandings that seek to address a human need by designing a product, system, and/or environment to solve a practical problem. Technological/engineering design-based learning has been demonstrated to positively affect students' attitudes towards science in addition to improving their science content knowledge when the learning is specifically designed to target science concepts, and when the design challenge directly utilizes science concepts (Schnittka, 2011; Schnittka, Turner, Colvin, & Ewald, 2014; Wells, 2014/2016). Just like their students, teachers are learners and need rich experiences to alter practices and beliefs (Crawford, 2014; Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2009; Moore, 2008). By placing teachers in the same design-based learning environment as their students, similar outcomes can be anticipated (Gess-Newsome, 1999; Posnanski, 2002; Slangen, VanKeulen, & Gravemeijer, 2011).

Effective professional development that unites science and engineering pedagogical content knowledge and active learning practices can provide the approach to build teacher confidence relative to content and pratices. Yoon, Diefes-Dux, and Strobel (2013) determined that professional development was extremely effective at improving the participating elementary teachers' pedagogical and content knowledge of the engineering design process as well as changing teacher perceptions of integrating science with design, engineering and technological concepts. In their 2014 study, Schnittka, Turner, Colvin, and Ewald, reported that the participants in their engineering design professional development program made significant gains in science and engineering content knowledge and attitudes toward engineering and self-efficacy to teach engineering and science.

The merger of engineering and science content and practices is a building block of integrative STEM education, where technological/engineering design-based learning (T/E DBL) exemplifies active learning. Wells and Ernst (2012/2015) defined Integrative STEM Education as

> "the application of technological/engineering design based pedagogical approaches to intentionally teach content and practices of science and mathematics education through the content and practices of technology/engineering education. Integrative STEM Education is equally applicable at the natural intersections of learning within the continuum of content areas, educational environments, and academic levels."

The term *integrat**ive*** implies an ongoing, dynamic, learner-centered process of teaching and learning distinct from *integrat**ed*** which connotes a static, completed teacher-centered process (Wells, 2013).

As defined, Integrative STEM Education employs engineerning design as the vehicle for intentionally teaching science by making explicit connections to content and practices (Well, 2014/2016). Traditionally, the acquisition of scientific knowledge and problem-solving skills relies heavily on well-defined problems which lead to one definitive solution. T/E DBL assists the learner with constructing scientific knowledge on a *need to know* basis (Wells, 2014) and not treated simply as an *add-on* (Silk, Schunn, & Strand-Cary, 2009). According to Wells (2014), a student’s achievement of understanding with the *need to know* context is imposed by the challenge of designing an engineering solution. The focus of student engagement is derived from the particular questions the student designer asks themselves regarding what they need to know at any given point in the design process (Wells, 2016). Real-world problem-solving skills are applied by the learner to create not one, but possibly multiple solutions for an ill-defined problem (Kolodner, 2002, Wells, 2009).

However, purposing and implementing T/E DBL as an instructional approach can elicit teacher concerns. The most important component in any change initiative is people and identifying how teachers react throughout a change, such as implementing T/E DBL as part of teaching science, is at the heart of the challenge of educational reform (George, 2015; Hord, Rutherford, Huling-Austin, & Hall, 1987; Rogers, 2003). Teachers are likely to resist a new innovation unless they are convinced there are benefits for their students and they have a role in the process (Gusky, 1988; Rogers, 2003). According to Hall and Hord (1987/2001), teachers will have differing thoughts, feelings, attitudes, and perceptions—concerns—about the adoption and use of an innovation. As a result, a better understanding of teacher concerns involved in the implementation of the innovation, T/E DBL, is needed.

Statement of the Problem

As the literature previously presented indicated, the strong connection between science and engineering and the need to teach these subjects in an integrative manner were strongly emphasized in the current science education reforms agenda. However at the elementary level, the lack of science instruction and professional development generated a weakness for both pre- and in-service teachers and prompted elevated concerns about teaching science (Anderson, 2002; Goodrum, Cousins, & Kinnear, 1992). Research (Lewis, 1999/2006; Wells, 2014) suggested that one way to address this weakness was through the technological/engineering designed-based approach within the context of integrative STEM education. Building on the need for such research, the goal of this study was to provide evidence supporting the mitigation of elementary teacher concerns toward teaching science as a result of professional development on the intentional teaching of targeted science content and practices through the teaching of engineering design content and practices.

Purpose of the Study

The purpose of the study was to gain an understanding of change in science instructional content and practice through professional development that educates elementary teachers to implement T/E DBL as part of teaching science. The outcomes of this study will enhance the development of the teaching and learning of T/E DBL and assist in the planning and development of professional development workshops that focus on science teaching and T/E DBL. To document these changes, data were collected to answer the ensuing research questions.

Research Questions

The following research questions served as the basis for this study:

After participation in professional development on implementing T/E DBL for intentionally teaching elementary science:

1. What changes in teacher concerns regarding implementation of T/E DBL were revealed?
2. What change in planning of practice toward use of T/E DBL was evidenced in teachers' instructional design?
3. To what extent do teachers feel their understanding of the targeted science concepts was positively impacted?

Limitations of the Study

The limitations of the study included sample size and completion of the survey instruments. The sample size for the study was small, homogenous and one of convenience. Therefore, results of this research cannot be generalized and transferred beyond these multiple case studies. Another limitation was that of validity for the Stages of Concern Questionnaire. Cheung, Hattie, and Ng (2010) pointed to a lack of empirical information about the reliability, and construct validity. Finally, the time needed to complete the survey instruments may have been a limitation. Completion of these instruments could take up to 40 minutes each, which might have served as a deterrent to teachers with demanding schedules.

Definition of Terms

Directly related to the purpose of the study were the definitions of key terms. The following terms were defined to provide clarity as to their meaning in the context of this study.

Content Knowledge. A deep understanding of subject matter that can help students create useful cognitive maps, relate one idea to another and addresses misconceptions (Shulman, 1986).

Design Process. An iterative decision-making process that produces plans by which resources are converted into products or systems that meet human needs and wants, or solve problems (ITEA, 2003, p. 137).

Learning Experiences. Instructional training that consists of management, presentations, interactions, group work, discipline, questioning, and discovery and inquiry instruction (Glatthorn, Jones, & Bullock, 2006).

Motivation. Activation to action. Level of motivation is reflected in a choice of courses of action and in the intensity and persistence of effort (Bloom, 1974).

Professional Development. A continuous process of lifelong learning and growth that begins in life, continues through the undergraduate, pre-service experience, and experience through the in-service years of teaching (ITEA, 2003, p. 140)

Concern. “The composite representation of the feelings, preoccupation, thought, and consideration given to a particular issue or task” (Hall, George, and Rutherford, 1977, p. 5).

STEM. Science, technology, engineering, and mathematics (Ramaley, 2001).

Technological/Engineering Design-Based Learning (T/E DBL). A pedagogy in which the goal of designing an artifact contextualizes all curricular activities. Design is viewed as a vehicle through which scientific knowledge and real-world problem-solving skills can be constructed (Wells, 2014).

Chapter Summary

In this chapter, the lack of confidence by elementary teachers to teach science was explored, as well as their lack of science preparation and available professional development opportunities targeting science content and practices. The utilization of technological/engineering design based learning for intentionally teaching science in the classroom was described and purposed as a method for addressing these weaknesses in science instructional content and practices.

At the elementary level, the lack of science instruction and professional development generated a weakness for both pre- and in-service teachers and prompted elevated concerns about teaching science (Goodrum, Cousins, & Kinnear, 1992; Anderson, 2002). Research (Lewis, 1999/2006; Wells, 2014) suggested that one way to address this weakness was through the technological/engineering designed-based approach within the context of integrative STEM education. Building on the need for such research, the goal of this study was to provide evidence supporting the mitigation of elementary teacher concerns toward teaching science as a result of professional development on the intentional teaching of targeted science content and practices through the teaching of engineering design content and practices.

The purpose of the study was to gain an understanding of change in science instructional content and practice through professional development that educates elementary teachers to implement T/E DBL as part of teaching science. The outcomes of this study will enhance the development of the teaching and learning of T/E DBL and assist in the planning and development of professional development workshops that focus on science teaching and T/E DBL. The following research questions served as the basis for this study:

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1. What changes in teacher concerns regarding implementation of T/E DBL are revealed?
2. What change in planning of practice toward use of T/E DBL is evidenced in teachers' instructional design?
3. To what extent do teachers feel their understanding of the targeted science concepts was positively impacted?

Sample size and time needed to complete the survey have been identified as limitations of the study. The sample size for the study was small, homogenous and one of convenience. Therefore, results of this research cannot be generalized and transferred beyond these multiple case studies. Another limitation is the time needed by the participants to complete the survey instruments. Finally, the definitions of terms used in the study are delineated.

CHAPTER 2: LITERATURE REVIEW

In preparation for the development of the research design, related literature concerning the research questions for this study was reviewed. Several key topics emerged from this analysis including the theoretical framework, teacher concerns, science education and elementary teachers, technological/engineering design and previous research methods regarding use of T/E DBL as an instructional method. These key topics generate the sub-sections within this chapter. The relevant information presented within each section establishes the rationale for the selected research design.

The first section explores the theoretical framework of the study through an examination of the change process, the model of teacher change, the design framework for professional development in science and mathematics, and the learning theory foundation for design. The second section begins with a discussion of concerns as a construct, followed by the concerns-based model and use, and teacher concerns and professional development. The third section surveys the relationship between science education and elementary teachers that impact teaching and learning. In the fourth section the pedagogical requirements of elementary teachers teaching T/E DBL are introduced, along with the exploration of technological/engineering design based learning pedagogy and the 5E instructional model. The fifth and final section presents a review of research design and data collection of previous studies of the T/E DBL instructional approach to better inform the methods of this study.

Underlying Theories of Learning and Instruction

The concept of personal expectancy has a rich history in psychological theory on human motivation. Research conducted within various theoretical traditions supports the idea that expectancy can influence behavioral instigation, direction, effort, and persistence (Schunk, 1991,

p. 207). Three theoretical frameworks and the learning theory foundation for design interact to provide the underpinnings for this study. These frameworks are (a) Roger's change process, (b) Guskey' model of teacher change, and (c) Loucks-Horsley, Love, Stiles, Mundry, and Hewson's Design Framework for Professional Development in Science and Mathematics.

Change Process

Professional developers can be guided by the extensive body of knowledge about how effective change happens in education settings (Evans, 1996; Fullan, 2001; Hall & Hord, 2001).

> "We are, in my view faced with an entirely new situation in education where the goal of education, if we are to survive, is the facilitation of change and learning. The only man who is educated is the man who has learned how to learn; the man who has learned to adapt and change; the man who realized that no knowledge is secure, that only the process of seeking knowledge gives a basis for security. Changingness, a reliance on process rather than upon static knowledge, is the only thing that makes any sense as a goal for education in the modern world" (Rogers, 1969).

Rogers' point of view emphasized the inclusion of feelings and emotions in education. He believed that education and therapy shared similar goals of personal change and self-knowing. He was interested in learning that leads to personal growth and development. His 1983 book, *Freedom to Learn for the 80's* presented the full theory of experiential learning. He believed that the highest levels of significant learning included personal involvement at both the affective and cognitive levels, were self-initiated, were so pervasive they could change attitudes, behavior, and in some cases, even the personality of the learner. Learnings needed to be evaluated by the learner and take on meaning as part of the total experience (Rogers, 1983).

Model of Teacher Change

Guskey's model (Figure 1) represents the process that teachers go through when participating in professional development programs (Guskey, 1986. p. 7), whereby, the professional development program functions as the initial activating mechanism in the change process. According to the model, significant change in teachers' beliefs and attitudes is likely to take place only after changes in student learning outcomes are evidenced (Guskey, 1986, p. 7). Guskey's model echoes the principal assertions of Rockeach's Belief Systems Theory and the Expectancy-Value Theory. Rockeach's Belief Systems Theory states that the more central a belief the more it will resist change. In addition, the more central a changed belief the more widespread the effects to the rest of the system (Rockeach, 1968).

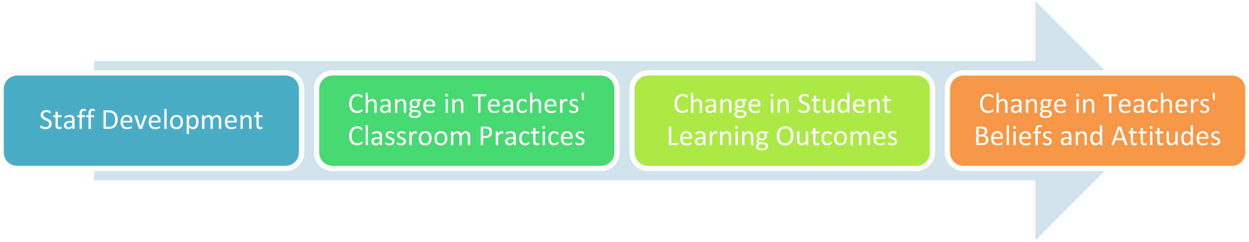

Figure 1. A Model of the Process of Teacher Change (Guskey, 1986, p. 7)

The Expectancy-Value Theory (Atkinson, 1957; Wigfield & Eccles, 2000) is one of the major frameworks for explaining achievement motivation and expectancies. This theory explains that a person's motivation to engage in a behavior is the product of the individual's expectations to perform the task (i.e., meet a goal) and the perceived value of that goal (Atkinson, 1964; Eccles, 2005). Two key concepts are discussed in the Expectancy-Value Theory: (1) value, which refers to the extent to which the tasks or the established goal by an individual is meaningful and valuable, so the individual would engage in the task and sustain effort to successfully achieve it and (2) expectancies for success or ability beliefs which refer to the extent that an individual is confident on performing a particular task (Wigfield & Eccles, 2000).

The perspective on teacher change presented in Guskey's model is predicated on the idea that change is a learning process for teachers that is developmental and primarily experientially based. The instructional practices most veteran teachers employ are determined and fashioned to a large extent by their experiences in the classroom (Guskey, 1986, p. 7). Guskey (1986, p. 8) asserts that when teachers see that a new program or innovation enhances the learning outcomes of students in their classes, only then, is significant change in their beliefs and attitudes likely to occur. In their 2009 case study, Grierson and Gallagher identify factors supporting teacher change processes and expounds upon Guskey's assertion. The researchers specifically cite the provision of believable vicarious experiences in a local school context, which they deem as "seeing is believing", as central to the change process (Grierson & Gallagher, 2009).

Design Framework for Professional Development in Science and Mathematics

The Design Framework for Professional Development in Science and Mathematics (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2009) provides a foundational structure for the development of the professional development intervention. This framework suggests that planning and implementing effective professional development for science and mathematics teachers requires immersion experiences, ongoing reflection, decision making, and dialogue between the participants and the deliverer of the professional development.

Briscoe, Peters, and O'Brien (1993) asserted that in order for a teacher to construct meaningful knowledge, he or she must be provided with experiences through which new information can be connected to what is already known. Traditional professional programs which do not provide experiences that allow connections to be made, foster rote learning and the belief that science knowledge is nothing more than a set of unchanging facts to be learned (Briscoe, Peters, & O'Brien, 1993, p. 4). The professional development used in this study provides an immersion experience for the participants that challenges them with a problem set in a real-world context.

Loucks-Horsley, Love, Stiles, Mundry, & Hewson (2009) developed a schema based on Shulman's (1986) model of pedagogical reasoning and action that describes professional development strategies employed in the change process. Strategies that focus on developing awareness are usually used during the beginning phases of change to introduce teachers to new approaches or content. Strategies that focus on building knowledge provide opportunities for teachers to develop science and mathematics content knowledge and pedagogical content knowledge. Strategies that help teachers translate new knowledge into practice engage teachers in drawing on their knowledge base to plan instruction and improve their teaching. Strategies that focus on practicing teaching help teachers learn through the process of using a new approach, practice, or process with their students. Strategies that provide opportunities to reflect deeply on teaching and learning engage teachers in examining their experiences in the classroom, assessing the impact of the changes on their students, and thinking of ways to improve (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2009).

Participation in professional development provides vicarious experiences for teachers as they observe another person model specific teaching strategies (Sandholtz, & Ringstaff, 2014, p. 729). Those providing the professional development typically have the background experience and qualifications to be viewed as competent by the participating teacher. Following the professional development experience, teachers implement their newly acquired teaching strategies in the classroom, thus, engaging in mastery experiences. Sandholtz and Ringstaff (2014, p. 730) point out that as teachers experience success with these new instructional practices, they feel more capable and confident in using them. If science and mathematics teachers are to become the teachers envisioned by the deliverer of the professional development, they need to experience for themselves the science and mathematics learning they will want their students to do (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2009). Hence, for elementary teachers to implement T/E DBL, then they need to be provided with the same experiences with T/E DBL that their students will have in the classroom.

Learning Theory Foundation for Design

One cannot talk about what is learned separately from how it is learned, as if a variety of experiences all lead to the same understanding. Rather, what we understand is a function of the content, the context, the activity of the learner, and the goals of the learner (Gredler, 2005; Savery & Duffy, 1995; Woolfork, 2010). So, where does knowledge come from and how do people come to know? Learning is associated not with changes in the possibility of response, but rather with isolated changes between states of knowledge. Learning is concerned not so much with what learners *do* but with *what* they know and *how* they come to acquire it (Jonassen, 1991b; Uden & Beaumont, 2006). Two learning theories fundamental to the pedagogical preparation of elementary teachers using the T/E DBL approach are cognitivism and constructivism.

Cognitive theories focus on the process by which information is received by a learner's mind, systematized, saved, and then retrieved. This focus also includes the mental activities of the learner that lead up to a response and acknowledges the processes of mental planning, goal-setting, and organizational strategies (Shuell, 1986). Environmental cues and instructional components alone cannot account for all the learning that results rather, additional key elements include the way that learners attend to, code, transform, rehearse, store and retrieve information. Learners' thoughts, beliefs, attitudes, and values are also considered to be influential in the learning process (Ausubel, Novak, & Hanesian, 1978; Schunk, 1992). The real emphasis of the cognitive approach is on changing the learner by encouraging him/her to use appropriate learning strategies.

Memory is given a prominent role in the learning process. Researchers (Bartlett, 1932, 1958; Mandler, 1984, Rumelhart, 1980) suggested that memory takes the form of schema which provide a mental framework for understanding and remembering information. Learning results when information is stored in memory in an organized, meaningful manner. Transfer is a function of how information is stored in memory (Schunk, 1991). When a learner understands how to apply knowledge in different contexts, then transfer has occurred. Prior knowledge is used to establish boundary constraints for identifying the similarities and differences of novel information. Not only must the knowledge itself be stored in memory but the uses of that knowledge as well (Bartlett, 1958). Specific instructional or real-world events will trigger particular responses, but the learner must believe that the knowledge is useful in a given situation before he or she will activate it.

For learning to take place, one has to understand that individuals bring various learning experiences to the learning situation which can impact learning outcomes. The most effective manner in which to organize and structure new information is to tap into the learners' previously acquired knowledge, abilities, and experiences (Stepich and Newby, 1988). Enensen and Hmelo's (2001) statements about the function of a problems approach that "problems…trigger the cognitive processes of accessing prior knowledge, establishing information into knowledge that both fits into and shapes new mental models" echoes Piaget's (1957) concept of equilibration, a dynamic process of self-regulated process. Underlying the concept are the assumptions that cognitive structures generate new possibilities when disturbed, and subsequent reflection brings about a structural change. Schmidt (2004) surmised that cognitivism means that problem-based learning is an active mental process of accessing prior knowledge, making connections between old and new concepts and using the elaboration of relationships to engage in theory construction.

Constructivism is a theory that equates learning with creating meaning from experience (Bednar, Cunningham, Duffy, & Perry, 1991). Even though constructivism is considered to be a branch of cognitivism (both conceive of learning as a mental activity), it distinguishes itself from traditional cognitive theories in a number of ways. Most cognitive psychologists think of the mind as a reference tool to the real world; constructivists believe that the mind filters input from the world to produce its own unique reality (Jonassen, 1991a). As with the rationalists of Plato's time, the mind is believed to be the source of all meaning, yet like the empiricists, individual, direct experiences with the environment are considered critical. Constructivism crosses both categories by emphasizing the interaction between these two variables (Jonassen, 1991b).

Humans *create* meaning as opposed to *acquiring* it. Since there are many possible meanings to glean from any experience, we cannot achieve a predetermined, *correct* meaning. Learners do not transfer knowledge from the external world into their memories; rather they build personal interpretations of the world based on individual experiences and interactions. Thus, the internal representation of knowledge is constantly open to change; there is not an objective reality that learners strive to know (Ertmer & Newby, 1993, p. 63; Shoffner, Jones, & Harmon, 2000). Knowledge appears in the contexts within which it is applicable. Therefore, in order for the learning that has taken place with an individual to be understood, the actual experience must be investigated.

John Dewey (1938) rejected the notion that schools should focus on repetitive, rote memorization and proposed a method of “directed living”—students would engage in real-world, practical workshops in which they would demonstrate their knowledge through creativity and collaboration. Students should be provided with opportunities to think for themselves and articulate their thoughts. Dewey (1938) called for education to be grounded in real experience. Within his theory, Piaget (1973) surmised that the basis of learning is discovery: “To understand is to discover, or reconstruct by rediscovery, and such conditions must be complied with if in the future individuals are to be formed who are capable of production and creativity and not simply repetition”. Learning must therefore be a process of discovery where learners build their own knowledge, with the active dialogue of teachers, building on their existing knowledge (Bruner, 1973).

Roth (2001, p. 781) contended that technological design activities inherently make available activity structures recommended by constructivist educators. For example, when students are called on to develop their design ideas, the lessons automatically start at developmentally appropriate points for each students. Furthermore, because this form of design asks for the students’ own ideas, motivation is inherently intrinsic (Roth, 2001, p. 781). Roth (2001, p. 778) observed that through designing technological artifacts, students were able to turn their ideas from a vague form to a concrete form that is situated in the environment. Through constructing the design artifacts, students made decisions that were based on their constructed knowledge (Roth, 2001, p. 778). Likewise, elementary teachers must understand how their students learn and experience learning in the same way.

If we believe that knowledge consists of learning about the real world, then we endeavor first and foremost to understand that world, organize it in the most rational way possible, and, as educators, present it to the learner. This view prompts us to provide the learner with designed based activities, with hands-on learning, and with opportunities to experiment and manipulate the objects of their world. However, the intention is always to make clear to the learner that they ultimately structure their own learning about the world around them. Solving real-world problems in order to provide a practical application or context presents the learner with an opportunity for an integrative approach to learning (Fennema, 1992; Mehalik, Doppelt, & Schunn, 2008).

Teacher Concerns

Concerns as a Construct

Why do many of the educational change efforts introduced into the classroom fail or if adopted are radically modified? Adoption of an innovation is a singular decision and each teacher must decide whether the innovation is valuable to them and their students and the extent of the innovation's use. Adoption of the innovation is not a specific event, but a process that occurs over time (Rutherford, 1977). Individual teachers have different kinds of concerns during the implementation of an innovation. Hall, George, and Rutherford (1977) defined *concern* as "the composite representation of the feelings, preoccupation, thought, and consideration given to a particular issue or task" (p. 5). They hypothesized that teacher concern regarding an innovation is a developmental construct, consisting of a total of seven sequential stages: awareness, informational, personal, management, consequence, collaboration, and refocusing (Hall, George, & Rutherford, 1977).

According to Hall's model (1977), every teacher's concerns about an innovation progress through these seven Stages of Concern (SoC). A teacher can experience several SoC concurrently, but there are differential degrees of intensity. As a result, peaks or valleys appear across the seven SoC, resulting in a wave-like *concerns profile*. Hall, George, and Rutherford (1977) proposed that the concerns of a teacher shift from one stage to another in a systematic fashion as he or she moves from awareness of an innovation into beginning use, and then into more highly sophisticated use. Furthermore, the correlations among the seven SoC constructs are assumed to form a simplex structure (Guttman, 1954); that is, correlations among the seven latent SoC variables in a correlation matrix are expected to decrease as one moves away from the main diagonal (Cheung & Ng, 2000). A teacher concern about an innovation must be addressed before they can move to a higher stage of concern and adopt the innovation.

Concerns-Based Model and Use

The concept of teacher concerns and the associated theoretical model finds its foundation in the work of Fuller (1969) in response to the innovation focus approach to educational reform. Richardson and Placier (2001, p. 910) describes her concerns-based model of teacher development as “perhaps the most classic of stage theories in that it was meant to be relatively invariant, sequential and hierarchical.” In her study of the concerns of novice teachers, Fuller (1969) posits a “three phase developmental conceptualization of teachers’ concerns” (p. 221). The three stages advance from: (a) pre-teaching – no-concern, (b) early teaching – concerns with self, to (c) late teaching – concerns with pupils (Fuller, 1969). Fuller believed that these concerns occurred in a natural sequence and is not simply a consequence of the quality of a particular teacher program (Fuller, 1969). In 1975, Fuller and Brown revised the developmental stages to progressing from concerns about self, concerns about tasks or situations, and concerns about impact on students.

In later work, parts of Fuller’s model were extracted and summarized into four major clusters of concerns (Hall & Hord, 1987). Fuller categorized these as unrelated concerns, self-concerns, tasks concerns, and impact concerns. Preservice teachers in the study identified unrelated concerns as passing a course or getting a good grade on an exam. Self-concerns were associated with feelings of self-doubt or feelings of inadequacy about their teaching knowledge, while task concerns centered more on issues related to the job of teaching. Impact concerns are more likely to be expressed by experienced teachers and focused on how their teaching affects students, the school, and self-improvement.

Conway and Clark (2003) pointed to two strands of research that have grown out of this widely cited study. One strand is the "developmental dynamics" of teacher candidates and early career teachers (Conway & Clark, 2003, p. 466). The second is the Concerns-Based Adoption Model (CBAM) purposed by Hall, Wallace, and Dossett (1973) at the Texas Research and Development Center as a result of their investigation of teachers involved in implementing changes to their instruction due to an innovation adoption process (Anderson, 1997; Hall & Hord, 2001; Hall, Wallace, & Dossett, 1973). The researchers observed that the concerns expressed by the teachers were similar to those described by Fuller (George, Hall, & Stiegelbauer, 2006).

Created through a decade of development, the CBAM is used to measure, describe, and explain the process of change experienced by the teachers. The diagnostic dimensions of CBAM, developed by Hall, George, and Rutherford (1977), have three components, but the Stages of Concern Questionnaire is the most commonly used. Horsley and Loucks-Horsley (1998) argued that one of the greatest strengths of CBAM is that it provides evidence for, and supplies a description of, teachers' feelings of new program or practice, and the model also helps teachers move the change along and evaluation the process. Consequently, they further proposed that as a part of CBAM, the SoCQ describes the affective dimension of change and many people regard it as the most helpful tool for teachers' professional development purpose.

Hall, George, and Rutherford (1977) developed the 35-item Stages of Concern Questionnaire (SoCQ), a quick-scoring measure of what the teacher is feeling about the innovation as reflected in the intensity of each SoC. The authors intend the SoCQ to be used as a tool to help researchers evaluate and understand the change process and support the implementation process. In addition, the SoCQ findings are to be used as a means to develop, focus, and support professional development (George, Hall, & Stiegelbauer, 2006). By being aware of the teacher concerns allows those in charge of the innovation to tailor the support provided to the teachers (Krueger, Boboc, Smaldino, Cornish, & Callahan, 2004; Rakes & Casey, 2002; Yuliang & Huang, 2005).

Seven types of concerns experienced by teachers during the implementation of an innovation are outlined in the CBAM model: awareness, informational, personal, management, consequences, collaboration, and refocusing. While most teachers may exhibit several concerns at different stages of the change process, certain types of concerns are more prevalent than others. The researchers refer to these seven types as stages because there is developmental movement through them; that is, the user of an innovation may experience a certain type of concern rather intensely, and then as that concerns subsides, another type of concern may emerge (George, Hall, and Stiegelbauer, 2006). In addition, they cautioned that it is critical to note that development of higher-level concerns cannot simply be engineered by an outside agent, but that these concerns are a dynamic of the individual (George, Hall, and Stiegelbauer, 2006).

George, Hall, and Stiegelbauer (2006) posit that teachers usually begin at Stage 0, the *awareness* stage, wherein they are not concerned about the proposed innovation or their involvement. During Stage 1, teachers have *informational* concerns and want to learn more about the innovation such as how and why the innovation and implementation has been designed. At Stage 2, the *personal* concerns stage, teachers are anxious about how the change will impact their lives on a daily basis, for example, their role in implementing the innovation. Stage 3 concerns are focused on the *management* of change, whereby teachers consider the amount of time and resources and the processes and tasks required for implementing the innovation. At Stage 4, teachers contemplate the *consequences* of the innovation with regards to the impact on their students, and the school. During Stage 5, teachers contemplate the *collaborative* aspect of the innovation implementation, that is, how they will coordinate and cooperate with other teachers. Finally, Stage 6 teachers have *refocusing* concerns that reveal a more universal consideration for refining, improving, or replacing the innovation. In this study, the goal is not to categorize the participants' concerns, but to use the SoC model to show change in their levels of concerns before treatment and after its completion.

Teacher Concerns and Professional Development

Teachers are likely to resist change, unless they are convinced that the innovation will significantly benefit themselves and their students (Thompson, 1992). In his 2008 study, Leung surmised that many teachers are at the later Stages of Concern and are much concerned about the impacts on their students. As teachers search for ways to cope with change and the impact on their students, professional development is important in improving the competency of teachers facing the implementation of an innovation. The goal of professional development is to improve teacher learning and practices, and ultimately improve student learning (Fishman, Marx, Best, & Tal, 2003; Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010; Whitworth, & Chiu, 2015). The results of the study by Kwok (2014) suggests that professional development programs should incorporate collaboration among teachers into their program design as one way to address student impact and reduce the concerns expressed by teachers. Kwok (2014) points out that in constructive learning collaboration among pupils is encouraged with the teacher assuming the role of facilitator. Therefore, effective professional development for teachers should employ the same principle in order to foster and model collaboration.

Chamblee, Slough and Wunsch’s (2008) work with mathematics teachers also revealed their interest in working with others to further their knowledge of the implemented innovation (using graphing calculators in the classroom) and address their concerns. He concluded that the teachers needed to see others model the innovation and work in teams to develop new learning tasks and strategies. As a result of the professional development, the teachers made statistically significant improvements in their post scores. Teachers who experience a constructivist approach in a professional development program have a deeper insight into the learning process and, and in the classroom, are more confident, more sensitive to the use of language and the challenges to learning for their students (Peers, Diezmann, & Watters, 2003; Summers & Kruger, 1994; Thorley and Sofflett, 1996). Since teachers are central to the process of change, professional development is fundamental to the successful implementation of the innovation (Goodrum, Hackling, & Rennie, 2001).

Science Education and Elementary Teachers

Science is a way of knowing, a systematic study of the physical and natural world. Science education prepares students to study science at higher levels of education, to enter the workforce, and to become more scientifically literate (National Research Council, 1996, 2011; AAAS, 1993). Researchers assert that elementary school teachers are not known to be science oriented and merely regard science as a school subject detached from everyday life (Nemecek and Yam; Park, 2000; Cobern and Loving, 2002). Given the impact that teachers have on the achievement of their students (Sanders & Rivers, 1996; Gibson & Chase, 2002; Rockoff, 2004), teachers' knowledge of science and their attitude toward teaching it should be of considerable concern.

In his study of elementary teachers and science content, Appleton (2008), suggested that elementary school teachers work with pedagogical content knowledge (PCK) in different ways. Working with specific topic PCK, they usually start with the idea that science should be activity based and work from specific activity ideas. This view may affect their perceived needs for improvement. Rarely do elementary teachers have the opportunity to develop specific discipline PCK because so few develop a science discipline specialization. The majority of elementary school teachers tend to have limited knowledge in both science content knowledge and in science PCK, given that few elementary school teachers are science discipline specialists (Appleton, 2008).

Traditionally, scientific inquiry has been the effective avenue to help students master science content and develop explanations for the natural world (NRC, 1996/2011; Romberg, Carpenter, & Dremock, 2005). In order to be able to employ inquiry-based teaching practices, elementary teachers have to be comfortable with the science content to be taught. Facilitating inquiry-based instruction with frequency and quality has proven a difficult task for many elementary teachers (Adamson, Santau, & Lee, 2012; Woodbury & Gess-Newsome, 2002; Yerrick, 2000), and they are further challenged by the expectation to implement reform-oriented practices (Adamson, Santau, & Lee, 2012; Barab & Luehmann, 2003; National Center for Education Statistics, 2001). In addition, many of the inquiry-based experiences teachers rely on provide heavy scaffolding in a cookbook-style, step-by-step approach, that directs the sequencing of how any experiment is put together, run, and is used as a way to gather data (Nagle, Hariani, & Siegel, 2006). Hence, studies that consistently reveal problems with elementary science education are a reflection of the science knowledge and practice held by elementary school teachers (Appleton, 2008; Graham, Burgoyne, Cantrell, Smith, St. Clair, & Harris, 2009; Levitt, 2002).

Technological/engineering design-based learning has been found to be an effective approach in science education (Ercan, & Sahin, 2015; Fortus, Krajcik, Dershimer, Marx, & Mamlok-Naaman, 2005; Kolodner, 2002; Mehalik, Doppelt, & Schunn 2008; Roth, 2001; Wendell, 2008; Leonard & Derry, 2011). T/E DBL provides a reason for learning science content by engaging the student in design and using a natural and meaningful venue for learning both science and design skills (Doppelt, Mehalik, Schunn, Silk, & Krysinski, 2008; Kolodner, 2002). The potential of teaching science through design based learning is that the design task provides the context for applying the science knowledge and the science concepts provide a part of the content needed for performing the design task (Sidawi, 2007). Learning science through design activity has been shown to be a productive way to promote deep science learning (Fortus et al., 2004; Hmelo, Holton, & Kolodner, 2000; Kolodner, Camp, Crismond, Fasee, Gray, Holbrook, Puntambekar, & Ryan, 2003).

T/E DBL Instructional Approach

Pedagogical Requirements of Elementary Teachers

Active learning is an educational approach that puts the students at the center of the learning process and recognizes the variation among different learning styles (Dewey, 1916; Gardner, 1993; Kolb, 1985; Perkins, 1992; Sternberg, 1998). In DBL learning environments, learners develop deep, integrated understanding of content and processes. The teacher is no longer merely a provider of facts but rather a resource provider, learning environment shaper, and a tutor (Sidawi, 2007).

At the elementary level, there is considerably less concern about the content of separate subject fields and more attention given to immersing students in basic skills such as reading, writing, and mathematics, along with social skills such as working together, following directions, and keeping the classroom orderly. Instruction is often organized around themes rather than formal content divisions. Activities involving T/E DBL can be utilized to further these objectives (Bethke & Rogers, 2013; Herschbach, 2009; Penner, Giles, Lehrer, & Schauble, 1997, 1998; Roth, 1969; Wells, 2008).

These approaches promote responsibility and independent learning and actively engage students in various types of tasks, thereby meeting the diverse learning needs of many different students. Students build their own knowledge by active learning and interacting with the environment as suggested by the constructivist approach, working independently or collaborating in teams, and creating a real product. Active learning changes the teacher’s role from that of lecturer to that of tutor, guide, and partner in the learning process (Prince, 2004).

Teaching is a complex cognitive skill occurring in an ill-structured, dynamic environment (Leinhardt & Greeno, 1986; Spiro, Coulson, Feltovich, & Anderson, 1988; Spiro, Feltovich, Jacobson, & Coulson, 1992). Historically, the knowledge base of teacher education has focused on the content knowledge of the teacher (Shulman, 1986; Veal & MaKinster, 1999). However, Shulman (1986, 1987) suggested that there are seven knowledge bases required for teaching. Three that are relevant to the pedagogical requirements of elementary teachers attempting to support student learning using T/E DBL are (a) content knowledge, (b) knowledge of general pedagogy, and (c) pedagogical content knowledge (PCK).

Content knowledge is related to the discipline and includes subject matter knowledge and ways of working in the disciple. General pedagogy constitutes the common strategies and procedures used in teaching. Shulman (1987) suggested, however, that PCK was different from both content knowledge and knowledge of general pedagogy: he thought that it consisted of such knowledge as how to represent subject matter to students, ideas about student conceptions, and understandings of specific learning difficulties students may have with the subject matter (van Driel, Verloop, & de Vos, 1998). That is, it is knowledge of how to teach specific content in specific contexts—a form of knowledge in action (Mellado, Blando, & Ruiz 1998)—and exists at the intersection of content and pedagogy.

PCK represents the blending of content and pedagogy into an understanding of how particular aspects of subject matter are organized, adapted, and represented for instruction (Mishra & Koehler, 2006, p.1021). For teachers to be successful, they would have to confront both issues (content and pedagogy) simultaneously by embodying ‘‘the aspects of content most germane to its teachability’’ (Shulman, 1986, p. 9). At the heart of PCK is the manner in which subject matter is transformed for teaching. This occurs when the teacher interprets the subject matter and finds different ways to represent it and make it accessible to learners.

Elementary teachers learning DBL require a focus on these three interrelated aspects of teacher knowledge (Shulman 1986, 1987). To teach all students according to today’s standards, teachers indeed need to understand subject matter deeply and flexibly so they can help students map their own ideas, relate one idea to another, and re-direct their thinking to create powerful learning. Teachers also need to see how ideas connect across fields and to everyday life. These are the building blocks of pedagogical content knowledge (Solís, 2009).

Technological/Engineering Design-Based Learning Pedagogy

Drake and Burns (2004) have identified three instructional approaches when implementing integrative curricula – multidisciplinary, interdisciplinary, and transdisciplinary. The multidisciplinary approach focuses primarily on the disciplines, while the intradisciplinary approach integrates the subdisciplines within a subject area. However, it is the transdisciplinary approach that organizes the curriculum around student questions and concerns in a real-world context. Wells (2008, p. 11; 2013, p. 34; 2014, p. 7, & 2015) asserts that the instructional methodology in technology education most closely resembles this approach whereby students develop content specific knowledge on a *need-to know* basis as they pursue solutions to a design-based problem. Furthermore, Christian Schunn (2009) at the University of Pittsburgh asserts that design-based learning is a form of project-based learning in which students learn what they need to learn in a *just-in-time* fashion while trying to design something and has structured DBL units for middle and high school math, science, and technology classroom using engineering design processes.

A key element of integrative STEM education requires the application of the technological/engineering design-based pedagogical approach to integrate the STEM education disciplines (Wells & Ernst, 2012/2015). Wells (2014) asserts that the design-based teaching strategy serves as the contextual bridge for integrative learning of STEM content and practice, thus supporting a blended pedagogical approach. The ultimate goal of integrative learning is to have the learner understand the STEM content connections and the iterative and cyclical aspect of engineering design challenges students to make those connects through the exploration of their understandings and/or misunderstandings of the content (Cajas, 2001; Puntambekar & Kolodner, 2005).

Numerous models illustrating the technological/engineering design process have been developed and published with each model having their own distinctive number of steps or stages, with or without prompting questions (ITEA/ITEEA, 2000, 2002, 2007; Museum of Science, 2015; Teach Engineering, 2014). However, each version has comparable central concepts and provides guidance in devleoping solutions for a design challenge that addresses a human want or need. The process of designing does not follow a lock-step path, but is interative and cyclical in nature and learners can enter the process at any point. Fortus, Dershimer, Krajcik, Marx, and Mamlok-Naaman (2004) stressed that the aim of technology and engineering education is to have students engage in design and build understanding of content across disciplines and not merely to train them on the process of design.

The traditional STEM education models will not suffice in conveying the conceptual and/or pedagogical approach of Integrative STEM Education (Wells, 2016). Therefore, the model used in this study is the PIRPOSAL Model: Conceptual/Pedagogical Framework of Integrative STEM Education (Wells, 2016) (Fig. 2).

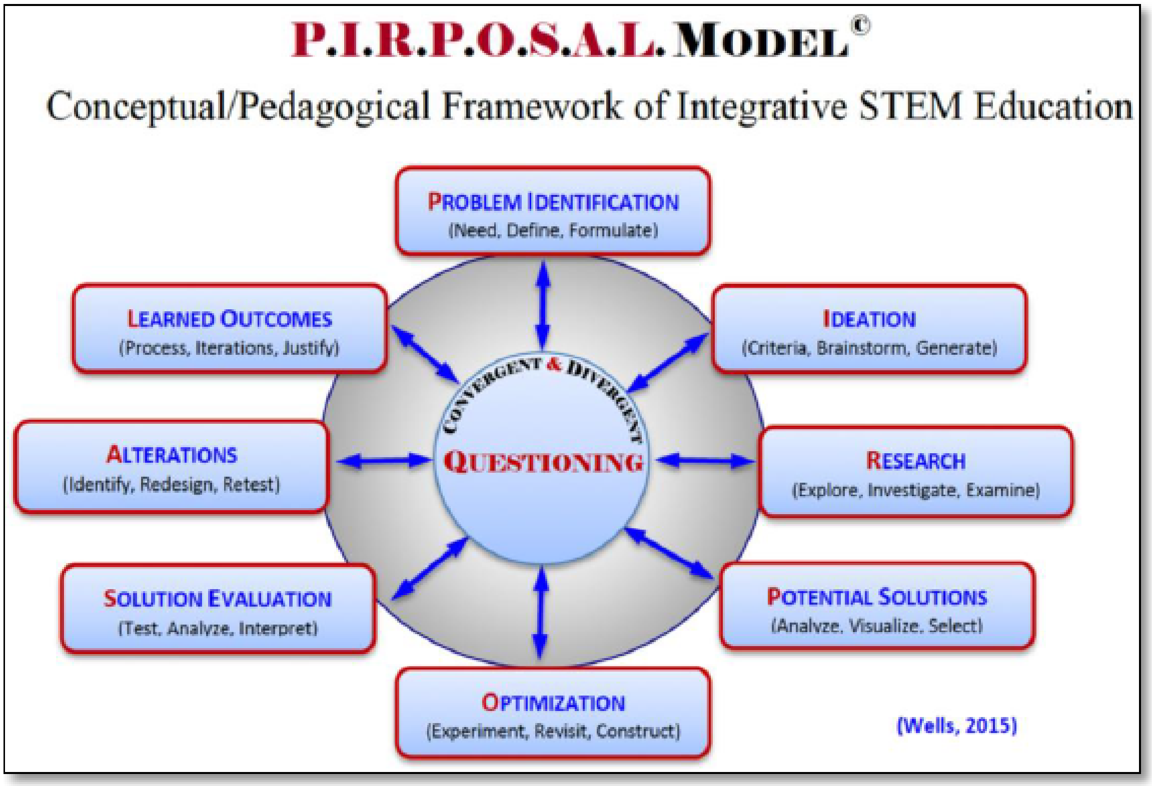

Figure 2. PIRPOSAL Model of Integrative STEM Education

According to Wells (2016) this model embraces the integration of concurrent pedagogies and is deliberate in their employ to teach not only technology and engineering education content and practices, but those of other inherent disciplines, such as science and mathematics. Through the PIRPOSAL model, engineering design is represented as *phases of engagement* encountered by the designer when attempting to resolve an engineering challenge (Wells, 2016). Each phase in the PIRPOSAL Model intentionally positions a student's achievement within the "need to know" context imposed by the challenge of designing an engineering solution (Wells, 2014) and reflects the designerly focus of student engagement as derived from the particular questions the student designer asks themselves regarding what they need to know at any given point in the design process (Wells, 2016).

Central to the Model is the continuous questioning process by the learner that moves in and out of convergent and divergent thinking, informing a series of on-going transformation decisions. Wells (2016) asserts that regardless of which design phase the learner finds themselves engaged in, they are confronted with a need to know which in turn elicits designerly questioning. Initial lower level questioning elicits the learner's prior knowledge about what they already know about the the given topic and serves as the scaffolding for creating questions regarding what they need to know. Wells (2016) asertains that this progression from convergent to divergent designerly questioning involves a series of ongoing transitions between knowledge and concept domains that ultimatley results in design decisions. Thus, learner questioning, their habits of mind, facilitates their transistions among the various phases of engineering design (Wells, 2016).

Each phase of the PIRPOSAL model is comprised of three designerly questioning focal points, each of which highlights the intentional integration of specific designerly practices (Wells, 2016). In the Problem Identification phase, the learner recognizes the need, operationally defines the solutions, and states the problem and the T/E design challenge, including criteria, parameters, and constraints. The Ideation phase includes a review of the criteria, brainstorming ideas and generating a summary of the results. Exploration for information of potential solutions, investigation of various technologies, physical/biological information, and previous solutions, and an examination of solutions in nature comprise the Research phase. The Potential Solutions phase is characterized by an analysis of the information gather thus far, visualization of potentials solutions by means of sketching, and selection of the best two or three designs with justification.

In the Optimize phase, experiments are performed on each potential solution, and the learner revisits the criteria and constraints of the design challenge. Finally, the learner constructs models and working prototypes. For the Solution Evaluation phase, the learner tests the prototype, evaluates all criteria, analyzes all data from sub-experiments, interprets the findings through summation, and describes the implications of the evaluation. The Alterations phase includes the identification of problems and solutions, and a redesign and retest of the purposed solution. The Learning Outcomes phase is an opportunity for the learner to communicate and describe their procedures and process/iterations, and justify their final solution.

5 E Instructional Model and T/E DBL

With the development and subsequent publication of *A Framework for K-12 Science Education* (NRC, 2012) and the *Next Generation Science Standards* (NGSS Lead States, 2013), engineering in science has moved from an implicit role to one of embedded practices. According to *A Framework for K-12 Science Education* (NRC, 2012), engaging in the practices of engineering helps students understand the work of engineers, as well as the links between engineering and science. Participation in the practices also helps students form an understanding of the crosscutting concepts and disciplinary ideas of science and engineering; moreover, it makes students' knowledge more meaningful and embeds it more deeply into their world view (NRC, 2012). These eight practices, six specifically addressing science and two specifically addressing engineering, are incorporated into the Next Generation Science Standards (NGSS) as one of three dimensions. The practices characterize what the learner is supposed to do and are not to be considered instructional methods or curriculum.

NGSS also delineates two other dimensions: *Cross Cutting Concepts* and *Disciplinary Core Ideas* that includes various components of engineering. However according to Puzer, Moore, Baker, and Berland (2014), these various components are disconnected in the performance expectations and recommend that all three dimensions be considered together. Furthermore, if the engineering activities utilized in the classroom do not meaningfully integrate science and mathematics content, the authors contend that these activities no longer fully represent engineering (Puzer, Moore, Baker, and Berland, 2014). However, technological/engineering design based learning can provide the means for connecting these various components of engineering and intentionally teaching science content.

The 5E instructional model describes an instructional design that is intended to facilitate the process of conceptual change by guiding the learner through five phases – engagement, exploration, explanation, elaboration, and evaluation – and placing them at the center of their learning experiences. The 5E instructional model was developed in 1967 by the Biological Sciences Curriculum Study (BSCS) team using an adaptation of the learning cycle purposed by J. Myron Atkin and Robert Karplus (1962) and employed in the elementary school program Science Curriculum Improvement Study (SCIS). The Atkin and Karplus learning cycle used the terms exploration, invention, and discovery (Bybee, Taylor, Gardner, Van Scotter, Powell, Westbrook, & Landes, 2006). However, the origins of the 5E instructional model can be traced back to even earlier models by Herbart (1901) and Dewey (1938).

The traditional roles of the teacher and student are virtually reversed in the 5E model with students taking on much of the responsibility for their learning as they construct knowledge through discovery (Morgan & Ansberry, 2007). During the Engagement phase, the teacher endeavors to access the learners' prior knowledge and capture their curiosity in a new concept. Hand-on experiences and the generation of new ideas from posed questions help learners begin to construct concepts and develop skills in the Exploration phase. In the Explanation phase, learners articulate their understanding of the new concept. The Elaboration phase is characterized by activities that address the correction of remaining misconceptions and the generalization of the learned concepts into broader contexts. Finally, learners self-assess their understanding of concepts and the teacher assesses learner progress during the Evaluation phase.

As with the iterative and cyclical nature of the T/E design process, learners move within the phases of the 5E model as they construct their own learning. The phases of the PIRPOSAL model and the 5E model dovetail to create a seamless instructional model based on a blended pedagogical approach to implement T/E DBL in the classroom (Wells, 2012/2014). By creating a learning experience that is student-centered, T/E DBL affords new possibilities for teaching science. The active learning prompted by the 5E model and employed by T/E DBL changes the role of the teacher from that of lecturer to guide and facilitator. Rather than using scripted-inquiry, T/E DBL provides a reason for learning science content by engaging the student in design and using a natural and meaningful venue for learning both science and design skills (Doppelt, Mehalik, Schunn, Silk, & Krysinski, 2008, p. 23).

Research Methodologies in Prior Studies

In order to accomplish the goal and purpose of research, emphasis should be placed on designing an appropriate research method. In addition, the research design should be considered in conjunction with the goal and research questions (Crestwell, 2003). Therefore, an examination of research methodologies of prior studies focusing on design based learning is included in this review of literature.

Research on T/E DBL

Wells (2010) purposed that prior analyses of published research in technology education over the past several decades (Foster, 1992/1996; Hoepfl, 2002/2007; Lewis, 1999; McCrory, 1987; Petrina, 1998; Waetjen, 1992; Zuga, 1994/1995/1997) revealed significant gaps in the research needed to establish the viability of pedagogical practices in technology education. He (2010) concluded that the most recent analyses and summary assessments (Johnson & Daugherty, 2008; Wells, Figliano, Kwon, & Carlson, 2008; Wells, Pembridge, Greene, & Dobroth, 2009) of published technology education studies further verified previous findings regarding those gaps in technology education research. T/E DBL was one of the identified gaps in technology education research.

The intertwining of science and technology can be documented as early as the Renaissance era to Leonardo de Vinci and Francis Bacon who viewed science and technology as interactive domains (Sidawi, 2007). Wells (2010) asserted that capitalizing on the vast amount of teaching and learning research in science education has the potential to provide direction for research in technology education and establishing credibility. To this end, the studies examined here are situated more in the area of science rather than in technology education. Furthermore, the studies focus on the student populations rather than educator populations.

Doppelt, Mehalik, Schunn, Silk, and Krysinski (2008) asserted that technology education is not a required subject in high school, typically an elective in middle school, and most like not offered at the elementary level. The researchers identified a gap between the standards and the implementation of the existing learning environment was particularly lacking in the design process (Doppelt, Mehalik, Schunn, Silk, and Krysinski, 2008). As a result, the researchers designed a new learning module, Electrical Alarm System: Design, Construction, and Reflection, that addressed this gap. Their study was an in-depth case study of eight-grade students centered on enhancing science education through design-based learning and employed both quantitative and qualitative data collection. Students completed pre- and post-tests and submitted portfolios of their work. The findings from this study suggests that DBL has the potential to increase students' desire to learn, enhance students' success in science class, and increase students' interest in science topics (Doppelt, Mehalik, Schunn, Silk, and Krysinski, 2008).

Several studies by Fortus, Krajcik, Dershimer, Marx, and Mamlok-Naaman (2003/2004/2005) focused on design-based science (DBS) aimed at helping high school students construct scientific understanding and real-world problem-solving skills by engaging them in the design of artifacts. The researchers viewed DBL as providing a reason for learning science content by engaging the student in design and using a natural and meaningful venue for learning both science and design skills (Fortus, et al.,2003/2004/2005). Quantitative and qualitative data collection methods employed in their case studies included pre- and post-tests and collecting artifacts. The findings demonstrated that the students had substantial science knowledge that they were able to apply to the solution of design problems.

Studies by Roth (1995a/1998a/2001) and Huang and Roth (2004/2006) cited similarities between open-inquiry science classrooms and technology-centered courses. A case study research design focused on middle school student populations was utilized in the studies whereby both qualitative and quantitative data, pre- and post-tests and artifacts, were collected and analyzed. The researchers (Huang & Roth, 2004/2005; Roth, 1995a/1998a/2001) concluded that technological activities can play a key role in an integrative approach to teaching from which students can engage in a variety of discourses.

While studies by Kolodner, Camp, Crismond, Fasse, Gray, Holbrook, Puntambekar, and Ryan (2003) and Vattam and Kolodner (2008) focused on the Learning by Design™ curriculum that featured a problem-based learning instructional strategy, students learned science in the context of achieving design-and-build challenges. The researchers asserted that design challenges promoted and focused learning, provided opportunities for application, and allowed skill and concept learning (Kolodner et al., 2003; Vattam & Kolodner, 2008). A case study research design was used in both studies using middle school student populations. Quantitative and qualitative data were collected through pre- and post-tests, observations, and artifacts. Although the Kolodner, Camp, Crismond, Fasse, Gray, Holbrook, Puntambekar, and Ryan (2003) study focused on students, the researchers did state that although teachers may have trouble learning the science, "if they have bought in to what could be in the classroom and if they have help as they are learning to implement the new approach, their classes thrive."

The focus for each of these studies may be somewhat different, but the commonality is the use of the design based learning instructional approach as a way to construct scientific and technological content knowledge within real-world scenarios. The case study and multiple case study research designs afforded the researchers a method to describe an intervention and the real-life context in which it occurred (Yin, 2003). Qualitative and quantitative data collection and analysis was used to focus on the adoption and diffusion of the educational innovation through pre-and post-tests and artifacts.

Chapter Summary

Three theoretical frameworks and the learning theory foundation for design interact to provide the underpinnings for this study. These frameworks are (a) Roger's change process, (b) Guskey' model of teacher change, and (c) Loucks-Horsley, Love, Stiles, Mundry, and Hewson's Design Framework for Professional Development in Science and Mathematics. Rogers' point of view emphasized the inclusion of feelings and emotions in education. He believed that the highest levels of significant learning included personal involvement at both the affective and cognitive levels, were self-initiated, were so pervasive they could change attitudes, behavior, and in some cases, even the personality of the learner. Learnings needed to be evaluated by the learner and take on meaning as part of the total experience (Rogers, 1983).

Guskey’s model (Figure 2) represents the process that teachers go through when participating in professional development programs (Guskey, 1986. p. 7), whereby, the professional development program functions as the initial activating mechanism in the change process. According to the model, significant change in teachers' beliefs and attitudes is likely to take place only after changes in student learning outcomes are evidenced (Guskey, 1986, p. 7).

The Design Framework for Professional Development in Science and Mathematics (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2009) provides a foundational structure for the development of the professional development intervention. This framework suggests that planning and implementing effective professional development for science and mathematics teachers requires immersion experiences, ongoing reflection, decision making, and dialogue between the participants and the deliverer of the professional development. If science and mathematics teachers are to become the teachers envisioned by the deliverer of the professional development, they need to experience for themselves the science and mathematics learning they will want their students to do (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2009). Hence, for elementary teachers to implement T/E DBL, they need to be provided with the same experiences with T/E DBL that their students will have in the classroom.

Learning is concerned not so much with what learners *do* but with *what* they know and *how* they come to acquire it (Jonassen, 1991b; Uden & Beaumont, 2006). Two learning theories fundamental to the pedagogical preparation of elementary teachers using the T/E DBL approach are cognitivism and constructivism. For learning to take place, one has to understand that individuals bring various learning experiences to the learning situation which can impact learning outcomes. The most effective manner in which to organize and structure new information is to tap into the learners' previously acquired knowledge, abilities, and experiences (Stepich and Newby, 1988). Humans *create* meaning as opposed to *acquiring* it. Roth (2001, p. 778) observed that through designing technological artifacts, students were able to turn their ideas from a vague form to a concrete form that is situated in the environment.

Many of the educational change efforts introduced into the classroom often fail or if adopted are radically modified to the point that the change effort bears no resemblance to the original innovation (Blanchard, 2010; Nudzor, 2013)). Adoption of an innovation is a singular decision and each teacher must decide whether the innovation is valuable to them and their students and the extent of the innovation's use. Individual teachers have different kinds of concerns during the implementation of an innovation that must be addressed before the teacher will adopt the innovation. Created through a decade of development, the CBAM is used to measure, describe, and explain the process of change experienced by the teachers. The diagnostic dimensions of CBAM, developed by Hall, George, and Rutherford (1977), have three components, but the Stages of Concern Questionnaire is the most commonly used to determine what the teacher is feeling about the innovation. As teachers search for ways to cope with change and the impact on their students, professional development is important in improving the competency of teachers facing the implementation of an innovation. In this study, the SoC model is used to show change in participants' levels of concerns before treatment and after its completion.

The majority of elementary school teachers tend to have limited knowledge in both science content knowledge and in science PCK, given that few elementary school teachers are science discipline specialists (Appleton, 2008). In order to be able to employ inquiry-based teaching practices, elementary teachers have to be comfortable with the science content to be taught. Facilitating inquiry-based instruction with frequency and quality has proven a difficult task for many elementary teachers (Adamson, Santau, & Lee, 2012; Woodbury & Gess-Newsome, 2002; Yerrick, 2000), and they are further challenged by the expectation to implement reform-oriented practices (Adamson, Santau, & Lee, 2012; Barab & Luehmann, 2003; National Center for Education Statistics, 2001). Hence, studies that consistently reveal problems with elementary science education are a reflection of the science knowledge and practice held by elementary school teachers (Appleton, 2008; Graham, Burgoyne, Cantrell, Smith, St. Clair, & Harris, 2009; Levitt, 2002).

Technological/engineering design-based learning has been found to be an effective approach in science education (Ercan, & Sahin, 2015; Fortus, Krajcik, Dershimer, Marx, & Mamlok-Naaman, 2005; Kolodner, 2002; Mehalik, Doppelt, & Schunn 2008; Roth, 2001; Wendell, 2008; Leonard & Derry, 2011). T/E DBL provides a reason for learning science content by engaging the student in design and using a natural and meaningful venue for learning both science and design skills (Doppelt, Mehalik, Schunn, Silk, & Krysinski, 2008; Kolodner, 2002). Solving real-world problems in order to provide a practical application or context presents the learner with an opportunity for an integrative approach to learning (Fennema, 1992; Mehalik, Doppelt, & Schunn, 2008). Elementary teachers learning DBL requires a focus on at least three interrelated aspects of teacher knowledge (Shulman 1986, 1987): content knowledge, general pedagogy knowledge, and pedagogical content knowledge. A key element of integrative STEM education requires the application of the technological/engineering design-based pedagogical approach to integrate the STEM education disciplines (Wells & Ernst, 2012/2015). Wells (2014) asserts that the design-based teaching strategy serves as the contextual bridge for integrative learning of STEM content and practice, thus supporting a blended pedagogical approach.

The traditional STEM education models will not suffice in conveying the conceptual and/or pedagogical approach of Integrative STEM Education (Wells, 2016). Therefore, the model used in this study is the PIRPOSAL Model: Conceptual/Pedagogical Framework of Integrative STEM Education (Wells, 2016). According to Wells (2016) this model embraces the integration of concurrent pedagogies and is deliberate in their employ to teach not only technology and engineering education content and practices, but those of other inherent disciplines, such as science and mathematics. Through the PIRPOSAL model, engineering design is represented as *phases of engagement* encountered by the designer when attempting to resolve an engineering challenge (Wells, 2016). Each phase in the PIRPOSAL Model intentionally positions a student's achievement within the "need to know" context imposed by the challenge of designing an engineering solution (Wells, 2014) and reflects the designerly focus of student engagement as derived from the particular questions the student designer asks themselves regarding what they need to know at any given point in the design process (Wells, 2016).

The 5E instructional model describes an instructional design that is intended to facilitate the process of conceptual change by guiding the learner through five phases and placing them at the center of their learning experiences. As with the iterative and cyclical nature of the T/E design process, learners move within the phases of the 5E model as they construct their own learning. The phases of the PIRPOSAL model and the 5E model dovetail to create a seamless instructional model based on a blended pedagogical approach to implement T/E DBL in the classroom (Wells, 2012/2014).

Research methodologies of prior studies focusing on design based learning inform the purposed study. Wells (2010) purposed that prior analyses of published research in technology education over the past several decades (Foster, 1992/1996; Hoepfl, 2002/2007; Lewis, 1999; McCrory, 1987; Petrina, 1998; Waetjen, 1992; Zuga, 1994/1995/1997) revealed significant gaps in the research needed to establish the viability of pedagogical practices in technology education. He (2010) concluded that the most recent analyses and summary assessments (Johnson & Daugherty, 2008; Wells, Figliano, Kwon, & Carlson, 2008; Wells, Pembridge, Greene, & Dobroth, 2009) of published technology education studies further verified previous findings regarding those gaps in technology education research. T/E DBL was one of the identified gaps in technology education research.

Capitalizing on the intertwined relationship of science and technology and the vast amount of teaching and learning in science education that can provide direction for technology education, the studies examined are situated more in the area of science rather than in technology education. Furthermore, these studies focus on the student populations rather than educator populations. Doppelt, Mehalik, Schunn, Silk, and Krysinski (2008) identified a gap between the standards and the implementation of the existing learning environment was particularly lacking in the design process (Doppelt, Mehalik, Schunn, Silk, and Krysinski, 2008). Their study was an in-depth case study of eight-grade students centered on enhancing science education through design-based learning and employed both quantitative and qualitative data collection. Students completed pre- and post-tests and submitted portfolios of their work. The findings from this study suggests that DBL has the potential to increase students’ desire to learn, enhance students’ success in science class, and increase students’ interest in science topics (Doppelt, Mehalik, Schunn, Silk, and Krysinski, 2008).

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The focus for each of these studies may be somewhat different, but the commonality is the use of the design based learning instructional approach as a way to construct scientific and technological content knowledge within real-world scenarios. The case study and multiple case study research designs afforded the researchers a method to describe an intervention and the real-life context in which it occurred (Yin, 2003). Qualitative and quantitative data collection and analysis was used to focus on the adoption and diffusion of the educational innovation through pre-and post-tests and artifacts.

CHAPTER 3: METHOD

The purpose of the research presented was to gain an understanding of change in science instructional content and practice through professional development that educates elementary teachers to implement T/E DBL as part of teaching science. Described in this chapter is the method selected to investigate the RQs, which is organized in the following sections: research design, methodology, the population and sample, instrumentation, data collection procedures, and data analysis. The following RQs served as the basis for investigating this topic:

After participation in professional development on implementing T/E DBL as part of teaching elementary science:

1. What changes in teacher concerns regarding implementation of T/E DBL were revealed?
2. What change in planning of practice toward use of T/E DBL was evidenced in teachers' instructional design?
3. To what extent do teachers feel their understanding of the targeted science concepts was positively impacted?

Research Design

A multiple case study was the overarching design chosen to investigate the RQs as this research occurred within the context of a professional development intervention using a variety of data sources where multiple facets informing the research questions could be revealed and understood (Baxter & Jack, 2008; McMillan, 2012; Teddlie, & Tashakkori, 2006; Yin, 2003). As a multiple case study, this particular research design adhered to a concurrent mixed method approach, as represented in Figure 3, whereby there were two relatively independent strands: one with quantitative questions, data collections and analysis techniques and the other with qualitative questions, data collection and analysis techniques. Inferences made on the basis of the results from each strand were synthesized to form meta-inferences at the end of the study (Crestwell, 2009; Teddlie, & Tashakkori, 2006). The approach was selected because the separate use of quantitative and qualitative methods results in findings that could provide a holistic description of change in concerns and practices. Recognizing the multiple case study method would not be representative of a wider social setting, the results of the research could not be generalized. Rather the results were used to demonstrate the potential for change in concerns and practice (Yin, 2003; Jan Dijk, 2010).

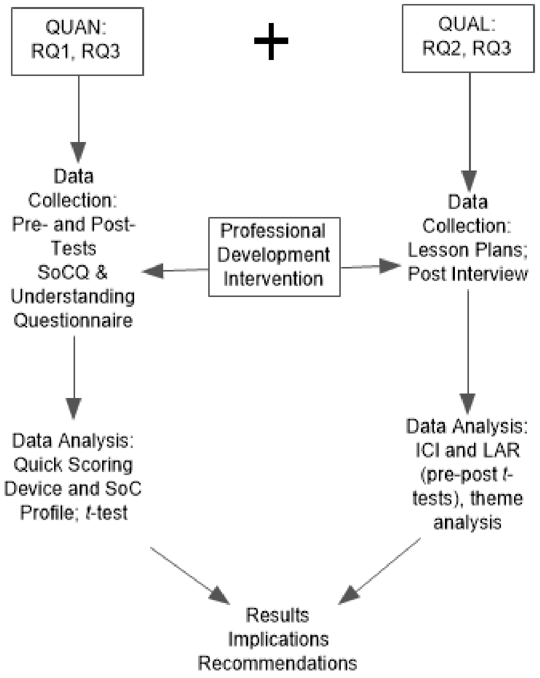


Figure 3. Concurrent Mixed Methods Design for this Study

The independent variable for the study was the technological/engineering design-based learning (T/E DBL) instructional strategy employed in this research as an approach for teaching science concepts. The dependent variables were 1) teacher concerns regarding implementation of the T/E DBL approach, 2) the lesson plans generated and implemented by the teachers as a result of the intervention and 3) teacher understanding of the targeted science concepts.

Quantitative analysis of teacher responses on the Stages of Concern Questionnaire (SoCQ) and the Understanding of a Virginia Science Standard of Learning Questionnaire provided the evidentiary basis to answer RQ1 and RQ3, respectively. A qualitative analysis of the data collected from the lesson plans through the use of the Indicators of Instructional Change instrument, and the T/E DBL Lesson Assessment Rubric (Wells, Wells, & Deck, 2015) was used to establish the evidence to answer RQ2. A qualitative analysis was also used to analyze the data from the Post Interview to address RQ3. Table 1 presents the alignment between the research questions, the data sources, and the procedures used for data analysis.

Table 1

Alignment between Research Questions, Data Sources, and Analysis Procedures

Research Question	Data Source	Data Analysis
What changes in teachers' concerns regarding implementation of T/E DBL were revealed?	Pre/Post Stages of Concern Questionnaire	Quick Scoring Device SoC Profile *t*-tests
What change in planning of practice toward use of T/E DBL was evidenced in teachers' instructional design?	Lesson Plans	Instructional Change Indicators Lesson Assessment Rubric *t*-tests of pre/post scores
To what extent do teachers feel their understanding of the targeted science concepts was positively impacted?	Pre/Post Understanding VA Science SOL Questionnaire Post interview	*t*-test Theme analysis

Participants and Recruitment Procedures

The participants for this study consisted of four practicing elementary teachers currently teaching fourth or fifth grade and purposefully selected from a pool of 71 teachers who previously participated in a science professional development program (McMillan & Schumacher, 2001; Patton, 2002). The participants were recruited upon receipt of approval from the Institutional Review Board at Virginia Tech to conduct this study (Appendix A). Each teacher completed and signed an Informed Consent Letter prior to participating in the research study (Appendix B). These participants were also selected because of their availability and their grade level teaching assignment that correlated to an analysis of the 2013 science state accountability test, Standards of Learning (Pyle, 2015), which identified science concept weaknesses (Erlandson, Harris, Skipper, & Allen, 1993, p. 46; Patton, 2002). All four teachers have more than five years of teaching experience and were from rural elementary schools in the southwest of a mid-south state. The sample was 100% female, Caucasian, and certified in elementary education. For a complete demographic description of the sample refer to Appendix C.

Instrumentation

The following sub-sections describe the different data collection instruments utilized to assess changes in participant concerns about T/E DBL implementation (RQ1), the changes in participant use of T/E DBL in their instructional design (RQ2), and the extent teachers feel their understanding of the targeted science concepts was positively impacted (RQ3).

Stages of Concern Questionnaire

The Stages of Concern Questionnaire (SoCQ) is one of three components that comprise the diagnostic dimensions of the Concerns-Based Adoption Model developed in the 1970s by Hall, George, and Rutherford at the Research and Development Center for Teacher Education, the University of Texas at Austin (Hall & Hord, 1987). The SoCQ component is based on a key understanding—for a new program/innovation to succeed, it is critical to address the level of concerns of the people charged with implementing it (George, Hall, & Stiegelbauer, 2006). Participants may respond to change in many ways, from stress and anxiety to cynicism and burnout. For this study, the SoCQ was modified as prescribed by the instrument authors to identify the innovation as T/E DBL (refer to Appendix D).

The SoCQ instrument consists of and describes seven categories of possible concerns related to an innovation—awareness, informational, personal, management, consequence, collaboration, and refocusing. This 35-item Likert scale questionnaire asks participants to rate the extent to which they agree with various statements related to an innovation, such as how they will be able to manage all that a new innovation requires. When the SoCQ is administered, participants are asked to mark each item according to their concerns about the innovation at that time. Responders indicate their level of concern regarding each statement using a rating scale from 0 to 7. The closer the respondent's selection is to 7 the higher the respondent's concern is for the construct indicated by that statement. Conversely, the closer the respondent's selection is to 0, the lower the respondent's concern is for the construct indicated by that statement (Hall, Dirksen, & George, 2006). People who are in the earlier stages of a change process will likely have more internal concerns, such as worries about whether they can learn a new innovation or how it will affect their job performance. As individuals become more comfortable with and skilled in using an innovation, their concerns shift to focus on broader impacts, such as how the initiative will affect their students or their working relationships with colleagues (Hall, Dirksen, & George, 2006). These concerns data can therefore be indicators of how effective a PD has been in mitigating early adopter concerns, which in this study are concerns toward the T/E DBL intervention and its use for teaching science.

Reliability of the Stages of Concern Questionnaire. Based on a 1974 study which had a sample size of 830 participants, Hall, George, and Rutherford (1986, p. 11) reported that the coefficients of internal reliability ranged from .64 to .83 on the seven constructs measured: (a) awareness (.64), (b) informational (.78), (c) personal (.83), (d) management (.75), (e) consequence (.76), (f) collaboration (.82), and (g) refocusing (.71). The researchers (1986, p. 19) stated that "Items representing each stage on the questionnaire were selected in a manner that high internal reliability was very likely."

Two weeks after the initial administration of the SoCQ, 171 of the original 830 participants were asked to retake the questionnaire again to determine consistency of the responses. Results of the retest indicated that the Pearson-r coefficients of the 132 participants who responded during this procedure were: (a) awareness (.65), (b) informational (.86), (c) personal (.82), (d) management (.81), (e) consequence (.76), (f) 26 collaboration (.84) and (g) refocusing (.71) (Hall, George, & Rutherford, 1986). The Pearson-r coefficient measures the amount of the sum of squares that is due to regression (Pedhazur, 1982).

Subsequently, the difference between the Pearson-r and 1 indicates the portion of the sum of squares that is due to error (Pedhazur, 1982). Thus, the higher the Pearson-r, the more likely the construct indicated is being measured. For the study by Hall, George, and Rutherford (1986), the Pearson-r values indicate that responses were consistent when the same participants were administered the SoCQ.

In 2008, George, Hall, and Stiegelbauer conducted a study to revisit the internal reliability for the SoCQ. The researchers determined that the alpha scores for the individual scales range from $r = .64$ to $r = .83$. To ensure high internal reliability, a statement or item was included only if it had a response that correlated more highly with responses to other items measure the same Stage of Concern than with responses to items in other stages. Table 2 identifies a series of studies, including the study by George, Hall, and Stiegelbauer, that provides the sample size and coefficients of reliability for each stage scale in each study. Essentially, the high construct intercorrelation means that the instrument may measure the constructs it was intended to measure. “These coefficients reflect the degree of reliability among items on a scale in terms of overlapping variance” (George, Hall, & Stiegelbauer, 2013, p. 20).

Table 2

Coefficients of Internal Reliability for Different Stages of Concern Questionnaires

		Stage Scales						
Authors	N	0	1	2	3	4	5	6
Hall, George & Rutherford, (2008)	830	.64	.78	.83	.75	.76	.82	.71
Van den Berg & Vandenberghe, (1981)	1585	.77	.89	.86	.80	.84	.80	.76/.73*
Kolb, (1983)	718	.75	.87	.72	.84	.79	.81	.82
Barucky, (1984)	614	.60	.74	.81	.79	.81	.79	.72
Jordan-Marsh, (1985)	214	.50	.78	.77	.82	.77	.81	.65
Martin, (1989)	388	.78	.78	.73	.65	.71/.78*	.83	.76
Hall, Newlove, George, Rutherford & Hord, (1989)	750	.63	.86	.65	.73	.74	.79	.81

* In two studies, authors have proposed two subscales in place of the original SoC scale

Note. Coefficients of Internal Reliability for Different Stages of Concern Questionnaires. “Measuring Implementation in Schools: The Stages of Concern Questionnaire,” by A.A. George, G. E. Hall & S.M. Stiegelbauer, p. 18. Copyright 2006 by the Concerns Based Systems, International.

Validity of the Stages of Concern Questionnaire. Hall, George, and Rutherford (1986) stated that documenting validity was made more difficult by the fact that there were no other concerns-based survey instruments available when the SoCQ was developed. However, several validity studies contributed to increased confidence that the questionnaire measured the hypothesized Stages of Concern (Barucky, 1984; Jordan-Marsh, 1985; Kolb, 1983; Martin, 1989; & Van den Berg & Vandenberghe, 1981). Also by following the strategy outlined by Cronbach and Meehl (1955), Hall, George, and Rutherford (2008) used correlation matrices and factor analysis to show that there was high intercorrelation between the constructs measured.

Instructional Change Indicators

The lesson plan for teaching the targeted science concept was evaluated using a revision of the Indicators of Instructional Change (IIC). The 37-item instrument was developed by Mitchem, Wells, and Wells (2003) as an instructional design assessment tool for Trek 21, a PT3 funded K-12 professional development grant, to compare unit plans developed by K-12 teachers. Trek 21 sought to affect sustained change in the culture of teacher practice, with participating educators demonstrating exemplary forms of effective integration of instructional technologies (Mitchem, Wells, & Wells, 2003).

The instrument was reviewed by the Trek 21 professional developers and project director with recommendations incorporated into the final instrument. The instrument was designed to assess indicators of instructional change including active student engagement, increase in instructional technologies (IT), and the inclusion of instructional variables (Mitchem, Wells, & Wells, 2003). Three main areas were assessed on the IIC: 1) instructional procedures; 2) instructional strategies; and 3) IT integrations. A five-level coding scheme was used to evaluate the indicators: 0 = absence of variable; 1 = presence of variable; 2 = assessment is linked to objectives/extension involves IT; 3 = each objective is assessed; and + = active student engagement.

For the purpose of this study, the instrument was revised (with permission granted) to reflect T/E DBL and renamed T/E DBL Instructional Change Indicators (ICI) (Wells, Wells, & Deck, 2015) (refer to Appendix E). The Curriculum category was expanded to include not only the objectives, but both formative and summative assessments for science and technology. The Instructional Procedures were replaced with the 5E Instructional Design model, a systematic instructional design process. These five phases were as follows: 1) engagement, 2) exploration, 3) explanation, 4) elaboration, and 5) evaluation. The 5E approach to learning focused on the outcomes of instruction and closely reflected the procedures followed when using the T/E DBL teaching practices as described in the PIRPOSAL Model. The list of Instructional Strategies and the IT Integrations categories were eliminated as they have no bearing on this study. The eight Phase Integrations of the PIRPOSAL model were added to capture the use of T/E DBL strategies in the participants' lesson plans. Finally, the coding scheme was updated: 0 = absence of variable, 1 = presences of variable, 2 = assessment linked to objectives, and 3 = each objective is assessed.

T/E DBL Lesson Assessment Rubric

The T/E DBL Lesson Assessment Rubric (LAR) was used to evaluate the participants' lesson plans (refer to Appendix F) for instructional design. This instrument was a revision (permission granted) of Unit/Lesson Assessment Rubric also developed by Mitchem, Wells, and Wells (2003) as an instructional design assessment tool for Trek 21. Like the ICC, the three-level 10 category instrument was reviewed by the Trek 21 professional developers and project director with recommendations incorporated into the final instrument. The purpose of the instrument was to assess teacher-made lesson plans to ensure that the content and practices match the purpose of the activities, and include effective instructional variables. Ten main areas were assessed on the LAR: 1) title, 2) objectives, 3) assessment, 4) state accountability standards, 5) materials and resources, 6) instructional strategies, 7) teacher preparation, 8) teacher procedures, 9) student procedures, and 10) extensions. A three-level coding scheme was used to evaluate the indicators: accomplished (3 points), developing (2 points), and vague (1 point). This coding scheme was retained for the revised instrument.

For the purpose of this study, the rubric scheme of the LAR was revised to reflect the areas of the ICI. The Unit Overview assessed four areas: the unit summary and time frame, learning objectives (state science standards and Standards of Technological Literacy), and instructional design (5E Model and T/E: P.I.R.P.O.S.A.L Model). Additionally, each lesson plan was evaluated in five areas: title, learning objectives (state science and technology standards), instructional design (5E Model and T/E: P.I.R.P.O.S.A.L Model), and formative and summative assessments for both science and technology. The *Extensions* area was eliminated because it was not applicable to the research questions of this study.

Understanding of a Virginia Science Standards of Learning Questionnaire

The Understanding of a Virginia Science Standards of Learning Questionnaire (Appendix G) was developed in collaboration with experts in the field of science and T/E DBL. This three-item Likert scale instrument questioned the extent of participant understanding of a Virginia Standards of Learning (SOL) science concept—*identify possible impacts of human activity on the ecosystem*—as assessed on the state accountability test and identified by Pyle (2015) as a weakness for fourth and fifth grade students. Upon administration of the questionnaire, participants were directed to mark each item according to their understanding of the SOL, the instructional requirements for teaching the science content in the SOL, and the science concept in the SOL that students were expected to demonstrate.

Participants indicated their level of understanding regarding each question using a rating scale ranging from 1 to 7 with 1 denoting their lack of understanding and 7 signifying that they understand the SOL completely. The data generated by this instrument served to indicate the degree that participants feel the T/E DBL approach positively impacted their understanding of the targeted science concept.

Post Interview Protocol

Interview questions for the Post-Interview Protocol (Appendix H) were specifically designed to examine the rationale for participant choices on the Understanding of a Virginia Science Standards of Learning Questionnaire. The interview questions were crafted to address the survey items and probe for deeper participant rating choice motivation and understanding of the targeted science concept.

Data Collection Procedures

Described in this section are the procedures followed in collecting data generated within each of the three research phases: pre-treatment, treatment, and post-treatment. These three research phases of the study are depicted in Table 3 along with the key Professional Development (PD) activities that occur during each phase.

Table 3

Treatment Phases Flow Chart

Pre-Treatment	Treatment	Post-Treatment
Phase 1 (~ 1 week) a. Prior Understanding VA Science SOL Questionnaire b. SoCQ administration c. Unit 1 submission d. ICI/LAR analysis	Phase 2: PD1 (~ 1 week) a. Teach the processes and strategies of T/E DBL b. Revise and submit Unit 1 c. ICI/LAR analysis of Unit 1 Phase 2: PD2 (~ 2 weeks) a. Individual PD feedback session on ICI /LAR analysis b. Design and submit Unit 2 c. ICI/LAR analysis of Unit 2 Phase 2: PD3 (~ 2 weeks) a. Individual PD feedback session on ICI/LAR analysis b. Implement Unit 2 c. Based on implementation, revise and submit Unit 2	Phase 3 (~ 3 days) a. SoCQ administration b. Post Understanding VA Science SOL Questionnaire c. Post interview d. ICI/LAR analysis of Unit 2

Phase 1: Pre-Treatment

The purpose Phase 1: Pre-Treatment was to establish a baseline for data collected throughout the study. The Pre-Treatment included (a) administration of the Understanding of a Virginia Science Standards of Learning questionnaire, (b) administration of the SoCQ, (c) the collection of the participants’ lesson plan (Unit 1) used to teach the targeted science concept during the previous year, and (d) analysis of submitted units using the ICI and LAR instruments. This initial measurement of information prior to the start of Phase 2 (Treatment) served as the point of reference to demonstrate whether or not change has occurred. To keep the data confidential, the name of each participant was replaced by an alphabetic code on all recorded data. For this study, a science concept was identified as a weakness for fourth and fifth grade students by researchers at a mid-south state university based on the analysis of the 2013 state accountability test, the Virginia Standards of Learning, of that same state (Pyle, 2015). The concept was *identify possible impacts of human activity on the ecosystem*. This concept was assessed by following specific test item on the Grade 5 Science Standards of Learning test:

Which of these is an impact made by humans?

A. Marble being dug from a rock quarry

B. Marble forming from sedimentary rock

C. Oceans drying and exposing limestone

D. Limestone forming from shells of ocean animals

Each participant submitted a lesson plan (Unit 1) that they had taught in the previous academic year and designed to specifically address the identified science concept. This lesson plan was evaluated for use of the T/E DBL strategy employing the ICI and LAR (Wells, Wells, & Deck, 2015). The SoCQ, which was modified as per Rutherford, et al. to identify T/E DBL as the innovation, and the Understanding of a Virginia Science Standards of Learning questionnaire were administered via paper copies.

Phase 2: Treatment

The purpose of Phase 2 (PD1, PD2, and PD3) was to collect the data necessary to answer RQ2 of the study. The Treatment involved three separate PD sessions (Phase 2: PD1, Phase 2:

PD2, Phase 2: PD3) and related research activities as follows. In Phase 2: PD1 part (a) participants received targeted professional development (PD1) via an immersion experience using T/E DBL, in part (b) they revised Unit 1 to reflect use of this strategy, and in part (c) they submitted their lesson for ICI and LAR analyses. Phase 2: PD2 began with part (a) a PD session (PD2) to provide participants with feedback on Unit 1 based on the ICI and LAR analyses, followed by part (b) where they designed and submitted Unit 2 which targets a new science concept, and part (c) ICI and LAR analyses of their Unit 2. In Phase 2: PD3 part (a) participants were provided with feedback in an individualized PD session (PD3) on Unit 2 based on the ICI and LAR analyses, in part (b) they implemented the Unit 2 in the classroom, and in part (c) participants revised and submitted Unit 2 for ICI and LAR analyses.

Phase 2: PD1. A seven-hour professional development session (PD1), the details of which can be found in Appendix I, was used to introduce participants to T/E DBL through an immersion experience targeting the identified science concept. The instructional design model used for the T/E DBL immersion experience was the 5E Instructional Model, and the pedagogical framework used to structure the T/E DBL immersion experience was the Integrative Design-Based Learning (IDBL) PIRPOSAL model (Wells, in press 2016). As discussed in Chapter 2, this model is a blended pedagogical model that illustrates the natural concurrent integration of content and practice of both technology and engineering design with those of scientific inquiry (Wells, in press 2016).

Participants were presented with the T/E DBL lesson template (refer to Appendix J) and asked to revise Unit 1 using the template provided. The Lesson Plan template was designed to include the areas reflected and evaluated on the ICI and the LAR instruments. During the week following PD1, participants submitted their redesigned Unit 1 to be evaluated for use of the T/E DBL strategy employing the ICI and the LAR instruments (Wells, Wells, & Deck, 2015).

Phase 2: PD2. One week after submitting their revised Unit 1, a four-hour professional development session (PD2) was held. The goals of this session were (a) to provide the participants with the results of the ICI and LAR analyses for their revised Unit 1 and (b) task them with incorporating the T/E DBL strategy in their instructional design of Unit 2. The science concept addressed by Unit 2 must be a concept that participants will teach within the following two weeks (in accordance with their school division pacing guide). This science concept must also be a concept weakness identified in the analysis of the 2013 state accountability test, Virginia Standards of Learning (Pyle, 2015). Participants submitted an electronic copy of Unit 2 to the researcher for ICI and LAR analyses one week after PD2.

Phase 2: PD3. Immediately following the ICI and LAR analyses, individual one-hour professional development sessions (PD3) were held with each participant to discuss the results and make necessary revisions as needed. Participants implement Unit 2 in their classroom within two weeks following PD3. The final version of Unit 2 was electronically submitted one week after implementation for ICI and LAR analyses.

Phase 3: Post-Treatment

The purpose of Phase 3 was to complete data collection for the study and answer research questions, RQ1, RQ2, and RQ3. Post-Treatment involved (a) the administration of the SoCQ, (b) the administration of the Understanding of a Virginia Science Standards of Learning Questionnaire, (c) the administration of the Post Interview Protocol and (d) the ICI and LAR analyses of Unit 2. The SoCQ and the Understanding of a Virginia Science Standards of Learning questionnaire were administered via paper copies within three days following the submission of Unit 2 by the participant. The post interview was also conducted within this three-day time frame. Additionally, Unit 2 was analyzed for use of the T/E DBL strategy using the ICI and the LAR instruments (Wells, Wells, & Deck, 2015).

Data Analysis

Quantitative Analyses

Stages of Concern Questionnaire. In order to examine the data collected from the SoCQ to answer RQ1, all participant responses on the Likert-type items were analyzed using descriptive (means and standard deviations) and inferential statistics (*t*-tests and effect sizes), which were calculated for each of the subscales included within the questionnaire instrument. Scoring of the SoCQ requires calculating raw scores for each of the seven stages—awareness, informational, personal, management, consequence, collaboration, and refocusing—locating the percentile score for each scale in a table provided in the user manual, and plotting the results on the Stages of Concern Profile Chart (Hall, George, & Rutherford, 1986).

The Quick Scoring Device (Appendix D) was used to hand score the SoCQ responses and to plot an individual participant profile. This device was especially useful when only a small number of questionnaires need to be process (George, Hall, & Stiegelbauer, 2006). The SoCQ responses were transferred to the device, entered into seven scales, and each scale was totaled. Then, the seven raw score totals were translated into percentile scores and plotted on a grid to produce the participant’s SoCQ profile.

To determine whether participant concerns changed significantly from Phase 1 to Phase 3 paired samples *t*-tests were performed on each of the seven stages for each of the six participants. Based on the Stages of Concern framework, individuals engaged in an implementation would initially have higher scores in the lower levels of self-related concerns (awareness, informational, and personal) before decreasing in those areas and exhibiting higher scores in task-related concerns (management) and impact-related concerns (consequence, collaboration, and refocusing) (Hall, George, & Rutherford, 1986). De Winter's (2013) study showed that there was no fundamental objection to using a regular *t*-test with extremely small sample sizes. Frequencies, percentages, means, standard deviations and ranges of the highest levels of concern are used to display the results.

Understanding of a Virginia Science Standards of Learning Questionnaire. To inform RQ3, the data generated from participant responses on the Likert-type items from the pre- and post-tests Understanding of a Virginia Science Standards of Learning Questionnaire were analyzed using descriptive (means and standard deviations) and inferential statistics (*t*-tests and effect sizes). A paired comparison *t*-test was conducted to compare the means of the pre- and post- tests and determine if the difference between these tests was significant.

Qualitative Analyses

T/E DBL Instructional Change Indicators and T/E DBL Unit/Lesson Assessment Rubric. Descriptive statistics (means and standard deviations) were used to analyze the results of the ICI and the LAR for correlation with change in instructional design to address RQ2. Five lessons of two units were evaluated with the ICI and the LAR instruments with the evaluations for Unit 1 and Unit 2 occurring at both the pre- and post- revision points. Paired sample *t*-tests of each unit—pre- and post-revisions for Unit 1 and Unit 2—as well as the level of significance were calculated for the submitted unit plans of the six participants to determine change in practice toward use of T/E DBL as an instructional practice.

T/E DBL Instructional Change Indicators. The data collected using the ICI was used to inform scoring choices on the LAR. In the Curriculum category, Objectives may be scored 0, 1, or 3 while Assessment section will utilize the entire scoring range. The evaluation key for the ICI is 0 = absence of variable, 1 = presences of variable, 2 = assessment linked to objectives, and 3 = each objective is assessed. The evaluation key for Bloom's Taxonomy is 1 = knowledge, 2 = comprehension, 3 = application, 4 = analysis, 5 = synthesis, and 6 = evaluation. Each indicator of the sections of the 5E Instructional Design and Phase Integrations categories were scored 0 or 1 with the Bloom's Taxonomy categories scored 1 through 6. The individual section and category scores provided the researcher with comparison data across the intervention.

T/E DBL Unit/Lesson Assessment Rubric. The unit sections of the Unit Overview and each section of each lesson (at least five) were scored either accomplished (3), developing (2), or vague (1). The scores from the Unit Overview were totaled as well as the scores on each lesson. The individual section ratings were determined from the range of scores indicated on the instrument. This determination assisted with informing the researcher about change in the participants' instructional design and guided the participant through any necessary revision to the lesson plan(s) or the entire unit.

Post interview protocol. Interviews occurred within three days after the submission of Unit 2 via Adobe Connect, Skype, or phone and last approximately 30 minutes. Participant responses were audio recorded to assist with qualitative analysis of the interviews. Interview responses provided more in-depth data regarding participant rating choice motivation and understanding of the science concept. To inform RQ3, theme analysis was used to identify, analyze, and report patterns that emerge within the collected data, illuminate participant rating choice, and further expand on participant rating scores.

Table 4 provides a summary of the three phases, research questions, instrumentation, and data analysis.

Table 4

Alignment of Phases, Research Questions, Instrumentation, and Data Analysis

Phases	Instrumentation			Data Analysis
	RQ1: What **changes in teachers' stages of concern** regarding implementation of T/E DBL were revealed?	RQ2: What **change in planning of practice toward use of T/E DBL** was evidenced in teachers' instructional design?	RQ3: To what extent do teachers **feel their understanding of the targeted science concepts was positively impacted**?	Quantitative or Qualitative
Phase 1: Pre-Treatment	SoCQ	ICI/LAR	Understanding Questionnaire	Quantitative and Qualitative (pre-tests)
Phase 2: Treatment				
Phase 2: PD1		ICI/LAR		Qualitative (pre- & post *t*-tests)
Phase 2: PD2		ICI/LAR		
Phase 2: PD3		ICI/LAR		
Phase 3: Post-Treatment	SoCQ		Understanding Questionnaire; Post Interview Protocol	Quantitative and Qualitative (pre-post *t*-tests, theme analysis)

Chapter Summary

In this chapter, the research method utilized to investigate the research questions of the study was delineated. The research design was a multiple case study with six participants who were recruited because of their availability and their grade level teaching assignment that correlated to an analysis of the 2013 science state accountability test, Standards of Learning (Pyle, 2015), which identified science concept weaknesses.

Data were generated and collected within each of the three research phases: pre-treatment, treatment, and post-treatment. Five instruments were used to collect data in order to answer RQ1, RQ2, and RQ3: the Stages of Concern Questionnaire, the Instructional Change Indicators, and the Technological/Engineering Design Based Learning Lesson Assessment Rubric, the Understanding of a Virginia Standards of Learning Science Concept Questionnaire, and the Post Interview Protocol. The purpose of Phase 1: Pre-Treatment was to establish a baseline for data collected throughout the study. The Pre-Treatment includes (a) administration of the Understanding of a Virginia Science Standards of Learning questionnaire, (b) administration of the SoCQ, (c) the collection of the participants' lesson plan (Unit 1) used to teach the targeted science concept during the previous year, and (d) analysis of submitted units using the ICI and LAR instruments.

The purpose of Phase 2 (PD1, PD2, and PD3) was to collect the data necessary to answer RQ2 of the study. The Treatment involved three separate PD sessions (Phase 2: PD1, Phase 2: PD2, Phase 2: PD3) and related research activities as follows. In Phase 2: PD1 part (a) participants received targeted professional development (PD1) via an immersion experience using T/E DBL, in part (b) they revised Unit 1 to reflect use of this strategy, and in part (c) they submitted their lesson for ICI and LAR analyses. Phase 2: PD2 began with part (a) a PD session (PD2) to provide participants with feedback on Unit 1 based on the ICI and LAR analyses, followed by part (b) where they designed and submitted Unit 2 which targeted a new science concept, and part (c) ICI and LAR analyses of their Unit 2. In Phase 2: PD3 part (a) participants were provided with feedback in an individualized PD session (PD3) on Unit 2 based on the ICI and LAR analyses, in part (b) they implemented the Unit 2 in the classroom, and in part (c) participants revised and submitted Unit 2 for ICI and LAR analyses.

The purpose of Phase 3 was to complete data collection for the study and answer research questions, RQ1, RQ2, and RQ3. Post-Treatment involved (a) the administration of the SoCQ, (b) the administration of the Understanding of a Virginia Science Standards of Learning Questionnaire, (c) the administration of the Post Interview Protocol and (d) the ICI and LAR analyses of Unit 2. The SoCQ and the Understanding of a Virginia Science Standards of Learning Questionnaire were administered via paper copies within three days following the submission of Unit 2 by the participant. The Post Interview Protocol was also conducted within this three-day time frame. Additionally, Unit 2 was analyzed for use of the T/E DBL strategy using the ICI and the LAR instruments (Wells, Wells, & Deck, 2015).

In order to examine the data collected from the SoCQ to answer RQ1, all participant responses on the Likert-type items were analyzed using descriptive (means and standard deviations) and inferential statistics (*t*-tests and effect sizes), which were calculated for each of the subscales included within the questionnaire instrument. The Quick Scoring Device was used to hand score the SoCQ responses and to plot an individual participant profile. To determine whether participant concerns changed significantly from Phase 1 to Phase 3 paired samples *t*-tests were performed on each of the seven stages for each of the six participants.

Descriptive statistics (means and standard deviations) and inferential statistics (*t*-tests and effect sizes) were used to analyze the results of the ICI and the LAR for correlation with change in instructional design to address RQ2. Five lessons of two units were evaluated with the ICI and the LAR instruments with the evaluations for Unit 1 and Unit 2 occurring at both the pre- and post- revision points. The data collected using the ICI was used to inform scoring choices on the LAR. The individual section and category scores provided the researcher with comparison data across the intervention. For the LAR, the scores from the Unit Overview were totaled as well as the scores on each lesson. The individual section ratings were determined from the range of scores indicated on the instrument. This determination assisted with informing the researcher about change in the participants’ instructional design and guided the participant through any necessary revision to the lesson plan(s) or the entire unit.

To inform RQ3, the data generated from participant responses on the Likert-type items from the pre- and post-tests Understanding of a Virginia Science Standards of Learning Questionnaire were analyzed using descriptive (means and standard deviations) and inferential statistics (*t*-tests and effect sizes). A paired comparison *t*-test was conducted to compare the means of the pre- and post- tests and determine if the difference between these tests was significant. Participant interview responses from the Post Interview Protocol provided more in-depth data regarding participant rating choice motivation and understanding of the science concept. Participant interview responses were audio recorded to assist with qualitative analysis of the interviews. Theme analysis was used to identify, analyze, and report patterns that emerge within the collected data, illuminate participant rating choice, and further expand on participant rating scores.

CHAPTER FOUR: FINDINGS

The purpose of this research study was to gain an understanding of changes in science instructional design and practice through professional development that educates elementary teachers to implement Technological/Engineering Design Based Learning (T/E DBL) as part of teaching science. Quantitative data were analyzed using descriptive (means and standard deviations) and inferential statistics (*t*-tests and effect sizes), and paired comparison *t*-tests were conducted to compare the means of the pre- and post- tests and to determine if the difference between these tests is significant. Theme analysis of qualitative data was used to identify, analyze, and report patterns that emerge within the collected data. This chapter presents the findings from statistical and corroborative analyses of data collected, and organized in response to each research question—RQ1, RQ2, and RQ3.

Sample Description

Initially, six teachers were recruited for this study, but participant attrition occurred before the pre-treatment phase began when three teachers dropped out of the study. To increase the sample size, an additional participant was recruited from the same pool of 71 teachers, which when combined with the remaining three participants, brought the total of participants for the study to four. A complete demographic description of the sample is detailed in Appendix C.

Data Analysis

Research Question One

The first research question, RQ1, guiding this study asked, “What changes in teacher concerns regarding implementation of T/E DBL are revealed” following targeted professional development. To address RQ1, analysis of participant responses on the pre-treatment (Phase 1) and post-treatment (Phase 3) Stages of Concern Questionnaire (SoCQ) instrument was conducted using the Quick Scoring Device to develop the Stages of Concern (SoC) profile for each participant. The participant responses to the PRE and POST treatment administration of the SoCQ and the analysis using the SoC Quick Scoring Device can be found in Appendix K.

Adhering to the scoring procedures developed by Hall, George, and Rutherford (1998) for the SoCQ, item responses for each of the seven stages were summed to represent total raw scores, which were then converted to percentile scores. The percentile scores were used in constructing graphical profiles of each participant representing the degree of concern across all seven stages of concern. To derive meaning regarding the concerns reflected by the percentile scores, an individual graphical overlay of the PRE and POST treatment SoC composite profiles for each participant was generated. Additionally, a graphical overlay of the PRE and POST treatment SoC composite profiles of all four participants was produced to provide a comparison of the group. To determine if the differences in PRE and POST percentile scores across all stages of concern were statistically significant, paired *t*-tests were conducted for each stage.

Group PRE/POST SoC Profile Comparison. T/E DBL PD treatment occurred over eight weeks with the administration of the SoCQ occurring before and after treatment commenced. Percentile scores for each stage of concern PRE/POST treatment were calculated to determine if each of the participants' internal and external concerns had increased or decreased. Mean percentile scores were calculated to provide comparison data for the group (Table 5). The percentile scores PRE/POST treatment for Participant A decreased for both internal and external concerns with exception of Management which increased. Percentile scores for Participant B decreased across all stages except Management experienced a slight increase and Collaboration remained static. Percentile scores for Participants C and D exhibited decreases across both internal and external concerns excluding the score for Refocusing for Participant D which was unchanged. The mean percentile scores for the group for both internal and external concerns decreased across all stages. However, any statistical significance cannot be ascertained without using statistical comparison methods.

Table 5

Group: PRE/POST Treatment SoC Percentile Score Means

Stages of Concern	Treatment	Participant Percentile Scores				Mean Percentile Scores (% $\bar{x}$)
		A	B	C	D	
0	PRE	55	98	87	81	80.25
Awareness	POST	40	94	40	40	53.50
1	PRE	69	80	95	90	83.50
Informational	POST	43	72	91	45	62.75
2	PRE	63	89	92	72	79.00
Personal	POST	31	83	91	17	55.50
3	PRE	23	97	85	85	72.50
Management	POST	34	98	60	15	51.75
4	PRE	86	92	76	33	71.75
Consequence	POST	54	59	71	8	48.00
5	PRE	84	48	80	16	57.00
Collaboration	POST	52	48	76	48	56.00
6	PRE	81	69	60	9	54.75
Refocusing	POST	47	42	42	9	35.00

To determine whether the PRE/POST changes in teacher concerns toward the innovation were statistically significant, a paired sample *t*-test was conducted on the mean group scores for each of the seven stages of concern. Results of this analysis (Table 6) indicate there was no statistical group difference PRE/POST in participants' internal concerns (stages 0 – 3), nor in their external concerns (stages 4-6). Based on analysis of these data, the overall group results would imply that the treatment did not significantly mitigate participants' concerns toward the innovation. Small samples tend to have larger standard deviations. An examination of the standard deviations for PRE/POST treatment in Table 6 indicated that PRE (Stages 3, 5, and 6) SD and POST (Stages 0, 2, 3, and 4) SD were more than the half the corresponding mean percentile scores. When sampling variability is high (i.e., the standard deviation is large, standard error is large) the *t*-test results are affected making statistical significance difficult to demonstrate.

Table 6

Group: Analysis of SoC PRE/POST Treatment

Stages of Concern	Treatment	% $\bar{x}$	SD	SEM	*t*	df	p	Cohen's *d*
0	PRE	80.25	18.25	9.12				
Awareness	POST	53.50	27.00	13.5	2.6015	3	0.0803	1.1608
1	PRE	83.50	11.50	5.75				
Informational	POST	62.75	23.01	11.51	2.2091	3	0.1142	1.1408
2	PRE	79.00	13.83	6.92				
Personal	POST	55.50	39.96	18.48	1.8790	3	0.1569	0.3177
3	PRE	72.50	33.48	16.74				
Management	POST	51.75	35.93	17.96	1.1474	3	0.3344	0.2663
4	PRE	71.75	26.66	13.33				
Consequence	POST	48.00	27.60	13.80	3.6547	3	0.0354*	0.8753
5	PRE	57.00	31.73	15.86				
Collaboration	POST	56.00	13.47	6.73	0.0763	3	0.9440	0.0410
6	PRE	54.75	31.69	15.84	2.6861	3	0.0747	0.7716
Refocusing	POST	35.00	17.49	8.75				

Note: * Statistically significant at the .05 level

However, the analysis did reveal that the PRE mean score for Stage 4 Consequence ($\bar{x}$ = 71.75, SD = 33.48) was statistically higher than the mean score for the POST treatment ($\bar{x}$ = 48.00, SD = 27.6), *t*(3) = 3.6547, p = 0.0354). Since the differences expressed by statistical significance could be due to chance alone and given the small participant sample, the strength of differences between the means an effect size using Cohen's *d* was determined. If the effect size is small, the difference is trivial even if it is statistically significant and the mitigation of group concerns through the treatment would be not a valid conclusion.

The effect size for the statistical difference found in the Stage 4 means was 0.88 (Table 6), which exceeds Cohen's (1988) convention for a large effect ($d = .80$). In addition, both Stage 0 ($t(3) = 206.015$, $p = 0.0803$) and Stage 6 ($t(3) = 2.6861$, $p = 0.0747$) were approaching significance and each with large effect sizes, $d = 1.16$ and $d = 0.77$, respectively. Although Stages 0, 1, and 6 were found to be statistically non-significant ($p > .05$), the effect size for each was large ($d = 1.16$, $d = 1.14$, $d = 0.77$, respectively). A large effect size means that the sample size was not large to yield statistical significance and the treatment may or may not impact participant concerns. The non-significance may be due to chance and/or require further investigation. Additionally, Stages 2 and 3 were also statistically non-significant but with small effect size ($d = 0.32$, $d = 0.23$, respectively).

To gain perspective on the relationship between PRE and POST group concerns, a graphical overlay profile of the data from Table 5 was prepared (Figure 4). The PRE/POST overlay profile indicates that all four internal concerns of the group composite decreased after implementing the innovation (T/E DBL PD) and maintained a similar slope profile as the PRE treatment phase profile. As would be expected with any new innovation, the PRE profile reflected a typical high level of internal concerns and lower level of external concerns. The expectation in this study was that after treatment internal concerns would drop while external concerns would elevate. However, the POST group profile in Figure 4 is atypical in showing no relative changes between levels of internal or external concerns.

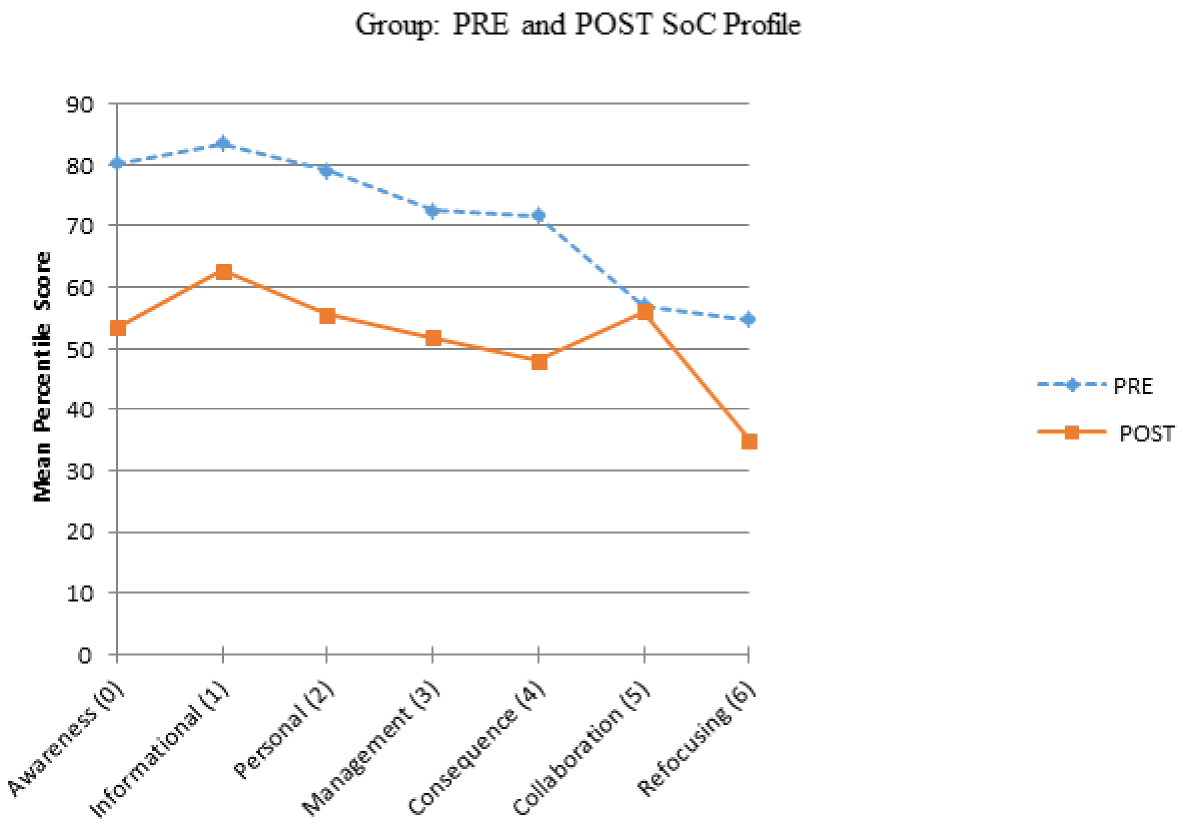


Figure 4. Group: PRE/POST Composite SoC Profile

Recognizing the sample size in this study was extremely small, finding there was not a typical SoC group effect was not unexpected. Given the results of the group data analysis, the profile generated did not exhibit the typical SoC profile pattern, and therefore, was not particularly useful for the purpose of the study. In light of this and given the case study approach is being used to guide this research, generating individual participant profiles may prove to better demonstrate the influence of the T/E DBL treatment. Hence, a qualitative examination of each participant PRE/ POST data was conducted to generate individual profiles and discern any changes in internal and/or external concerns post intervention. Quantitative data analysis was used to generate the profile.

Individual PRE/POST SoC Profile Comparison: Participant A. With one exception, the POST treatment profile for Participant A (Figure 5) illustrates that three of the four internal concerns decreased after treatment (employing the T/E DBL PD). Management was the one exception to this pattern and displayed a slight increase after treatment occurred. External concerns were uncharacteristically high at the PRE phase of the profile, but significantly decrease POST treatment. More in line with SoC expectations, the POST treatment profile for Participant A reflected a typical mitigation of internal concerns and a concurrent elevated level of external concerns.

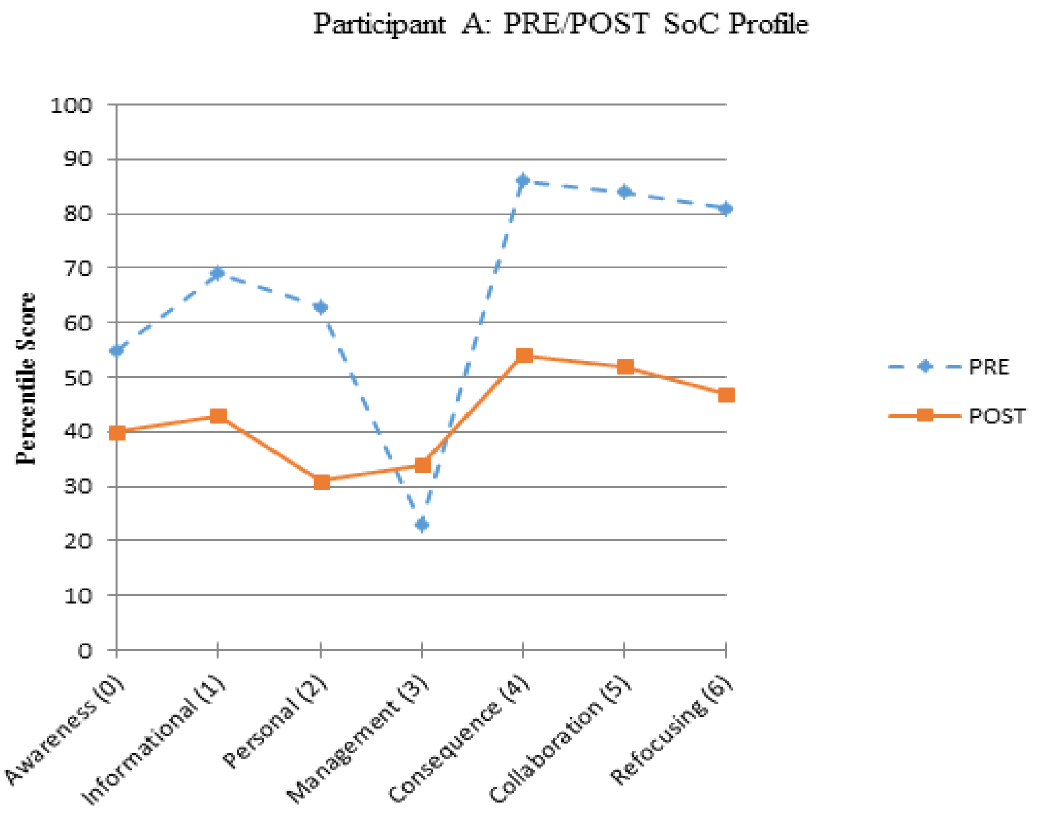


Figure 5. Participant A: PRE/POST Composite SoC Profile

Individual PRE/POST SoC Profile Comparison: Participant B. The SoC graphical overlay profile for Participant B (Fig. 6) revealed extremely high PRE treatment internal concerns. Furthermore, percentile scores in the Awareness and Management stages were both higher than the Informational and Personal stages during the PRE treatment phase. This relationship was also exhibited in the POST treatment profile. Interestingly for Participant B, all internal concerns were also extremely high POST phase. This was not the case for external concerns PRE/POST, and more important the external concerns remained lower than internal concerns for the PRE and POST phases. The SoC composite profile for Participant B was not a typical profile and corroboration with other collected data will be conducted to provide an explanation of these results.

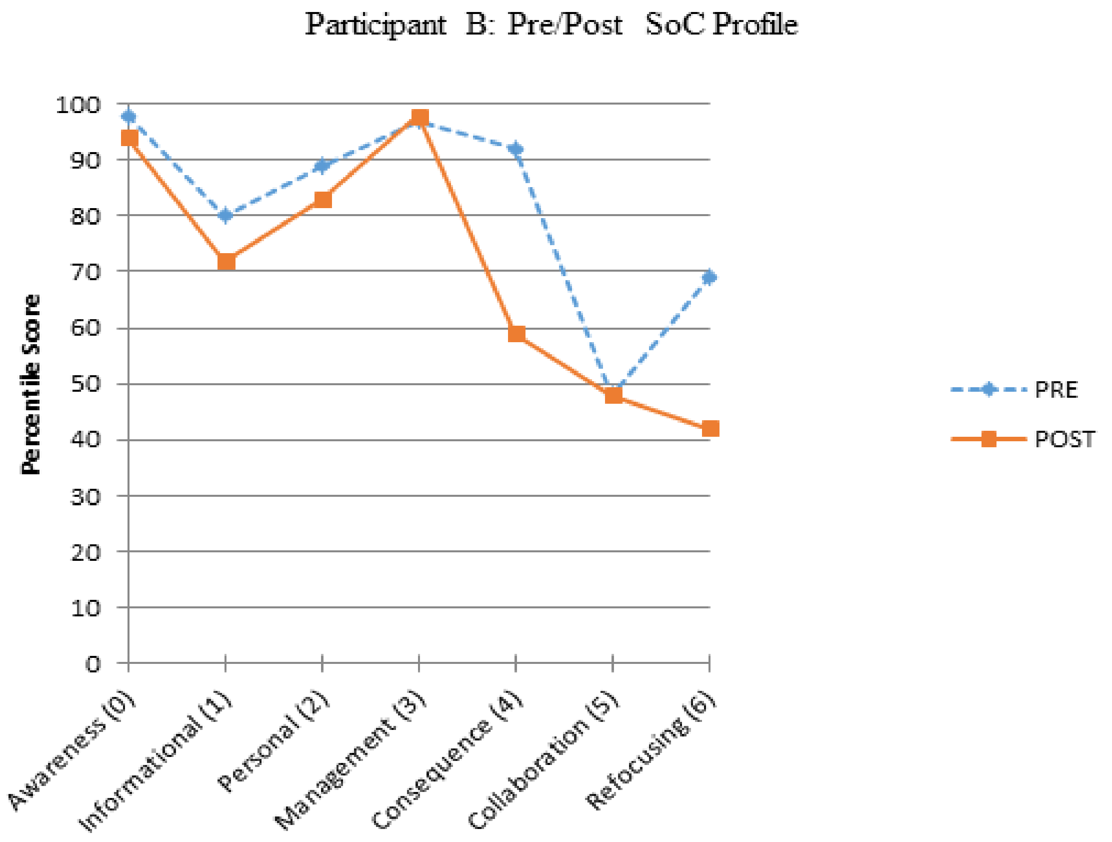


Figure 6. Participant B: PRE/POST SoC Profile

Individual PRE/POST SoC Profile Comparison: Participant C. Though very high, the PRE treatment profile for Participant C (Fig. 7) reflects a typical SoC profile prior to implementation of an innovation (T/E DBL PD); i.e., higher internal concerns and lower external concerns. Comparing the PRE/POST internal concerns portions of the profile, Awareness and Management percentile scores dropped significantly in a typical SoC fashion. However, Informational and Personal percentile scores remained uncharacteristically high. In contrast, the slope of the PRE/POST external concerns profiles were similarly high, with POST being slightly lower than PRE. As such to some degree the POST external concerns show a trend toward being typically higher than the internal concerns following treatment.

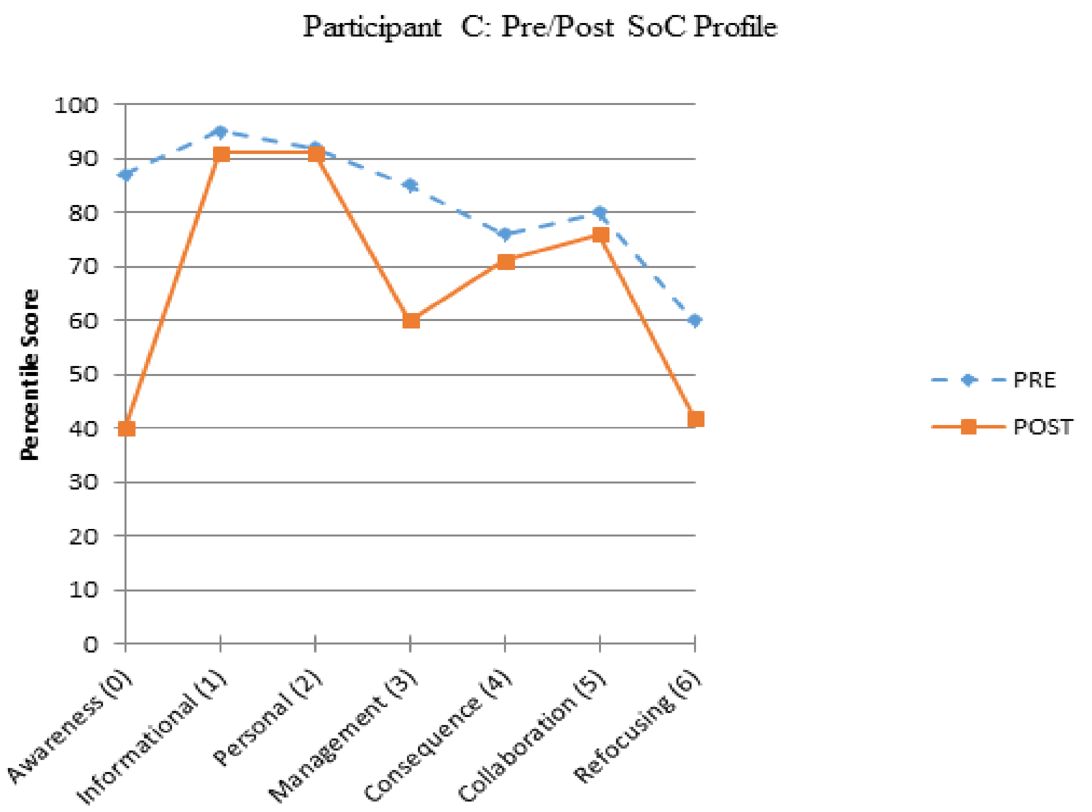


Figure 7. Participant C: PRE/POST SoC Profile

Individual PRE/POST SoC Profile Comparison: Participant D. The PRE treatment profile for Participant D (Fig. 8) reflects a typical high level of internal concerns coupled with a lower level of external concerns. The SoC PRE/POST overlay profile for Participant D showed that all four internal concerns decreased significantly after employing the T/E DBL PD. However, with the exception of an increase concern for Collaboration, the POST treatment profiled revealed decreases in external concerns for both the Consequence and Refocusing stages, As a result, the POST treatment external concerns profile does not display a typical SoC profile.

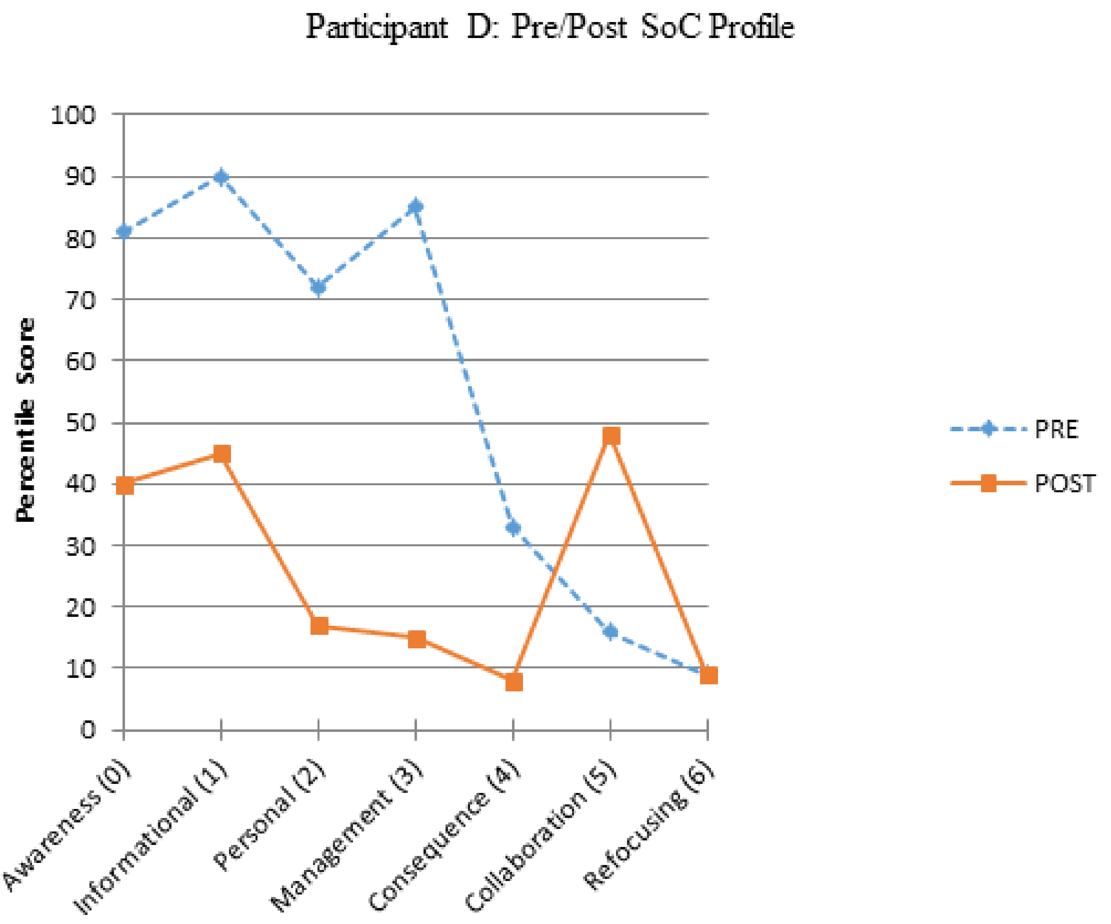


Figure 8. Participant D: PRE/POST SoC Profile

Summary of Findings: Research Question One. Findings revealed similarities between the SoC PRE/POST profiles of Participants A and D and between those of Participants B and C. Specifically, the profiles for Participant A and D show the POST treatment profiles presented a mitigation of internal concerns after employing the innovation (T/E DBL PD). For Participant A, the POST treatment external concerns were higher than the internal concerns, and were more typical of a POST treatment SoC profile. The POST treatment profile for Participant D did not have a typical SoC profile with the two out of three external concerns being lower than the internal concerns.

For both Participants B and C, the external concerns remained consistently lower than internal concerns for both PRE and POST treatment phases. The SoC composite profile for Participant B was not a typical profile with the POST treatment profile most resembling a PRE treatment profile to the extent that all internal concerns were extremely high for both the PRE and POST phases. The SoC profile for Participant C was characteristic of a typical PRE treatment profile where internal concerns were higher than external concerns prior to implementation of the T/E DBL PD. However, external concerns uncharacteristically decreased during POST treatment while two of the four stages of internal concerns remained high.

Research Question Two

The second of three research questions (RQ2) guiding this study asked, "What change in planning of practice toward use of T/E DBL is evidenced in teachers' instructional design" following participation in professional development. Data resulting from the lesson sweeps using the T/E DBL Instructional Change Indicators (ICI) and the T/E DBL Lesson Assessment Rubric (LAR) were analyzed to determined changes in instructional design of participant units to address RQ2. Although both instruments were designed with multiple data categories, only data from the T/E DBL Phase Integrations category of the ICI and the Instructional Design T/E PIRPOSAL Model category of the LAR were needed to address RQ2. The concurrent analyses of data from just these two categories were needed to arrive at a final determination of change in practice toward use of T/E DBL. The remaining categories on the ICI and LAR did not have any bearing on corroborating the integration of T/E DBL phases.

Example calculation. The following example explains the process by which the participant units were scored and analyzed in order to provide feedback to participants during the T/E DBL PD. The data needed from the ICI is found in the DBL Phase Integrations category, as displayed in Figure 9 below. Using the ICI, a sweep of each lesson in the unit resulted in frequency counts for the absence (0) or presence (1) of a given phase integration for T/E DBL. This is demonstrated by the fictitious sample data in Figure 9.

Participant Code:	Unit Title:							Grade Level:		
	Lesson 1		Lesson 2		Lesson 3		Lesson 4		Lesson 5	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
T/E DBL Phase Integrations										
Problem Identification										
Need/Define/Formulation	1									
Ideation										
Criteria/Brainstorm/Generate	1									
Research										
Explore/Investigate/Examine	1									
Potential Solutions										
Analyze/Visualize/Select	1									
Optimization										
Experiment/Revisit/Construct	1									
Solution Evaluation										
Test/Analyze/Retest	0									
Alterations										
Identify/Redesign/Retest	0									
Learned Outcomes										
Process/Iterations/Justify	0									
Total T/E DBL Phase Integrations	5									

Figure 9. ICI T/E DBL Phase Integrations

These frequency counts were recorded in the PRE column for each lesson and the total number of T/E DBL Phase Integrations recorded at the bottom of the column. The PRE column represents the unit prior to revision, while POST indicated the unit following revision. Where Phase Integration is found in a Unit, the LAR was used to determine the level of integration as illustrated by the scoring criteria (Figure 10) in the scoring portion of the LAR.

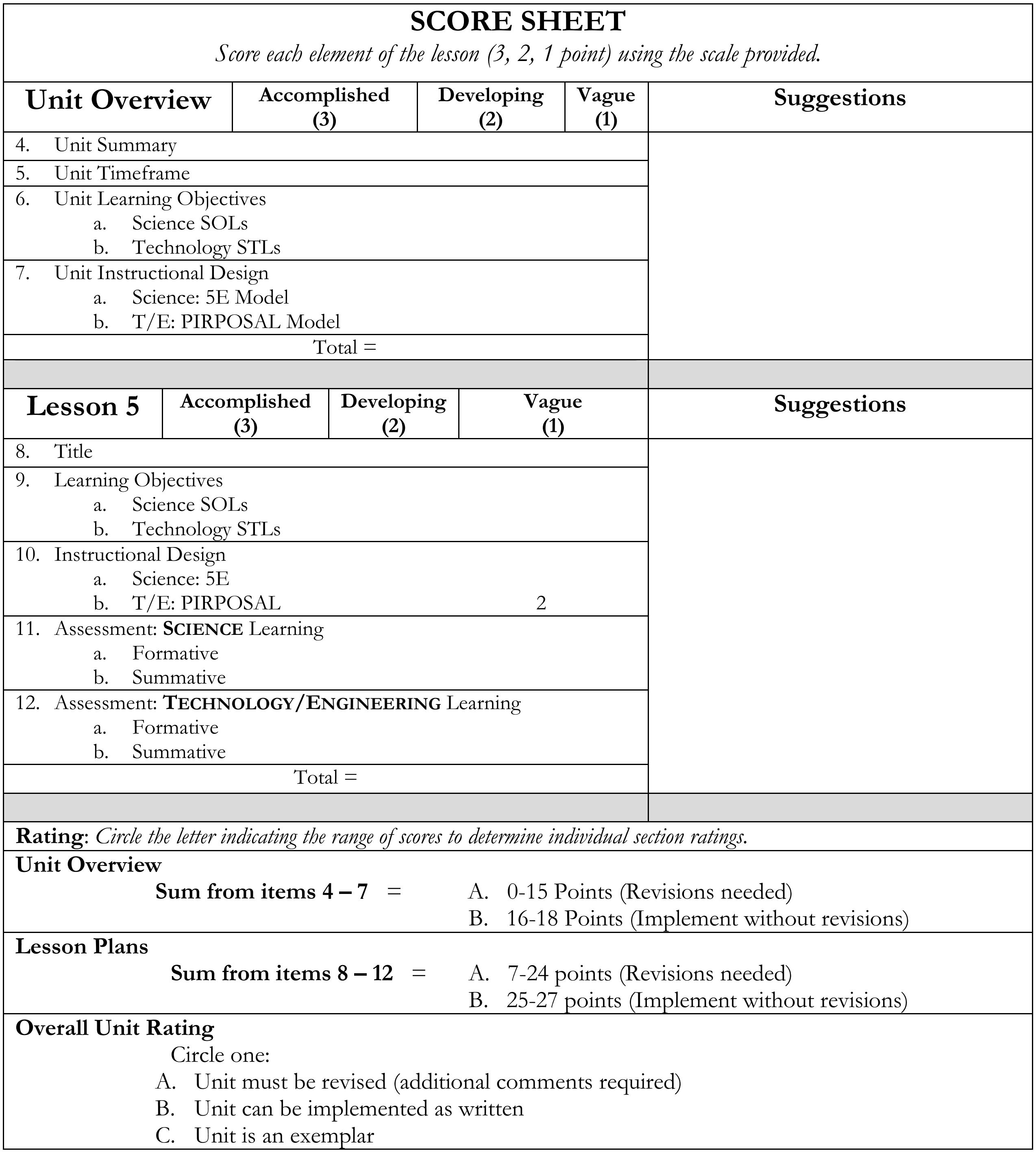
	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Instructional Design			
T/E: PIRPOSAL Model	All eight engagement phases are evident and employed as an integral component of the instructional design. Continuous, active student-centered approach that is fluid and fully integrated in the instructional design, intentionally teaches targeted science content, and promotes convergent and divergent questioning.	A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design. Active student-centered approach that is reflected but not fully integrated in the instructional design, and teaches minimal science content.	None or very few (4 or less) engagement phases are evident and employed as an integral component of the instructional design. Completed, inactive teacher-centered approach.

Figure 10. LAR Scoring Criteria for Instructional Design: T/E PIRPOSAL Model Category

The ICI frequency counts were used in concert with the scores from the LAR. For example, using the sample data from Figure 9, a total frequency count of 5 on the ICI for T/E DBL Phase Integrations indicated the lesson fell into the rubric category of “Developing” (Figure 10) because it fit the criteria of “a preponderance of engagement phases are evident”. This categorization of “Developing” resulted in a score of 2 points.

Figure 11 displays a segment of the LAR score sheet used in scoring the Unit Overview and Lessons 1 through 5. Using the LAR score sheet, the score determined using the rubric categories in Figure 10 (Developing, 2 points) was recorded in the corresponding category, which is cell 10 line b of Lesson 5 (Figure 11). Though not shown in the example, the scores for the other categories of the Unit Overview and Lessons 1 through 4 were also ascertained by this method and recorded on the LAR score sheet. Suggestions for improvement based on the LAR categories and T/E DBL phase integrations descriptions were also included. For the Unit Overview, the scores for items 4-7 were summed to determine the rating of the section. A score that fell in the range of scores 0-15 denoted that the Unit Overview needed revisions or if the score fell in the range of scores 16-18, the Unit Overview could be implemented without any revisions.

The rating for each lesson was established by summing items 8-12 and using the rating scale for Lesson Plans. Revisions to the lesson were needed if the score fell in the range of scores 7-24. However, the lesson could be implemented without revisions if the score fell in the range of scores 25-27.



SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit Overview	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
4. Unit Summary				
5. Unit Timeframe				
6. Unit Learning Objectives a. Science SOLs b. Technology STLs				
7. Unit Instructional Design a. Science: 5E Model b. T/E: PIRPOSAL Model				
Total =				

Lesson 5	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Rating: *Circle the letter indicating the range of scores to determine individual section ratings.*

Unit Overview

Sum from items 4 – 7 =
A. 0-15 Points (Revisions needed)
B. 16-18 Points (Implement without revisions)

Lesson Plans

Sum from items 8 – 12 =
A. 7-24 points (Revisions needed)
B. 25-27 points (Implement without revisions)

Overall Unit Rating

Circle one:
A. Unit must be revised (additional comments required)
B. Unit can be implemented as written
C. Unit is an exemplar

Figure 11. Example of LAR Score Sheet

In Phase 1 of the study (pre-treatment) participants submitted a unit they previously used (Unit 1 Initial) to teach the targeted SOL. Unit 1 Initial was analyzed using the ICI and LAR. In Phase 2 of the study participants attended the first professional development session (PD1).

Upon conclusion of this session participants were asked to revise their Unit 1 Initial to include at least five lessons and submit as their Unit 1 Revised for re-analysis. The Unit 1 Revised from each participant was again analyzed using both the ICI and LAR. At the second PD session (PD2) participants received a copy of the LAR analysis of their Unit 1 Revised which included suggestions for improvement. Building on this feedback participants were asked to design and submit a second unit of their choice that addressed a science concept identified as a weakness on the Virginia Standards of Learning Test.

Participants' initial draft of Unit 2 (Unit 2 Initial) was analyzed using the ICI and LAR, and then returned to the participant prior to its use for discussion during the third PD session (PD3). During PD3, participants revised their Unit 2 Initial which they were to later implement in the classroom. Both during and after the classroom implementation, participants were allowed to continue making revisions to their Unit. At the conclusion of classroom implementation, participants submitted their final version of Unit 2 (Unit 2 Revised) for analysis. Results of the ICI and the LAR analyses for each participant are located in Appendix L.

Based on the scores from the ICI and LAR and submission of Units 1 and 2 (initial and revised), comparisons of practice data could be conducted. Tables 7 through 10 display Unit 1 and Unit 2 comparison data for each participant using the Percent of Phase Integration as determined by ICI frequency counts for the T/E DBL Phase Integrations category. For example, in Table 7 the 1/8 = 12% denotes that only one T/E DBL phase was integrated out of a possible eight phases, therefore yielding 12% phase integration. The Level of Integration as ascertained by LAR scores for the Instructional Design T/E PIRPOSAL Model category was represented by the V for Vague, D for Developing, and A for Accomplished. Furthermore, because each of these categories represented a range of phases: V (0-4), D (5-7), and A (8), the actual number of

T/E DBL phases the participant used was written in parentheses following the letter notation; e.g., V (1 phase). Recording the actual number of phases used in each lesson was critical for determining any changes in practice as reflected by the increased integration of T/E DBL phases.

Participant A: Unit Analyses.

Comparison: Unit 1 Initial vs. Unit 1 Revised. For Participant A, the number of lessons increased from 1 in Unit 1 Initial to 5 in Unit 1 Revised with a slight increase in the level of T/E DBL Phase Integrations across the five lessons. Revision of Unit 1 showed an increase of integration of phases across the lessons with Lesson 5 exhibiting the greatest level of phase integration. Lessons 1 through 4 of Unit 1 Revised employed 0% -12% phase integration after the T/E DBL PD, but Participant A integrated five T/E DBL phases (62%) into Lesson 5 based on the suggestions provided as a result of the analysis of Unit 1 Initial.

Table 7

Participant A: Comparison of Unit 1 and Unit 2

	Participant A			
	Unit 1		Unit 2	
	Initial	Revised	Initial	Revised
Lesson 1				
% of Phase Integration	1/8 = 12%	0/8 = 0%	2/8 = 25%	2/8 = 25%
Level of Integration	V (1 phase)	V (0 phases)	V (2 phases)	V (2 phases)
*Lesson 2				
% of Phase Integration	Ø	1/8 = 12%	4/8 = 50%	5/8 = 62%
Level of Integration	Ø	V (1 phase)	V (4 phases)	D (5 phases)
*Lesson 3				
% of Phase Integration	Ø	1/8 = 12%	4/8 = 50%	4/8 = 50%
Level of Integration	Ø	V (1 phase)	V (4 phases)	V (4 phases)
*Lesson 4				
% of Phase Integration	Ø	1/8 = 12%	7/8 = 88%	7/8 = 88%
Level of Integration	Ø	V (1 phase)	D (7 phases)	D (7 phases)

(continued)

Table 7 Continued

Participant A				
	Unit 1		Unit 2	
	Initial	Revised	Initial	Revised
*Lesson 5				
% of Phase Integration	Ø	5/8 = 62%	7/8 = 88%	7/8 = 88%
Level of Integration	Ø	D (5 phases)	D (7 phases)	D (7 phases)

*no lesson; V = vague, D = developing, A= accomplishment

Comparison: Unit 1 Revised vs. Unit 2 Initial. The use of T/E DBL Phase Integrations by Participant A expanded in Unit 2 Initial when compared to Unit 1 Revised as indicated by the increase in Percentage of Phase Integration and the Level of Integration. The Level of Integration in Lessons 1 through 3 reflected the same LAR score (V) in Units 1 Revised and Unit 2 Initial, however, the number of T/E DBL phases used increased from zero to two in Lesson 1 (25% gain) and from one to four in Lessons 2 and 3 (38% gain). The Level of Integration used in Unit 1 Revised, Lesson 4 expanded from one phase to seven phases (76% gain) in Unit 2 Initial. An increase in the Level of Integration in Lesson 5 Unit 2 Initial (seven phases) from Unit 1 Revised (five phases) was evident even though the LAR score (D) remained the same.

Comparison: Unit 2 Initial vs. Unit 2 Revised. The Level of Integration for Unit 2 Revised remained the same as Unit 2 Initial with the exception of Lesson 2. The number of phases used in Lesson 2 increased from four phases to five phases, a gain of 12% phase integration. Suggestions given by the researcher for increasing phase integrations across Unit 2 Initial Lessons 1, and 3-5 were not incorporated in Unit 2 Revised.

Summary of Unit 1 Initial and Unit 2 Revised Comparison. In comparing Unit 1 Initial with Unit 2 Revised across the T/E DBL treatment, Participant A expanded on the use of T/E DBL engagement phases from 0% in Unit 1 Initial, Lesson 1 to 25% in Unit 2 Revised, Lesson 1. In addition, the number of lessons in Unit 2 Revised grew to five with Lesson 2 including five phases (62%), Lesson 3 including four phases (50%), and Lessons 4 and 5 including seven phases (88%) of engagement.

Participant B: Unit Analyses.

Comparison: Unit 1 Revised vs. Unit 1 Initial. As displayed in Table 8, Unit 1 Initial for Participant B included four lessons with Lesson 4 utilizing five phases (62%) of the T/E DBL PIRPOSAL model. Unit 1 Revised expanded to five lessons and included additional Levels of Integration in Lessons 2 through 5. Lesson 3 increased from zero phases in Unit 1 Initial to include two phases in Unit 1 Revised while the Level of Integration in Lesson 4 remained unchanged with five phases (62%). Suggestions were made by the researcher to introduce the challenge during Lesson 1 and integrate more engagement phases into each lesson.

Table 8

Participant B: Comparison of Unit 1 and Unit 2

	Participant B			
	Unit 1		Unit 2	
	Initial	Revised	Initial	Revised
Lesson 1				
% of Phase Integration	0/8 = 0%	0/8 = 0%	1/8 = 12%	5/8 = 62%
Level of Integration	V (0 phases)	V (0 phases)	V (1 phase)	D (5 phases)
Lesson 2				
% of Phase Integration	0/8 = 0%	0/8 = 0%	2/8 = 25%	5/8 = 62%
Level of Integration	V (0 phases)	V (0 phases)	V (2 phases)	D (5 phases)
Lesson 3				
% of Phase Integration	0/8 = 0%	2/8 = 25%	1/8 = 12%	5/8 = 62%
Level of Integration	V (0 phases)	V (2 phases)	V (1 phases)	D (5 phases)
Lesson 4				
% of Phase Integration	5/8 = 62%	5/8 = 62%	4/8 = 50%	6/8 = 75%
Level of Integration	D (5 phases)	D (5 phases)	V (4 phases)	D (6 phases)
*Lesson 5				
% of Phase Integration	Ø	1/8 = 12%	0/8 = 0%	8/8 = 100%
Level of Integration	Ø	V (1 phase)	V (0 phases)	A (8 phases)

*no lesson; V = vague, D = developing, A= accomplishment

Comparison: Unit 2 Initial vs. Unit 1 Revised. When comparing Unit 1 Revised with Unit 2 Initial, increases were seen in the Level of Integration for Lessons 1 and 2 from zero phases to one phase and from zero phases to two phases, respectively, but were not reflected by the LAR scores (V). However, three lessons exhibited a decrease in the Level of Integration used with Lesson 3 dropping from two phases to one phase, Lesson 4 falling from five phases to four phases, and Lesson 5 declining from one phase to zero phases. The LAR scores for Lesson 3 and 4 did not capture this change as both were indicated by “V”. Again, suggestions were made to introduce the design challenge in Lesson 1 and to include more T/E DBL engagement phases into all lessons.

Comparison: Unit 2 Initial vs. Unit 2 Revised. A revision of Unit 2 yielded an increase in Level of Integration across all lessons. Lessons 1 through 3 displayed a 62% phase integration with five T/E DBL engagement phases included in each lesson, an increase from one phase in Lesson 1, two phases in Lesson 2, and one phase in Lesson 3 for Unit 2 Initial. The level of phase integration also increased in Lesson 4 from four engagement phases used to six phases. The largest gain in Level of Integration use was seen in Lesson 5 with inclusion of all eight engagement phases (100%).

Summary of Unit 1 Initial and Unit 2 Revised Comparison. When comparing Lessons 1 through 4 of Unit 1 Initial with Unit 2 Revised, an increase in the usage of T/E DBL engagement phases was seen across all lessons. Lessons 1 to 3 increased from zero phases to five phases and Lesson 4 increased from five phases to six phases.

Participant C: Unit Analyses.

Comparison: Unit 1 Initial vs. Unit 1 Revised. Participant C created only one Lesson for Unit 1 Initial which did not include any T/E DBL phases of engagement (Table 9). A revision of

Unit 1 yielded an increase in the Level of Integration by 12% (one phase), but the change was not reflected in the LAR score (V).

Table 9

Participant C: Comparison of Unit 1 and Unit 2

Participant C				
	Unit 1		Unit 2	
	Initial	Revised	Initial	Revised
Lesson 1				
% of Phase Integration	0/8 = 0%	1/8 = 12%	1/8 = 12%	5/8 = 62%
Level of Integration	V (0 phases)	V (1 phase)	V (1 phase)	D (5 phases)
*Lesson 2				
% of Phase Integration	Ø	2/8 = 25%	2/8 = 25%	5/8 = 62%
Level of Integration	Ø	V (2 phases)	V (2 phases)	D (5 phases)
*Lesson 3				
% of Phase Integration	Ø	3/8 = 38%	3/8 = 38%	5/8 = 62%
Level of Integration	Ø	V (3 phases)	V (3 phases)	D (5 phases)
*Lesson 4				
% of Phase Integration	Ø	5/8 = 62%	5/8 = 62%	8/8 = 100%
Level of Integration	Ø	D (5 phases)	D (5 phases)	A (8 phases)
*Lesson 5				
% of Phase Integration	Ø	1/8 = 12%	8/8 = 100%	8/8 = 100%
Level of Integration	Ø	V (1 phase)	A (8 phases)	A (8 phases)

*no lesson; V = vague, D = developing, A= accomplishment

Comparison: Unit 1 Revised vs. Unit 2 Initial. When comparing Unit 1 Revised with Unit 2 Initial, the Level of Integration remained consistent for Lessons 1 through 4, but a substantial increase was seen in Lesson 5. The Percent of Phase Integration increase by 88% due to the inclusion of all eight engagement phases. Suggestions for revision included increasing the integration of additional phases for Lessons 1 through 4.

Comparison: Unit 2 Initial vs. Unit 2 Revised. The increase in the use of the T/E DBL engagement phases continued with the revision of Unit 2. Lesson 1 phase integrations increased from one phase to five phases, Lesson 2 increased from two phases to five phases, and Lesson 3 increased from three to five phases. The integration of engagement phases also increased in Lesson 4 from five phases to include all eight phases. Lesson 5 remained consistent across Unit 1 Initial and Unit 2 Revised.

Summary of Unit 1 Initial and Unit 2 Revised Comparison. In comparison across the T/E DBL treatment, Participant C included only Lesson 1 in Unit 1 Initial while five lessons were incorporated into Unit 2 Revised. Participant C expanded on the use of T/E DBL engagement phases from 0% phase integration in Unit 1 Initial, Lesson 1 to 62% phase integration (5 phases) in Unit 2 Revised, Lesson 1.

Participant D: Unit Analyses.

Comparison: Unit 1 Initial vs. Unit 1 Revised. Unit I Initial created by Participant D was comprised of five lessons that included the use one T/E DBL engagement phase for each lesson (Table 10). Upon revision of Unit 1 (Unit 1 Revised), the Level of Integration increase across all lessons, even though the LAR score (V) did not reflect this increase. Lesson 1 increased from the integration of one to two phases of engagement, Lesson 2 increased from one to three phases, and Lesson 3 increased from one to four phases. Lesson 4 exhibited a rise in the Level of Integration from one phase to five phases while Lesson 5 increased from one phase to employing all eight phases of T/E DBL engagement.

Table 10

Participant D: Comparison of Unit 1 and Unit 2

	Participant D			
	Unit 1		Unit 2	
	Initial	Revised	Initial	Revised
Lesson 1				
% of Phase Integration	1/8 = 12%	2/8 = 25%	5/8 = 62%	5/8 = 62%
Level of Integration	V (1 phase)	V (2 phases)	D (5 phases)	D (5 phases)

(continued)

Table 10 Continued

Participant D				
	Unit 1		Unit 2	
	Initial	Revised	Initial	Revised
Lesson 2				
% of Phase Integration	1/8 = 12%	3/8 = 38%	5/8 = 62%	5/8 = 62%
Level of Integration	V (1 phase)	V (3 phases)	D (5 phases)	D (5 phases)
Lesson 3				
% of Phase Integration	1/8 = 12%	4/8 = 50%	6/8 = 75%	8/8 = 100%
Level of Integration	V (1 phase)	V (4 phases)	D (6 phases)	A (8 phases)
Lesson 4				
% of Phase Integration	1/8 = 12%	5/8 = 62%	7/8 = 88%	8/8 = 100%
Level of Integration	V (1 phase)	D (5 phases)	D (7 phases)	A (8 phases)
Lesson 5				
% of Phase Integration	1/8 = 12%	8/8 = 100%	8/8 = 100%	8/8 = 100%
Level of Integration	V (1 phase)	A (8 phases)	A (8 phases)	A (8 phases)

V = vague, D = developing, A= accomplishment

Comparison: Unit 1 Revised vs. Unit 2 Initial. Participant D continued to increase the level of phase integration with the design of Unit 2 Initial. An increase in the Level of Integration was exhibited across all Lessons with the exception of Lesson 5 which remained at eight phases. The Level of Integration for Lesson 1 increased from two phases in Unit 1 Revised to five phases in Unit 2 Initial, Lesson 2 increased from three phases to five phases, Lesson 3 increased from four phases to six phases, and Lesson 4 increased from five phases to seven phases.

Comparison: Unit 2 Initial vs. Unit 2 Revised. For Unit 2 Revised, the Level of Integration increased for Lesson 3 from six phases to eight. The Level of Integration for Lesson 4 also increased from seven phases to include all eight phases of engagement. Lessons 1, 2, and 5 remained constant from Unit 2 Initial to Unit 2 Revised.

Summary of Unit 1 Initial and Unit 2 Revised Comparison. In comparing Unit 1 Initial to Unit 2 Revised across the implementation of the T/E DBL treatment, Participant D progressed from integrating only one engagement phase across all five lessons in Unit 1 Initial to incorporating five phases in Lessons 1 and 2 and all eight phases in Lessons 3 through 5 of Unit 2 Revised. The percent of phase integration for Lessons 1 and 2 was 62% while Lessons 3 through 5 exhibited 100% phase integration.

Research Question Two Summary Findings. The units developed/revised by all participants consistently increased in the percent of phase integration and level of engagement across both units. Prior to treatment, two participants integrated at least one T/E DBL phase engagement in one lesson of the initial draft of Unit 1. Additionally, one participant included five phases integrations into a lesson and one participant did not include any phase integrations in Unit 1 Initial. By the conclusion of the T/E DBL PD, all four participants had integrated five or more engagement phases (≥ 62%) in at least three lessons in Unit 2 Revised while three participants incorporated all eight phases (100%) in two or more Unit 2 Revised lessons. The results showed a range of 25% to 100% for percent of phase integration after treatment.

Research Question Three

The third research question (RQ3) of this study asked, “To what extent do teachers feel their understanding of the targeted science concepts was positively impacted” following participation in professional development. Data results used to inform this question were collected from two sources, the Understanding of a Virginia Science Standard of Learning (SOL) Questionnaire and the Post Treatment Interview. Participants completed the Understanding of a Virginia Science Standard of Learning Questionnaire before and after the implementation of the T/E DBL PD.

Participant PRE/POST Understanding SOL Questionnaire. To address this question the Understanding of a Virginia Science Standard of Learning Questionnaire was used to assess participants' understanding of the targeted science concept, "*identify possible impacts of human activity on the ecosystem"*, based on responses to the following survey questions:

1. How well do you understand the SOL stated above?
2. How well do you understand the instructional requirements for teaching the science content in this SOL?
3. How well do you understand the science concept in this SOL that students are expected to demonstrate?

The data generated from participant responses on the seven-point Likert scale from the pre- and post-tests Understanding of a Virginia Science Standard of Learning Questionnaire were analyzed using descriptive and inferential statistics. Group means scores were calculated to determine an increase or decrease in the understanding of the Virginia science SOL. The questionnaire was administered before the T/E DBL PD treatment began and then again eight weeks later at the conclusion of treatment.

The scores for all three questions indicated that the level of understanding increased for Participants A and D over the course of the treatment (Table 11). And although the scores of Question 1 remained static for Participants B and C, their scores on Questions 2 and 3 increased, thus, denoting an increase in the level of understanding of instructional requirements and student performance of the Virginia science SOL. The mean scores for the group increased across all three questions PRE/POST treatment.

Table 11

Group Mean Scores for the Understanding of a VA Science SOL Questionnaire

Question	Treatment	Participant Score				Mean Score $\bar{x}$
		A	B	C	D	
1	PRE	4	6	7	5	5.50

(continued)

Table 11 Continued

Question	Treatment	Participant Score				Mean Score $\bar{x}$
		A	B	C	D	
1	POST	6	6	7	6	6.25
	PRE	4	3	5	4	4.00
2	POST	6	5	6	6	5.75
3	PRE	4	5	5	3	4.25
	POST	6	6	6	6	6.00

A paired *t*-test was conducted to compare group means of the pre- and post- tests and determine if the difference between these means was statistically significant. Results from survey data analysis for the group of four participants (Table 12) indicated that the paired sample *t*-test for Question 1 was found to be not statistically significant. This result indicated the degree to which participants understood the SOL was not enough to be statistically significant. However, there were statistically significant differences in (a) their understanding of the instructional requirements for teaching the science content and (b) how the students are to demonstrate the science concept in the SOL. The effect size for each of these analyses ($d = 2.13$ and $d = 2.3$, respectively) was found to exceed Cohen's (1988) convention for a large effect ($d = .80$). Though a difference in PRE/POST for Question 1 was not found to be statistically significant ($p > .05$), the effect size was large ($d = .77$) and indicative of a small sample size. The complete set of individual participant results of Understanding of a Virginia Science Standard of Learning Questionnaire ratings are found in Appendix M. As with the SoC data, "group comparisons" may not be the best reflection of the PD impact. Therefore calculating individual participant changes would provide a more accurate indicator, and be more in line with Case Study methodology.

Table 12

Group: Analysis of Understanding of a VA Science SOL Questionnaire PRE/POST Treatment

Question	Treatment	$\bar{x}$	SD	SEM	*t*	df	p	Cohen's *d*
1	PRE POST	5.50 6.25	1.29 0.50	0.65 0.25	1.5667	3	0.2152	0.7666
2	PRE POST	4.00 5.75	0.82 0.50	0.41 0.25	7.0000	3	0.0060*	2.1341
3	PRE POST	4.25 6.00	0.96 0.48	0.00 0.00	3.6556	3	0.0354*	2.3058

Note: * Statistically significant at the .05 level

Individual participant responses from the POST Treatment Interview provided in the next section serves to corroborate treatment impact.

POST Treatment Interview. The interview questions for the POST Treatment Interview were purposefully designed to address the survey items on the Understanding of a Virginia Science Standards of Learning Questionnaire. The interview questions examined the rationale for rating choice to the three questions and probe for motivation and understanding of the participant selection. The interviews were accomplished by phone within three days after participants completed the Questionnaire and lasted approximately 20 to 30 minutes. Following the Post Interview Protocol (Appendix G), participant responses were a result of three interview prompts designed to better determine the extent participants felt their understanding of the targeted science concept (*identify possible impacts of human activity on the ecosystem*) was positively impacted. Their responses to the following questions were electronically recorded on a computer:

1. Why did you chose to rate yourself at (#) for your understanding of this SOL?
2. Why did you chose to rate yourself at (#) for your understanding of the instructional requirements for teaching the science content in this SOL?

3. Why did you chose to rate yourself at (#) for your understanding of the science concept in this SOL that students are expected to demonstrate?

The (#) symbol was replaced by the participants' rating choice on the POST treatment Understanding of a Virginia Science Standards of Learning Questionnaire. Using a transcription kit, participant responses were transcribed to print and thematically analyzed. Theme analysis was used to identify, analyze, and report patterns that emerged within the collected data. Theme analysis involved the researcher identifying the unique phrases that were uttered by each participant that would explain their rating choices and also corroborate other participant findings of the study. In addition, patterns across the group were identified to recognize like phenomena in the interviews.

Participant A: POST Treatment Interview. When asked about her rating choice for Question 1, Participant A stated that she understood the science SOL very well because of her background as a master naturalist. However, she did reveal that on the PRE treatment questionnaire she rated herself lower due to nervousness about the PD and "how all of this was going to work" for her and her students. Recognizing that "T/E DBL is much better suited" as an instructional strategy than a PBL, Participant A confirmed that she better understood what was needed to teach the science concept/SOL after the PD sessions.

"Design based learning helped me design this unit better because it gave me a structure to follow where I can know where to use certain strategies, where to introduce the challenge, and connect everything together," declared Participant A. This line of thinking continued when asked about her understanding of students demonstrating the science concept. "If I teach it, I want to be able to assess it and DBL allows me to do this in such a way that really means something to the students," stated Participant A. She maintained that students could self-assess, had more of a framework for the concept, and were more in charge of their learning when presented with a problem and asked to produce a solution/product.

Participant B: POST Treatment Interview. Participant B "pretty much felt" she knew the differences between impacts of human activity and what would be considered impacts of nature when asked about her understanding of the SOL before she participated in the PD sessions. When the question about her understanding of the instructional requirement for teaching the science content was posed, Participant A asserted that it was difficult to connect the fourth grade living systems SOL with this fifth grade SOL and how she wanted to teach it, but after the sessions she "can see how it fits into how I wanted to teach it." Participant B also shared how difficult it was to "move away from the way of teaching" that she had always used in the classroom and that this strategy was a way to accomplish both.

Participant B went on to say that she just received notification that after 12 years of teaching, she may lose her job due to low SOL test results. She stated that "there are such better ways to teach kids, just like this way, but your hands are tied." Participant B continued that she "liked doing science this way, making it meaningful to learn." She would "like to participate in more PD sessions and learn more about the nuts and bolts of all of this over a much longer time." Participant B affirmed that she had a much better idea of how she wanted her students to demonstrate the science concept and how to make that assessment meaningful. She contended that "the design challenge provides the perfect platform for doing just that…and I know what that [student performance] should look like when I evaluate it."

Participant C: POST Treatment Interview. Prior to T/E DBL PD, Participant C felt she understood the SOL "pretty well" or at least she thought she did, but after the PD session, she "looked at this in a whole new light…a new way of teaching this SOL" to her students that made “more sense to teach it that way." Participant C stated that as a result, she probably scored the questions on both PRE and POST treatment Questionnaire with the same rating because of this way of thinking.

Participant C disclosed that she has not been including enough science in teaching this SOL and that she did not have a lot of experience teaching science. She attributed her increase in understanding the instructional requirements to the introduction of the “design challenge and structure of putting together a unit and lessons.” Participant C stated that the template helped her include science concepts in the design challenge in a way that was meaningful for her students. “I was able to cram in a lot of science, not just that SOL, but several others and also a great deal of math.” She asserted that her students did not have to learn ideas/concepts that were disjointed with her trying to make the connections. Instead, students were able to make the connections for themselves because of the relevancy of the ideas/concepts to the design challenge.

When asked about her understanding of the science concept in the SOL that students are expected to demonstrate, Participant C maintained that by “using a unit that is designed with a challenge gives a real purpose to learning the science where before the purpose was to cover the material and move on.” She continued by saying that she really understood what she wanted the students to demonstrate now as opposed to before her participation in the PD sessions. She wanted the students to use science to explore and pose solutions to a design challenge and be able to discuss their process.

Participant D: POST Treatment Interview. Participant D confessed her lack of understanding of the science concept in the SOL and her struggles with understanding human impact on the ecosystem. However, she went on to say that through her participation in the activities of the PD sessions—the DBL learning, the design challenge, the experimentation, the research—she understood the SOL completely. When questioned about the instructional requirements for teaching the science concept in the SOL, Participant D ascertained that if a teacher does not understand the content, then the teacher cannot teach it. “Instructionally, I really didn’t have a way to teach that specific SOL and I felt like after the PD I could.”

She also stated that she should have rated herself lower on PRE treatment Question 1 because now she has discovered that she really did not understand the SOL. Participant D also expressed her affinity for the model used during the PD sessions as it “provided concrete steps to follow in order to address the science content”, and involved students in their own learning. Finally when asked about student demonstration of the science concept in the SOL, Participant D revealed that before participating in the PD treatment, she “handled the SOL by just reading it in a book” and this hands-on way allowed students to use critical thinking skills. Students were able to actually demonstrate to her that they understood the science concept, apply it, and talk about the concept with others.

Group Analysis: POST Treatment Interview. When comparing PRE treatment rating responses to their POST treatment ratings, three of the four participants felt they had a better understanding of the targeted Virginia SOL, *identify possible impacts of human activity on the ecosystem*, as a result of their participation in the T/E DBL PD sessions. All four participants felt the structure of DBL (i.e., the PIRPOSAL model) introduced and used during the PD sessions provided them with an effective strategy for teaching science.

Three participants stated that DBL encouraged their students to be in charge of their own learning and purposefully connected the science content, whereas before learning about T/E DBL the design of their units/lessons required them to take charge of student learning and make the science content connections for the students. Two participants asserted that T/E DBL PD delivered the science content through an approach that made it meaningful to learn. Three participants maintained that this approach also made student assessment of the science concept more meaningful and relevant.

Summary of Findings

This chapter presented the findings from statistical and corroborative analyses of data collected and organized by case study of Participants A through D. The following section includes a profile for each participant that summarizes treatment impact as indicated by SoC profile, the ICI and LAR analyses, the Understanding of a VA Science Standards of Learning Questionnaire results, and POST Interview data.

Participant A Profile

The data collected for Participant A showed that the drop in internal concerns paralleled the increase in the number of phase integrations and levels of integration. The POST treatment profile for Participant A reflected a typical mitigation of internal concerns and a concurrent elevated level of external concerns. The use of T/E DBL phase integrations and levels of engagement by Participant A increased across both Unit 1 and 2. The Understanding of a VA Science Standard of Learning Questionnaire and POST Interview data indicated an increase in understanding of the SOL, the ability to teach the science concept, and the concept the students were to demonstrate. Participant A attributed her ability to design effective units and lessons to the T/E DBL framework introduced during the PD, which also provided a method for meaningful assessment of student performance.

Participant B Profile

The SoC composite profile for Participant B was not a typical profile, exhibiting extremely high internal concerns and low external concerns for both PRE and POST treatment profiles. The continued high level of concern expressed by Participant B about the innovation at a personal level was corroborated during the interview when she voiced her distress over her students' SOL test scores, the link the scores has to her job performance, and the possibility of job loss. In addition, she indicated that she wanted to learn more about T/E DBL and participate in additional PD sessions.

Even though these concerns remained high throughout the treatment, an increase in the use of T/E DBL engagement phases and levels of engagement was seen across all units and lessons. The Questionnaire and POST Interview showed an increase in participant ability to teach the science concept and an understanding of the science concept the students were to demonstrate. Participant B asserted that the structure of T/E DBL aided in making meaningful connections not only for her students, but also for herself.

Participant C Profile

The Awareness and Management percentile scores of the SoC composite profile dropped significantly in a typical SoC fashion for Participant C after the treatment. However, Informational and Personal percentile scores remained uncharacteristically high which indicated that Participant C was interested in learning more details about T/E DBL and was concerned about the demands of this innovation. In addition, external concerns showed a trend toward being typically higher than the internal concerns.

During the POST Interview Participant C revealed that she did not have a great deal of experience in teaching science, and therefore, did not adequately cover the science concept when teaching this SOL. Furthermore, she was still somewhat concerned about teaching the science through T/E DBL, which corroborated the low Informational and Personal percentile scores. The Questionnaire and POST Interview indicated an increase in ability to teach the science concept which she attributed to the introduction of the T/E DBL model that provided structure for units and lessons. Participant C expanded on the use of T/E DBL engagement phases and levels of engagement across all lessons of Units 1 and 2 which supported an increase in the understanding of the science concept demonstrated by students.

Participant D Profile

The SoC PRE/POST composite profile for Participant D showed that all four internal concerns decreased significantly after employing the T/E DBL PD. However, external concerns were low for Consequence and Refocusing. These low external concerns were supported by data collected during the POST Interview. Participant D indicated that after participating in the T/E DBL PD she felt that the T/E DBL framework provided structure for her students to be in charge of their own learning, allowed students to use critical thinking skills, and provided an authentic method for assessment.

Participant D progressed from integrating only one engagement phase to incorporating all eight phases with a significant increase in levels of engagement across all lessons. Questionnaire and POST Interview data showed an increase in her understanding of the SOL, her ability to teach the science concept, and the concept the students were to demonstrate. Participant D stated that before the PD she lacked understanding of the science concept in the SOL as evidence by her teaching strategy—reading about it in a book. She felt that the T/E DBL PD provided a method for teaching the science concept in the specified SOL and that she understood what was expected of her students.

Conclusions, implications, and recommendations for further research drawn from these findings are discussed in Chapter 5.

CHAPTER FIVE: CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Research Rationale and Purpose

As the literature previously presented in Chapter 1 indicated, the strong connection between science and engineering and the need to teach these subjects in an integrative manner were strongly emphasized in the current science education reforms agenda. However at the elementary level, the lack of science instruction and professional development generated a weakness for both pre- and in-service teachers and prompted elevated concerns about teaching science (Anderson, 2002; Goodrum, Cousins, & Kinnear, 1992).

Research has suggested that one way to address this weakness is through the technological/engineering designed-based approach within the context of integrative STEM education (Lewis, 1999/2006; Wells, 2014). Building on the need for such research, the goal of this study was to provide evidence that professional development on the intentional teaching of targeted science content and practices through the teaching of T/E DBL content and practices supports mitigation of elementary teacher concerns toward teaching science. This chapter begins with a presentation of conclusions drawn from findings, followed by implications for T/E DBL professional development at the elementary level. Chapter 5 closes with recommendations for researchers and practitioners and limitations uncovered through the implementation of the study.

Conclusions

The purpose of the following section is to draw meaning from the findings presented in Chapter 4 and lead to possible extrapolation about their implications in regards to each of the research questions of this study. The section presents the conclusions regarding participants' participation in professional development on implementing T/E DBL as part of teaching elementary science are explained in detail according to the three research questions.

Research Question One

The first research question (RQ1) driving this study asked, “What changes in teacher concerns regarding implementation of T/E DBL are revealed” following targeted professional development. Overall, the consensus data showed a trend toward mitigation of internal concerns following T/E DBL professional development, and therefore can be concluded that the PD did have some positive impact on alleviating concerns.

By examining the interview analysis and demographics of individual participants and determining outside influences, data indicate that the PD had an overall positive impact on mitigating internal concerns than their SoC profile alone would indicate. In the case of Participant B, the pre/post SoC profiles demonstrating consistently high internal concerns, coupled with results of interview data analysis revealing concerns about continued employment, give some justification for elevated internal concerns about the innovation before and after PD. Participant C had only been teaching for five years and had little experience in teaching science, thus the “novice” status of this participant is a variable that likely contributed to the anomaly of high Informational and Personal internal concerns.

Research Question Two

The second research question (RQ2) guiding this study queried, “What change in planning of practice toward use of T/E DBL is evidenced in teachers’ instructional design” following participation in professional development. From an examination of the findings in Chapter 4, the researcher concluded that the PD was effective in changing the participants’ instructional design use of T/E DBL phases of engagement to intentionally teach the targeted science concepts. This is evidenced by the increasing number of T/E DBL phases of engagements used in the revision of Unit 1 and the design and revision of Unit 2 as captured by the sweep instrument.

Additionally, the conclusion is supported by the instructional design change shown through the comparison of PRE and POST unit designs. Participants expanded the number of lessons in the planning of Unit 1 from a few lessons to a more robust five lessons in their revision. This deliberate planning continued in Unit 2 whereby the rubric assessment revealed the participant used a preponderance of T/E DBL engagement phases in each lesson included in the unit.

Research Question Three

The third and final research question (RQ3) of the study asked, “To what extent do teachers feel their understanding of the targeted science concepts was positively impacted” following participation in professional development. Based on the post survey responses and interview data, the conclusion drawn is that T/E DBL PD, as implemented, does have a positive impact on increasing an elementary teachers’ understanding of a targeted science concept students are expected to demonstrate, and belief in their ability to teach the targeted science concept.

In drawing this conclusion it is important to note that although a few participant responses on the Understanding of a VA Science SOL Questionnaire indicated no change in understanding, during post interviews participants explained that they *thought* they understood the target science concepts before participating in the PD. However upon completion of the PD, they realized their understanding of the targeted science concepts was incomplete and that the PD provided the clarification needed to fully understand the science concepts.

Summary

The professional development model investigated through this study was demonstrated to be effective in getting elementary teachers to implement T/E DBL. Data showed that following the PD, participants were better able to integrate T/E DBL when planning and designing instructional units, and demonstrated an improved understanding of the science concepts they were teaching.

Implications

The findings from this research study are based on four case studies, and therefore, is limited to only those participants that were involved in the study. Within these limitations, the conclusions reached regarding the use of T/E DBL as an effective pedagogical approach for elementary science and technology education have specific implications for: (a) in-service professional development providers; (b) pre-service preparation programs; and (c) researchers. Thus, the implications presented in the following section are reflective of the participants of the study.

1. For in-service professional development providers and pre-service preparation programs of science and technology education, the PD model presented in the study has strong potential for affecting a positive change in elementary science teaching practice through T/E DBL. By presenting science in the context of an authentic engineering design challenge using the PIRPOSAL model, teachers are more able to design units that promote higher-order thinking and intentionally teach science within a “need to know” context (Wells, 2014).
2. For researchers of science and technology education, the PD model presents a useful model for producing measureable outcomes of change in elementary science

teaching practice and T/E DBL. The instrumentation used in the study provides several data collection points and serves to corroborate findings.

3. Given the results pertaining to mitigating internal concerns, data suggests that the PD model is effective in identifying concerns teachers may have about implementing T/E DBL. Therefore, in-service professional development providers and pre-service preparation programs can adjust the PD to improve the overall fit of the model tailored to participant needs.
4. The positive impact of the PD on teacher understanding of the targeted science concepts implies the effectiveness of the model when teaching science concepts through T/E DBL to elementary teachers. For in-service professional development providers and pre-service preparation programs, using the PD model not only addresses teacher understanding and teaching of the science content, but also comprehending student performance of the concept.

Recommendations

Based on the findings and implications of this study, the following section presents recommendations for researchers and practitioners regarding the improvement of the teaching of science content and planning of practice through the implementation of technological/engineering design based learning.

Recommendations for Researchers

The following recommendations for further research resulted from the findings and conclusions of this study.

Replication of study. Researchers should replicate this study by incorporating the strategies of the PD model using the same data instruments described in Chapter 3. In order to successfully replicate the study, a multiple case study is essential due to the small sample size. The main drawback from using such a small sample size is the lack of statistical significance and small effect size which would provide higher statistical power.

Challenges do exist with using the data instruments. The scale of the Lesson Assessment Rubric (LAR) is too expansive and does not provide an accurate reflection of a participants' progressive use of T/E DBL engagement phases. Additionally, data is collected on the Instructional Change Indicators and LAR instruments during the course of the treatment that is not used in the final analysis. If modifications to the study and the instruments used therein is desired, recommendations for such follows.

Instructional Change Indicators and Lesson Assessment Rubric. Adjustments to the Unit Instructional Design, T/E: PIRPOSAL Model category on the LAR should be made to better reflect phases of engagement use. The scale of the rubric should be expanded and present a more diverse range: Vague (2 or less engagement phases, 1 point), Developing (3-4 engagement phases, 2 points), Accomplished (5-6 engagement phases, 3 points), and Exemplary (7-8 engagement phases, 4 points). As a result of the adjustment made to the scale on the LAR, the score sheet rating scale should also be revised.

1. Unit Overview: 0-20 points (Revisions needed); 21-24 (Implement without revisions)
2. Lesson Plans: 0-32 points (Revisions needed); 33-36 (Implement without revisions)

To focus solely on T/E DBL, eliminate unnecessary categories on the ICI and LAR and revise the LAR Score Sheet to reflect only the T/E DBL phases of engagement and instructional design. The Lesson Score Sheet should be reduced to Instructional Design, T/E: PIRPOSAL with the following rating scale: Lesson Plans: 1-2 Points (Revisions needed); 3-4 (Implement without revisions). However, be aware that by not including the additional categories and rating scales, the participants may not incorporate the other design elements into their unit or lesson plan.

Understanding the Virginia Science SOL Questionnaire. Reorder the questions on the Understanding the Virginia Science SOL Questionnaire as follows:

1. How well do you understand the SOL stated above?
2. How well do you understand the science concept in this SOL that students are expected to demonstrate?
3. How well do you understand the instructional requirements for teaching the science content in this SOL?

This question order allows the participant to first explore their understanding of student performance of the science concept which prepares him/her to contemplate his/her ability to teach the science content based on that student performance.

Classroom observations. Although not a part of this study, classroom observations could provide valuable information on the implementation of T/E DBL in the classroom and teacher practice. An analysis of these observations using a protocol such as the RTOP should be conducted to provide more detailed and precise evidence of change. Additionally, these observational studies would provide a coherent, well-substantiated knowledge base about effective T/E DBL and improve the PD model.

Recommendations for Practitioners

The following recommendations generated from the findings and conclusions of this study are geared toward science and technology educators, in-service professional development providers, and pre-service preparation programs.

Stages of Concern Questionnaire. The high level of internal concerns PRE and POST treatment displayed by Participant B suggests that an administration of the SoCQ mid-treatment could be useful in directing the PD model for individuals. This allows teacher educators to determine direction for in-service activities. Professional development providers can design additional strategies for those individuals in need of intervention and identify target groups for more intensive efforts. Finally, the additional SoCQ administration could provide information for planning support services when implementing T/E DBL in the classroom during the final phase of the PD model.

Professional development sessions. As shown from the SoC profile and the interviews, professional development is significantly influenced by the teacher's ability to teach science concepts. Knowing the teacher's experience level in teaching science and his/her belief in their ability is essential to the success of the PD sessions. Therefore, the PD sessions must provide knowledge about the science concept as well as explicitly demonstrate the T/E DBL phases of engagement to teach science content and design instruction.

Classroom observations. Classroom observations were not a part of this study, but could provide valuable feedback information on the implementation of T/E DBL in the classroom and teacher practice. These observations could assist in identifying challenges and strengths of implementation and practice that can be addressed during follow-up professional development sessions. Classroom observations can provide a framework for giving constructive and focused feedback that helps teachers incorporate higher levels of desired knowledge into their instruction (Stuhlman, Hamre, Downer, & Pianta, 2015).

Limitations

The following section presents limitations uncovered during the implementation of the study.

Sample Size

Given the absence of the statistical significance and large effect size for the group SoC PRE/POST profile analysis, the sample size should be increased. Large numbers yields typical results while small number sample leads to skewed data. The graphs and data were susceptible to the small sample and outliers yielding no overall group effect. In addition, generalizations to the population can be made when larger sample sizes are used with subsequent statistical significance.

Instrumentation

The Instructional Change Indicators and Lesson Assessment Rubric included categories that were not germane to the study. Therefore, data collected in these categories were unnecessary and may have served as a distractor to the researcher. In addition, the scale of the LAR was too broad in the number of T/E DBL engagement phases incorporated into a participant’s instructional design and did not accurately reflect the progressive use of engagement phases.

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Appendix A

Institutional Review Board Approval Letter

Office of Research Compliance
Institutional Review Board
North End Center, Suite 4120, Virginia Tech
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-4606 Fax 540/231-0959
email irb@vt.edu
website http://www.irb.vt.edu

FROM:	Virginia Tech Institutional Review Board (FWA00000572, expires January 29, 2021)
PROTOCOL TITLE:	Enhancing Science and Engineering Practices in Elementary Teachers
IRB NUMBER:	**15-1121**

Effective February 19, 2016, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the New Application request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

http://www.irb.vt.edu/pages/responsibilities.htm

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As:	**Expedited, under 45 CFR 46.110 category(ies) 5,6,7**
Protocol Approval Date:	**February 19, 2016**
Protocol Expiration Date:	**February 18, 2017**
Continuing Review Due Date*:	**February 4, 2017**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

Appendix B

Informed Consent Letter

Informed Consent for Participants

Title of Study: Enhancing Elementary Teacher Practice Through Technological/Engineering Design Based Learning

Investigators:
Dr. John Wells, Assoc. Prof., Integrative STEM Education (Principal, 540.231.8471/jgwells.vt.edu)
Anita Deck, Ed.D. Candidate, Integrative STEM Education (Co-Principal, 304.573.1258/adeck@vt.edu)

I. General Information Regarding Research Studies

A research study is an organized investigation designed to reveal new information about a problem or question. The research goal of a study is to use the information gained from the study to improve our understanding regarding a specific aspect of the human condition. Below you will find details specific to this study. Participation within this study is voluntary.

II. Purpose of this Research Study

The purpose of the study is to gain an understanding of change in science instructional content and practice through professional development that educates elementary teachers to implement T/E DBL as part of teaching science. The study is being conducted for dissertation research at Virginia Tech in Integrative STEM Education, and will involve research in the form of examination and evaluation of elementary teacher participant lesson plans using two rubrics, results from two questionnaires, and a post interview. These participants are selected because of their availability and their grade level teaching assignment that correlates to an analysis of the 2013 science state accountability test, Standards of Learning.

III. Procedures

If you agree to take part in this study, you will be asked to participate beginning the week of February 15, 2016 until April 16, 2016.

You will be asked to

1. complete two pre-study questionnaires (mailed to you) and return via mail,
2. submit a previously taught lesson plan (Lesson 1) targeting a specific Standard of Learning by mail or email,
3. participate in a one-day (7 hours) professional development session (PD1) on the Virginia Tech campus
4. submit (via email or mail) a redesigned Lesson 1 one week after PD1,
5. participate in a four-hour professional development session (PD2) via Skype or Adobe Connect,
6. design and submit (via mail or email) a lesson plan (Lesson 2) targeting a specific Standard of Learning one week after PD2,
7. participate in a four-hour professional development (PD3) via Skype or Adobe Connect,
8. implement Lesson 2 in your classroom within two weeks after PD3,
9. revise and submit (via email or mail) Lesson 2 one week after implementation, and
10. complete two post-study questionnaires (mailed to you) within three days of submitting Lesson 2 and mail back.
11. Participate in a post interview within the three-day timeframe.

IV. Risks and Freedom to Withdraw

Participating in this study will not involve any known risks above those normally encountered in daily life. The Co-Principal Investigator will withdraw at any time if a perceived risk appears or you voice concern. There will be no retribution of any sort for any response you provide. Again, if you feel nervous or uncomfortable about participating in the study, please feel free to withdraw at any time without penalty or reprisal. If for any reason you choose to seek medical or counseling services as a result of your participation neither the Principal Investigator, Co-Principal Investigator, nor Virginia Tech will provide funds to pay for such services. Therefore, the cost of the services must be paid by you.

V. Benefits and Compensation

As always, your participation is voluntary. Although there are no direct personal benefits for you and you will not receive any compensation for participating in the study, the information you provide will give the Co-Principal Investigator a better understanding about changes in teacher confidence and practice as a result of professional development regarding implementation of technological/engineering design-based learning (T/E DBL) to intentionally teach science. This kind of information may result in indirect benefits to you as a participant in the study in the form of adding to the knowledge base of integrative STEM education. However, no promise or guarantee of benefits and/or compensation will be made to encourage you to participate.

VI. Extent of Anonymity and Confidentiality

You will not be asked to give your name or any identifying information about yourself in the lesson plans or questionnaires. If you feel that your response to a question in the questionnaire might identify you, you can skip it. The Co-Principal Investigator who will handle the data will do everything she can to ensure its confidentiality by storing the data in a secure location, a locked cabinet at her home. Information you share will be kept confidential and will only be reported at an aggregated level in the summary report. It is possible that the Institutional Review Board (IRB) may view this study's collected data for auditing purposes. The IRB is responsible for the oversight of the protection of human subjects involved research. Data collected will be destroyed upon completion of the study and subsequent final report.

VII. Participant's Responsibilities and Permission

I voluntarily agree to participate in this study, I have the following responsibilities:

- Participate in a one-day and two four-day professional development sessions
- Design and submit two lessons for examination and evaluation
- Complete pre- and post-study questionnaires

I have read the Consent Form and conditions of this study. I have had all my questions answered. I hereby acknowledge the above and voluntary consent:

____ ______________________________
Subject Signature Date

If you have any questions, please contact the Co-Principal Investigator, Anita Deck (adeck@vt.edu, 304.573.1258) or the Principal Investigator, Dr. John Wells (jgwells@vt.edu, 540.231.8471). If you have any questions about the protection of human research participants regarding this study, contact Dr. David Moore, Chair Virginia Tech Institutional Review Board for the Protection of Human Subjects, telephone: (540) 231-4991; email: moored@vt.edu; address: Office of Research Compliance, 2000 Kraft Drive, Suite 2000 (0497), Blacksburg, VA 24060.

Appendix C

Participant Demographics

Participant Demographics

Demographic Questions	**Participant A**	**Participant B**	**Participant C**	**Participant D**
Years taught	19	12	5	12
Highest degree level	Master's + 45 hours, Elementary Ed.	Bachelors, K-6 Elementary Ed.	Bachelors, K-6 Elementary Ed.	Bachelors, K-6 Elementary Ed.
Grade level taught	5th	4th	5th	4th
Date of last PD session	November 2015	August 2015	May 2015	August 2015
Topic of last PD session	Mathematics	Virginia Studies	Math	English/language arts
Date of last PD focused on science	July 2015	June 2015	May 2014	June 2015
Location of school	Rural	Urban	Rural	Rural

Appendix D

The Stages of Concern Questionnaire

Stages of Concern Questionnaire

Name (optional): ____

The purpose of this questionnaire is to determine what people who are using or thinking about using various programs are concerned about at various times during the adoption process.

The items were developed from typical responses of school and college teachers who ranged from no knowledge at all about various programs to many years' experience using them. Therefore, **many of the items on this questionnaire may appear to be of little relevance or irrelevant to you at this time**. For the completely irrelevant items, please circle "0" on the scale. Other items will represent those concerns you do have, in varying degrees of intensity, and should be marked higher on the scale.

For example:

This statement is very true of me at this time.	0	1	2	3	4	5	6	[✓ 7]
This statement is somewhat true of me now.	0	1	2	3	[✓ 4]	5	6	7
This statement is not at all true of me at this time.	0	1	[✓ 2]	3	4	5	6	7
This statement seems irrelevant to me.	[✓ 0]	1	2	3	4	5	6	7

Please respond to the items in terms of **your present concerns**, or how you feel about your involvement with **this** innovation. We do not hold to any one definition of the innovation so please think of it in terms of your own perception of what it involves. Phrases such as "this approach" and "the new system" all refer to the same innovation. Remember to respond to each item in terms of your present concerns about your involvement or potential involvement with the innovation.

Thank you for taking time to complete this task.

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now			Somewhat true of me now		Very true of me now	

Circle one number for each item

1. I am concerned about students' attitudes toward the innovation.	0	1	2	3	4	5	6	7
2. I now know of some other approaches that might work better.	0	1	2	3	4	5	6	7
3. I am more concerned about another innovation.	0	1	2	3	4	5	6	7
4. I am concerned about not having enough time to organize myself each day.	0	1	2	3	4	5	6	7
5. I would like to help other faculty in their use of the innovation.	0	1	2	3	4	5	6	7
6. I have a very limited knowledge of the innovation.	0	1	2	3	4	5	6	7
7. I would like to know the effect of reorganization on my professional status.	0	1	2	3	4	5	6	7
8. I am concerned about conflict between my interests and my responsibilities.	0	1	2	3	4	5	6	7
9. I am concerned about revising my use of the innovation.	0	1	2	3	4	5	6	7
10. I would like to develop working relationships with both our faculty and outside faculty using this innovation.	0	1	2	3	4	5	6	7
11. I am concerned about how the innovation affects students.	0	1	2	3	4	5	6	7
12. I am not concerned about the innovation at this time.	0	1	2	3	4	5	6	7
13. I would like to know who will make the decisions in the new system.	0	1	2	3	4	5	6	7
14. I would like to discuss the possibility of using the innovation.	0	1	2	3	4	5	6	7
15. I would like to know what resources are available if we decide to adopt the innovation.	0	1	2	3	4	5	6	7
16. I am concerned about my inability to manage all that the innovation requires.	0	1	2	3	4	5	6	7
17. I would like to know how my teaching or administration is supposed to change.	0	1	2	3	4	5	6	7
18. I would like to familiarize other departments or persons with the progress of this new approach.	0	1	2	3	4	5	6	7

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now		Somewhat true of me now			Very true of me now	

Circle one number for each item

19. I am concerned about evaluating my impact on students.	0 1 2 3 4 5 6 7
20. I would like to revise the innovation's approach.	0 1 2 3 4 5 6 7
21. I am preoccupied with things other than the innovation.	0 1 2 3 4 5 6 7
22. I would like to modify our use of the innovation based on the experiences of our students.	0 1 2 3 4 5 6 7
23. I spent little time thinking about the innovation.	0 1 2 3 4 5 6 7
24. I would like to excite my students about their part in this approach.	0 1 2 3 4 5 6 7
25. I would concerned about time spent working with nonacademic problems related to the innovation.	0 1 2 3 4 5 6 7
26. I would like to know what the use of the innovation will require in the immediate future.	0 1 2 3 4 5 6 7
27. I would like to coordinate my efforts with others to maximize the innovation's effects.	0 1 2 3 4 5 6 7
28. I would like to have more information on time and energy commitments required by the innovation.	0 1 2 3 4 5 6 7
29. I would like to know what other faculty are doing in this area.	0 1 2 3 4 5 6 7
30. Currently, other priorities prevent me from focusing my attention on the innovation.	0 1 2 3 4 5 6 7
31. I would like to determine how to supplement, enhance, or replace the innovation.	0 1 2 3 4 5 6 7
32. I would like to use feedback from students to change the program.	0 1 2 3 4 5 6 7
33. I would like to know how my role will change when I am using the innovation.	0 1 2 3 4 5 6 7
34. Coordination of tasks and people is taking too much of my time.	0 1 2 3 4 5 6 7
35. I would like to know how the innovation is better than what we have now.	0 1 2 3 4 5 6 7

Stages of Concern Quick Scoring Device

The Quick Scoring Device can be used to hand score the Stages of Concern Questionnaire (SoCQ) responses and to plot an individual profile. It is especially useful when only a small number of questionnaires need to be processed or when computer processing is not available. By following the step-by-step instructions, the SoCQ responses are transferred to the device, entered into seven scales, and each scale is totaled. Then the seven raw scale score totals are translated into percentile scores and plotted on a grid to produce the individual's SoCQ profile.

Instructions

1. In the box labeled A, fill in the identifying information taken from the cover sheet of the SoCQ.
2. In the table labeled B on the Scoring Device, transcribe each of the 35 SoCQ circled responses from the questionnaire (raw data). Note that the numbered blanks are not in consecutive order.
3. Row C contains the Raw Scale Score Total for each stage (0–6). Take each of the seven col-umns (0–6) in Table B, add the numbers within each column, and enter the sum of each column (0–6) in the appropriate blank in Row C. Each of these seven Raw Scale Score totals is a number between 0 and 35.
4. Table D contains the percentile scores for each Stage of Concern. For example, find the Raw Scale Score Total for Stage 0 from Row C ("12" from the example) in the left-hand column in Table D, then look in the Stage 0 column to the right in Table D and circle that percentile rank ("69" in the example). Take the raw score for Stage 1 ("31" in the example) to Table D and locate that numeral in the left hand Raw Score Total column. Move across in the percentile table to the Stage 1 column and circle the percentile value ("98" in the example). Do the same for Stages 2 through 6.
5. Transcribe the circled percentile scores for each stage (0-6) from Table D to Box E. Box E now contains seven numbers between 0 and 99.
6. Box F contains the SoCQ grid. From Box E, take the percentile score for Stage 0 ("69" in the example) and mark that point with a dot on the Stage 0 vertical line of the SoCQ grid. Do the same for Stages 1–6. Connect the points to form the SoCQ profile.

You can now check your own scoring by using the blank profile sheet. You will want to make copies of the blank scoring device before writing on it. Reproduce the data in the example by recording the original data from the completed SoCQ.

Stages of Concern Quick Scoring Device

SoCQ 075

1	☐	19	☐
2	☐	20	☐
3	☐	21	☐
4	☐	22	☐
5	☐	23	☐
6	☐	24	☐
7	☐	25	☐
8	☐	26	☐
9	☐	27	☐
10	☐	28	☐
11	☐	29	☐
12	☐	30	☐
13	☐	31	☐
14	☐	32	☐
15	☐	33	☐
16	☐	34	☐
17	☐	35	☐
18	☐		

A

Date: ____________________

Site: ________ SS#: ____________

Innovation: ____________________

B

Stage 0	1	2	3	4	5	6
3 ___	6 ___	7 ___	4 ___	1 ___	5 ___	2 ___
12 ___	14 ___	13 ___	8 ___	11 ___	10 ___	9 ___
21 ___	15 ___	17 ___	16 ___	19 ___	18 ___	20 ___
23 ___	26 ___	28 ___	25 ___	24 ___	27 ___	22 ___
30 ___	35 ___	33 ___	34 ___	32 ___	29 ___	31 ___

Raw Score Totals **C** ___ ___ ___ ___ ___ ___ ___

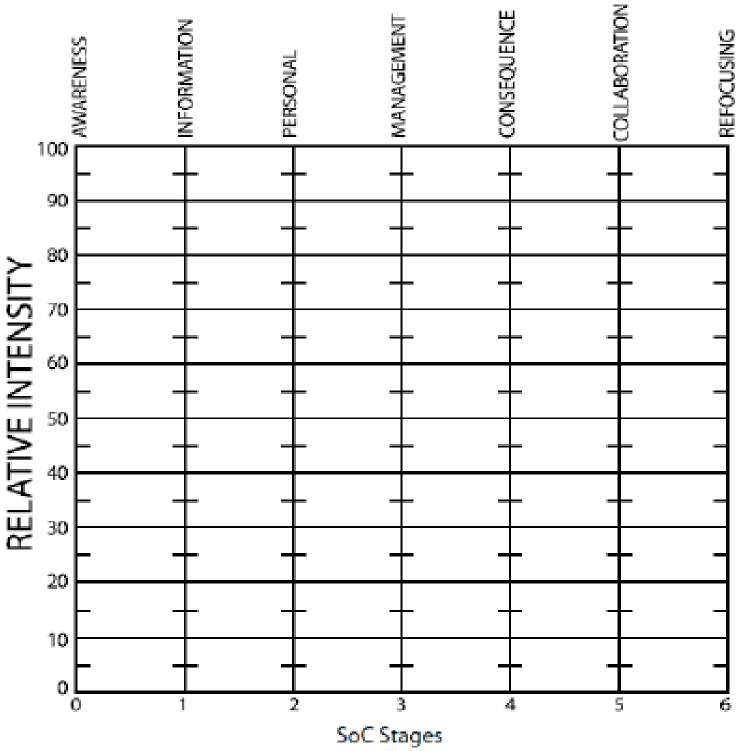
Percentile Scores **E** ___ ___ ___ ___ ___ ___ ___

D

Five Item Raw Scale Score Total	Percentiles for:						
	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
0	0	5	5	2	1	1	1
1	1	12	12	5	1	2	2
2	2	16	14	7	1	3	3
3	4	19	17	9	2	3	5
4	7	23	21	11	2	4	6
5	14	27	25	15	3	5	9
6	22	30	28	18	3	7	11
7	31	34	31	23	4	9	14
8	40	37	35	27	5	10	17
9	48	40	39	30	5	12	20
10	55	43	41	34	7	14	22
11	61	45	45	39	8	16	26
12	69	48	48	43	9	19	30
13	75	51	52	47	11	22	34
14	81	54	55	52	13	25	38
15	87	57	57	56	16	28	42
16	91	60	59	60	19	31	47
17	94	63	63	65	21	36	52
18	96	66	67	69	24	40	57
19	97	69	70	73	27	44	60
20	98	72	72	77	30	48	65
21	99	75	76	80	33	52	69
22	99	80	78	83	38	55	73
23	99	84	80	85	43	59	77
24	99	88	83	88	48	64	81
25	99	90	85	90	54	68	84
26	99	91	87	92	59	72	87
27	99	93	89	94	63	76	90
28	99	95	91	95	66	80	92
29	99	96	92	97	71	84	94
30	99	97	94	97	76	88	96
31	99	98	95	98	82	91	97
32	99	99	96	98	86	93	98
33	99	99	96	99	90	95	99
34	99	99	97	99	92	97	99
35	99	99	99	99	96	98	99

Concerns Based Systems International

F



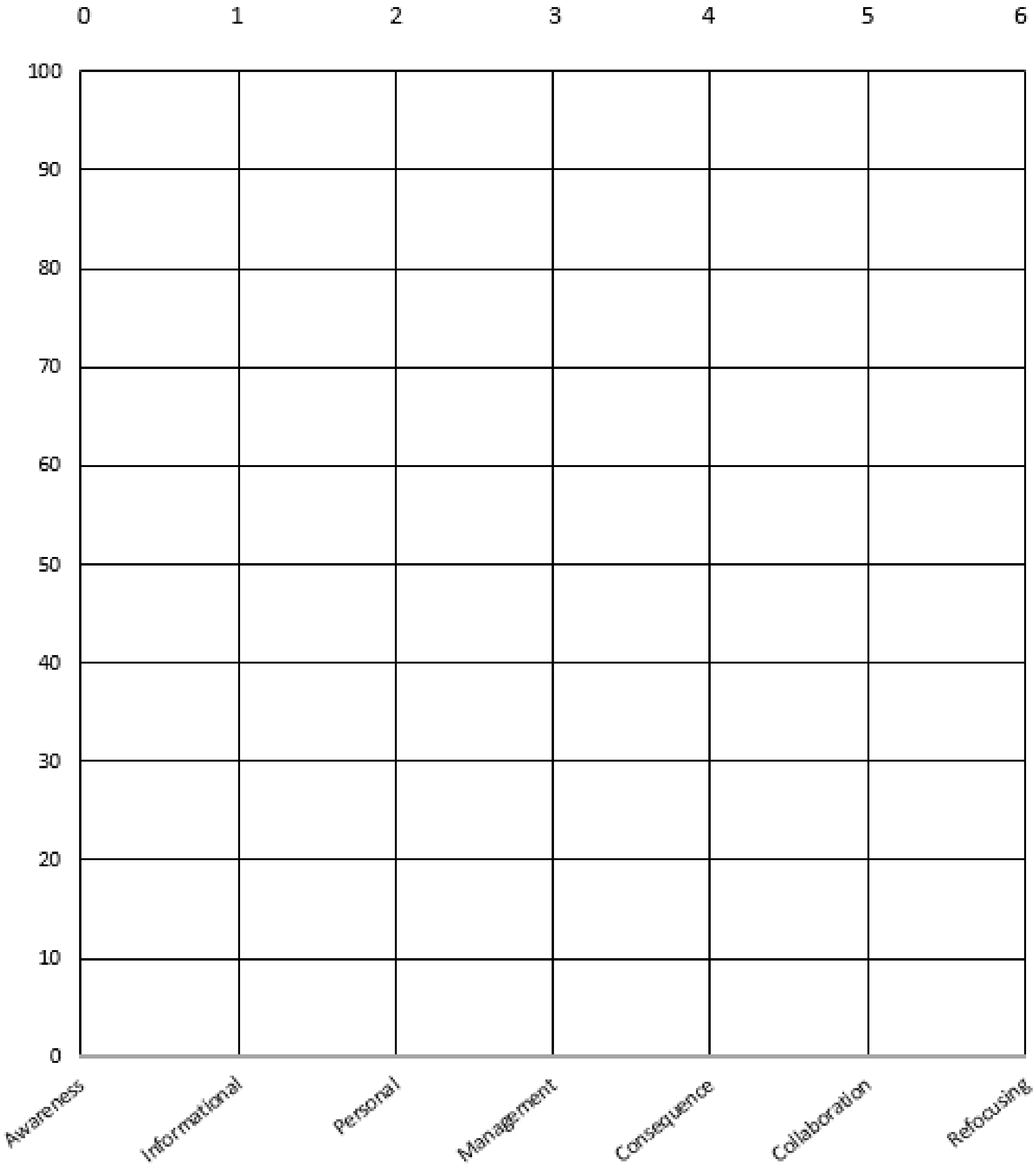
Wells Re-Make of Scoring Device Fall 2011

Stages of Concern Profile

Date: ______________________________

Participant Code: __________________

Innovation: ________________________



Appendix E

T/E DBL Instructional Change Indicators (ICI)

T/E DBL Instructional Change Indicators (ICI)

Participant Code:	Unit Title:							Grade Level:		
	Lesson 1		Lesson 2		Lesson 3		Lesson 4		Lesson 5	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Curriculum										
Objectives (action verb/measurable)										
Change Assessment (0, 1, 2, 3)										
Science										
Formative										
Summative										
Technology/Engineering										
Formative										
Summative										
5E Instructional Design										
Engagement										
Context/Scenario/Challenge										
Exploration										
Concepts/Know/Need to Know										
Explanation										
Understanding/Evidencing/Clarifying										
Elaboration										
Knowledge Trans/Interpret Results/Extend Application										
Evaluation										
Formative/Summative/Evidence										
Total Procedures										
T/E DBL Phase Integrations										
Problem Identification										
Need/Define/Formulation										
Ideation										
Criteria/Brainstorm/Generate										
Research										
Explore/Investigate/Examine										
Potential Solutions										
Analyze/Visualize/Select										
Optimization										
Experiment/Revisit/Construct										
Solution Evaluation										
Test/Analyze/Retest										
Alterations										
Identify/Redesign/Retest										
Learned Outcomes										
Process/Iterations/Justify										
Total T/E DBL Phase Integration										

Lesson Evaluation Key
Accomplished (3pts)
Developing (2pts)
Vague (1pt)

ICI Evaluation Key
0 = Absence of Variable
1 = Presence of Variable
2 = Assessment is linked to objectives
3 = Each objective is assessed

Participant Code:										
	Lesson 6		Lesson 7		Lesson 8		Lesson 9		Lesson 10	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Curriculum										
Objectives (action verb/measurable)										
Change Assessment (0, 1, 2, 3)										
Science										
Formative										
Summative										
Technology/Engineering										
Formative										
Summative										
5E Instructional Design										
Engagement										
Context/Scenario/Challenge										
Exploration										
Concepts/Know/Need to Know										
Explanation										
Understanding/Evidencing/Clarifying										
Elaboration										
Knowledge Trans/Interpret Results/Extend Application										
Evaluation										
Formative/Summative/Evidence										
Total Procedures										
T/E DBL Phase Integrations										
Problem Identification										
Need/Define/Formulation										
Ideation										
Criteria/Brainstorm/Generate										
Research										
Explore/Investigate/Examine										
Potential Solutions										
Analyze/Visualize/Select										
Optimization										
Experiment/Revisit/Construct										
Solution Evaluation										
Test/Analyze/Retest										
Alterations										
Identify/Redesign/Retest										
Learned Outcomes										
Process/Iterations/Justify										
Total T/E DBL Phase Integration										

Lesson Evaluation Key
Accomplished (3pts)
Developing (2pts)
Vague (1pt)

ICI Evaluation Key
0 = Absence of Variable
1 = Presence of Variable
2 = Assessment is linked to objectives
3 = Each objective is assessed

Summary of the 5E Instructional Model

The five phases of the 5E Instructional Model are designed to facilitate the process of conceptual change. The following table summarizes each phase with the key purpose of the phase highlighted in bold font.

Phase	Summary
Engagement	The teacher or a curriculum task **accesses the learners' prior knowledge and helps them become engaged in a new concept** through the use of short activities that promote curiosity and elicit prior knowledge. The activity should make connections between past and present learning experiences, expose prior conceptions, and organize students' thinking toward the learning outcomes of current activities.
Exploration	Exploration experiences provide students with a common base of **activities within which current concepts (i.e., misconceptions), processes, and skills are identified and conceptual change is facilitated**. Learners may complete lab activities that help them use prior knowledge to generate new ideas, explore questions and possibilities, and design and conduct a preliminary investigation.
Explanation	The explanation phase focuses students' attention on a particular aspect of their engagement and exploration experiences and provides opportunities to demonstrate their conceptual understanding, process skills, or behaviors. This phase also provides opportunities for teachers to directly introduce a concept, process, or skill. **Learners explain their understanding of the concept**. An explanation from the teacher or the curriculum may guide them toward a deeper understanding, which is a critical part of this phase.
Elaboration	**Teachers challenge and extend students' conceptual understanding and skills**. Through new experiences, the students develop deeper and broader understanding, more information, and adequate skills. Students apply their understanding of the concept by conducting additional activities.
Evaluation	The evaluation phase **encourages students to assess their understanding and abilities** and provides opportunities for **teachers to evaluate student progress** toward achieving the educational objectives.

Adapted from The BSCS 5E Instructional Model: Origins and Effectiveness, Executive Summary. http://bscs.org/sites/default/files/_media/about/downloads/BSCS_5E_Executive_Summary.pdf

P.I.R.P.O.S.A.L. MODEL©

Conceptual Framework of Integrative STEM Education

TECHNOLOGICAL/ENGINEERING DESIGN BASED LEARNING

8 PHASE P.I.R.P.O.S.A.L. MODEL – OUTLINE OF ENGAGEMENT

Problem Identification

- Need—recognition of the human need (not individual need) that requires a technological solution.
- Define—once the need has been recognized, the problem requiring a technological/engineering solution to meet that need must be operationally defined.
- Formulate—write a concise statement of the problem expressed within the context of the T/E design challenge, including criteria, parameters, constraints as outlined in the context and challenge.

Ideation

- Criteria—review problem information for standards by which the solution is judged.
- Brainstorm— free flow of ideas; solicited ideas from every member of the group regarding possible solution to the problem.
- Generate—create a summary of the brainstorming results including sketches, drawings, pictures, etc.
- Note: The Ideation phase is often concurrent with the Research phase

Research

- Explore—searching for information on the various elements of potential solutions.
- Investigate—technologies: physical/biological/informational; a way to discover solutions that have already been tried.
- Examine—sketches, diagrams, videos, images, etc.; look to nature for organic solutions to similar problems

Potential Solutions

- Analyze—draw from the results of brainstorming and researching; consider all information gathered
- Visualize—record all potential solutions including detailed sketches for these solutions
- Select—compile all notes, sketches, drawings, diagrams, pictures, etc.; consider size, shape, environment, systems and then select the best 2 or 3 designs with justification.

Optimize

- Experiment—reassess each potential solution and assess designs for the best fit to meet the criteria/constraints.
- Revisit—time, money (cost), resources, production, and impact on the environment, society/culture, and policy.
- Construct—create models and working prototypes.

Solution Evaluation

- Test—demonstrate proof of concept by testing the prototype; evaluate all criteria specific to the design challenge
- Analyze—list all attributes of solution addressing criteria and design a set of sub-experiments; gather, record, and analyze data from sub-experiments.
- Interpret—summarize findings and note where purposed solution met, exceeded, or failed specifications; describe the implications of the evaluation.

Alterations

- Identify—ascertain problems with tested solutions and list all issues to be addressed
- Redesign—review the definition of problem and incorporate alternative technologies, materials and processes as needed.
- Retest—test each alteration or combinations of alterations again and completely redesigned solution.

Learned Outcomes

- Process—communicate the procedures, both in writing and orally, providing an explanation of the solution components.
- Iterations—describe the process—from initial design to final solution; discuss consideration of solution elements; demonstrate knowledge gains.
- Justify—explain decisions and trade-offs; rationalize continued design improvements.

Appendix F

T/E Design Based Learning Unit/Lesson Assessment Rubric

Participant Code _______

T/E Design Based Learning Unit/Lesson Assessment Rubric

1. Unit Title:			
2. Grade Level:			
3. Date:			
For 4-12 below, use the scale below to determine the option that best describes the extent to which each item is completed in the lesson. Score the lesson on the score sheet.			
	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Unit Overview			
4. Unit Summary	Concise summary is clearly stated and includes content and skills students should know and be able to do.	Summary is clearly stated, but lacks complete information about content and skills students should know and be able to do.	Summary is unclear, too broad, or not present.
5. Unit Timeframe	Approximate number of class periods or sessions is clearly indicated, including specified timeframe.	Approximate number of class periods or sessions is clearly indicated, but timeframe is not specified.	Number of classes or sessions and timeframe is not clear or is not apparent.
6. Unit Learning Objectives			
Science (SOL)	A minimum of one key Sci-SOL for each lesson is clearly stated and correlates with lesson objectives.	A minimum of one key Sci-SOL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key Sci-SOL for each lesson is not clearly stated or apparent.
T/E DBL (STL)	A minimum of one key STL for each lesson is clearly stated and correlates with lesson objectives.	A minimum of one key STL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key STL for each lesson is not clearly stated or apparent.
7. Unit Instructional Design			
Science: 5E Model	Unit clearly adheres to a science 5E instructional design model to guide implementation of instruction.	Unit loosely adheres to a science 5E instructional design model to guide implementation of instruction.	Unit does not adhere to a science 5E instructional design model to guide implementation of instruction.
T/E: PIRPOSAL Model	All eight engagement phases are evident and employed as an integral component of the instructional design.	A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design.	None or very few (4 or less) engagement phases are evident and employed as an integral component of the instructional design.

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Lesson Plans			
8. Title	The lesson title is brief, and creatively summarizes the theme of the lesson.	The lesson title is brief, but does not capture the theme of the lesson.	The lesson title is too long or too short, and does not capture the theme of the lesson
9. Learning Objectives	Action verbs used to clearly specify observable student outcomes. Stated to measure high order thinking/learning skills.	Action verbs specify observable student outcomes, but not stated to measure high order thinking/learning skills.	Observable student outcomes not clear, and not stated to measure higher order thinking/learning skills.
Science SOLs			
Technology SOLs			
10. Instructional Design			
Science 5E Model	Thorough planning is evidenced through carefully constructed opportunities for students to engage in inquiry through active, hands-on exploration. Connection between all phases is explicit. Provides excellent opportunities for students to apply and expand their understanding, generate and explore questions, analyze data, and report findings. Appropriate assessment process measures student understanding of concepts and skills.	Provides adequate constructed opportunities for students to engage in inquiry through active, hands-on exploration. Phases are related, but connections are not explicit. Provides opportunities for students to expand their understanding, analyze data, and report findings. Adequate evidence of an appropriate assessment process to measure student understanding of concepts and skills.	Minimal and/or inappropriate opportunities for students to engage in inquiry through active, hands-on exploration. Phases have no obvious connections. Provides little opportunity for students to expand on existing knowledge. Final assessment is vague or absent.
T/E PIRPOSAL Model	Continuous, active student-centered approach that is fluid and fully integrated in the instructional design, intentionally teaches targeted science content, and promotes convergent and divergent questioning.	Active student-centered approach that is reflected but not fully integrated in the instructional design, and teaches minimal science content.	Completed, inactive teacher-centered approach.
11. Assessment: Science	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			
12. Assessment: Technology/Engineering	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			

SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
4. Unit Summary				
5. Unit Timeframe				
6. Unit Learning Objectives a. Science SOLs b. Technology STLs				
7. Unit Instructional Design a. Science: 5E Model b. T/E: PIRPOSAL Model				
Total =				

Lesson 1	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 2	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 3	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 4	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 5	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 6	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 7	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 8	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 9	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				
Lesson 10	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Rating: *Circle the letter indicating the range of scores to determine individual section ratings.*

Unit Overview

Sum from items 4 – 7 =
A. 0-15 Points (Revisions needed)
B. 16-18 Points (Implement without revisions)

Lesson Plans

Sum from items 9 – 12 =
A. 7-24 points (Revisions needed)
B. 25-30 points (Implement without revisions)

Overall Unit Rating

Circle one:
A. Unit must be revised (additional comments required)
B. Unit can be implemented as written
C. Unit is an exemplar

Additional Comments

Evaluator's Signature *Date*

Unit/Lesson –Interrater Feedback Log Following the assessment of the unit and lessons, use this log to indicate the major strengths (provide 3) and the major suggestions (provide 3) for improvement.	
Unit Overview	
Strengths 1. 2. 3.	Suggestions 1. 2. 3.
Lesson 1	
Strengths 1. 2. 3.	Suggestions 1. 2. 3.
Lesson 2	
Strengths 1. 2. 3.	Suggestions 1. 2. 3.
Lesson 3	
Strengths 1. 2. 3.	Suggestions 1. 2. 3.
Lesson 4	
Strengths 1. 2. 3.	Suggestions 1. 2. 3.
Lesson 5	
Strengths 1. 2. 3.	Suggestions 1. 2. 3.

Appendix G

Understanding of a Virginia Science Standard of Learning Questionnaire

UNDERSTANDING OF A VIRGINIA SCIENCE STANDARD OF LEARNING

The following science concept has been identified as a weakness for fourth and fifth grade students. The science concept is *identify possible impacts of human activity on the ecosystem*.

This concept was assessed using the following test item on the Grade 5 Science Standards of Learning test:

Which of these is an impact made by humans?

A. Marble being dug from a rock quarry

B. Marble forming from sedimentary rock

C. Oceans drying and exposing limestone

D. Limestone forming from shells of ocean animals

After reviewing the above science concept, please rate your understanding of the following.

1. How well do you understand the SOL stated above?

1	2	3	4	5	6	7
I do not understand this SOL			I somewhat understand this SOL.		I completely understand this SOL.	

2. How well do you understand the instructional requirements for teaching the science content in this SOL?

1	2	3	4	5	6	7
I do not understand the instructional requirements.			I somewhat understand the instructional requirements.		I completely understand the instructional requirements.	

3. How well do you understand the science concept in this SOL that students are expected to demonstrate?

1	2	3	4	5	6	7
I do not understand the science concept.			I somewhat understand the science concept.		I completely understand the science concept.	

Appendix H

Post-Interview Protocol

Post-Interview Protocol

Introduction:

The main focus of our interview is to understand your choice of ratings on the Understandings of a Virginia Science Standard of Learning Questionnaire. You were asked to rate your understanding of the science concept: *identify possible impacts of human activity on the ecosystem*.

This concept was assessed using the following test item on the Grade 5 Science Standards of Learning test:

Which of these is an impact made by humans?

A. Marble being dug from a rock quarry

B. Marble forming from sedimentary rock

C. Oceans drying and exposing limestone

D. Limestone forming from shells of ocean animals

While you answer the questions, please focus on the details of your reasoning for your rating choices. Any questions before we begin?

Questions:

1. Why did you chose to rate yourself at (#) for your understanding of this SOL?

   Follow On Probes:
   Can you further explain………?
   Can you better describe………?

2. Why did you chose to rate yourself at (#) for your understanding of the instructional requirements for teaching the science content in this SOL?

   Follow On Probes:
   Can you further explain………?
   Can you better describe………?

3. Why did you chose to rate yourself at (#) for your understanding of the science concept in this SOL that students are expected to demonstrate?

   Follow On Probes:
   Can you further explain………?
   Can you better describe………?

Appendix I

Technological/Engineering Design Based Learning Professional Development

Technological/Engineering Design Based Learning
Session Agenda

Outcomes:

- Participants will experience T/E DBL from a learner's perspective
- Participants will develop an understanding of T/E DBL, 5E Instructional Model, and the P.I.R.P.O.S.A.L Model
- Participants will analyze a design challenge using the T/E DBL Unit and Lesson Assessment Rubric
- Participants will be able to revise a lesson using T/E DBL

9:00 am – 9:30 am	Opening and Introductions
9:30 am – 12:00 pm	Rock the Quarry!
12:00 pm – 1:00 pm	Lunch
1:00 pm – 2:30 pm	Rock the Quarry! (cont.)
2:30 pm – 3:00 pm	Using T/E DBL to Teach Science Concepts: • 5E Instructional Model • P.I.R.P.O.S.A. L. Model
3:00 pm – 4:00 pm	Introduction of T/E DBL Unit and Lesson Template and Assessment Rubric: • Analysis of Rock the Quarry! • Lesson 1 Revision Assignment
4:00 pm – 4:30 pm	Closing

Professional Development Plan Based on the PIRPOSAL Model

Problem Identification (P.). Through experiential learning, participants are presented with a task situated in a real-world context incorporating the science concept, *identify possible impacts of human activity on the ecosystem*, and gain an understanding of T/E DBL from a learner's perspective. The context and design challenge used in this study are:

Context: Quarrying rocks and minerals has been an important resource for building human infrastructure for thousands of years. Quarrying is the process of obtaining resources found on or below the land surface. Water is used for tasks such as cutting with hig-pressure jets and the lubrication of solid cutting tools. As a result, nearly all mining processes generate vast amounts of waste water. Waste water can also include additional contaminants of unnatural substances, like oil and gas from machinery, and natural sediments in excessive quantities. To help reduce the amount of contaminated waste water dumped into the environment, we have partnered with Water Works Technology to design a system to clean the waste water in one of the small accumulation ponds (30 feet by 15 feet) for The Agate Company. Besides the area of the pond itself, there is an 8 foot wide area around the edge of the pond available for use. The Agate Company intends to use the treated waste water to be used as a water source for plant life when they reclaim the quarry site. Therefore, the treated waste water must meet the environmental requirements for supporting plant life. The company's budget does not allow for the treatment to exceed $10,000.

Challenge: Design a working prototype of a system that will clean the waste water in a small accumulation pond.

Throughout the immersion experience, participants use an Engineering notebook to record all activities associated with their solution development.

Ideation (I). In the Ideation phase, the participants work in dyads to generate ideas for possible solutions for waste water treatment. Usually this process also illuminates what is known and unknown about waste water and waste water treatment and may occur concurrent with the Research phase. Participants summarize their brainstorming ideas either in a narrative or graphic form.

Research (R.). Due to the technological and biological components of the problem, the participants have to address each to inform their possible solutions. Any information that may edify their solutions should be recorded.

Potential Solutions (P.). By analyzing the ideas generated and the information gathered through research, participants explore the feasibility of possible solutions to the treatment of the waste water. Participants should develop detailed sketches and notes of their purposed solutions.

Optimize (O.). The dyads experiment and explore their purposed solutions and determine their best idea considering elements such as time, resources, criteria, and constraints. After agreeing on a solution, participants construct a working prototype of their system to treat the waste water.

Solution Evaluation (S.). Participants test their design solution using the design criteria as testing criteria. Data should be collected, recorded, and analyzed for evaluation. Participants should create a summary of this analysis.

Alterations (A.). Participants use the results from their evaluation to make adjustments to their design solution. The results may lead them to revisit their potential solutions for another iteration of their design. Iterations should be recorded.

Learned Outcomes (L.). Each dyad presents their design solution through verbal and visual presentation detailing their design process. The participants are provided with a list of questions to address during their presentation.

Appendix J

T/E Design Based Learning Unit and Lesson Plan Template

T/E Design Based Learning Unit and Lesson Plan Template

Unit Details	
Title:	
Summary:	
Key T/E DBL Goals:	
Time:	Number of Lessons:

Curriculum Details	
Lesson Number and Title:	Time:
Objectives: •	
Assessment: •	
Standards of Learning (SOLs): •	Standards for Technological Literacy (STLs): •
Prior Knowledge (if applicable):	
Materials:	

5 E Model	T/E DBL Phases	What Does the Teacher Do?	What Does the Student Do?
Engagement			
Exploration			
Explanation			
Elaboration			
Evaluation			

T/E DBL Lesson Planning Model

5E Model Cycle	T/E DBL Engagement Phases * (PIRPOSAL)	PIRPOSAL Abbreviations
Engagement	Problem Identification (Need, Define, Formulate)	PR_N, PR_D, PR_F
Exploration	Ideation (Criteria, Brainstorm, Generate) Research (Explore, Investigate, Examine)	I_C, I_B, I_G R_E,R_I, R_x
Explanation	Potential Solutions (Analyze, Visualize, Select)	PS_A, PS_V, PS_S
Elaboration	Optimization (Experiment, Revisit, Construct) Solution Evaluation (Test, Analyze, Interpret)	O_E, O_R, O_C SE_T, SE_A, SE_I
Evaluation	Alterations (Identify, Redesign, Retest) Learned Outcomes (Process, Iterations, Justify)	A_I, A_{RD}, A_R LO_P, LO_I, LO_J

*Note: The T/E DBL Engagement Phases are fluid, cyclical, and iterative. Students may start at any phase of engagement as prompted by the questions they formulate during the process.

Appendix K

Stages of Concern Questionnaire Participant Responses and Stages of Concern Participant Profile

Pre

Stages of Concern Questionnaire

Name (optional): A

The purpose of this questionnaire is to determine what people who are using or thinking about using various programs are concerned about at various times during the adoption process.

The items were developed from typical responses of school and college teachers who ranged from no knowledge at all about various programs to many years' experience using them. Therefore, **many of the items on this questionnaire may appear to be of little relevance or irrelevant to you at this time**. For the completely irrelevant items, please circle "0" on the scale. Other items will represent those concerns you do have, in varying degrees of intensity, and should be marked higher on the scale.

For example:

This statement is very true of me at this time.	0	1	2	3	4	5	6	[✓ 7]
This statement is somewhat true of me now.	0	1	2	3	[✓ 4]	5	6	7
This statement is not at all true of me at this time.	0	1	[✓ 2]	3	4	5	6	7
This statement seems irrelevant to me.	[✓ 0]	1	2	3	4	5	6	7

Please respond to the items in terms of **your present concerns**, or how you feel about your involvement with **this** innovation. We do not hold to any one definition of the innovation so please think of it in terms of your own perception of what it involves. Phrases such as "this approach" and "the new system" all refer to the same innovation. Remember to respond to each item in terms of your present concerns about your involvement or potential involvement with the innovation.

Thank you for taking time to complete this task.

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now			Somewhat true of me now		Very true of me now	

Circle one number for each item

1. I am concerned about students' attitudes toward the innovation.	0	1	2	3	4	5	6	[✓ 7]
2. I now know of some other approaches that might work better.	0	1	[✓ 2]	3	4	5	6	7
3. I am more concerned about another innovation.	0	1	2	[✓ 3]	4	5	6	7
4. I am concerned about not having enough time to organize myself each day.	0	[✓ 1]	2	3	4	5	6	7
5. I would like to help other faculty in their use of the innovation.	0	1	2	3	4	5	6	[✓ 7]
6. I have a very limited knowledge of the innovation.	0	1	2	3	4	[✓ 5]	6	7
7. I would like to know the effect of reorganization on my professional status.	0	1	2	[✓ 3]	4	5	6	7
8. I am concerned about conflict between my interests and my responsibilities.	0	[✓ 1]	2	3	4	5	6	7
9. I am concerned about revising my use of the innovation.	0	1	2	3	[✓ 4]	5	6	7
10. I would like to develop working relationships with both our faculty and outside faculty using this innovation.	0	1	2	3	4	5	[✓ 6]	7
11. I am concerned about how the innovation affects students.	0	1	2	3	4	5	[✓ 6]	7
12. I am not concerned about the innovation at this time.	0	[✓ 1]	2	3	4	5	6	7
13. I would like to know who will make the decisions in the new system.	0	1	[✓ 2]	3	4	5	6	7
14. I would like to discuss the possibility of using the innovation.	0	1	2	3	4	[✓ 5]	6	7
15. I would like to know what resources are available if we decide to adopt the innovation.	0	1	2	3	4	5	[✓ 6]	7
16. I am concerned about my inability to manage all that the innovation requires.	0	[✓ 1]	2	3	4	5	6	7
17. I would like to know how my teaching or administration is supposed to change.	0	1	2	3	4	[✓ 5]	6	7
18. I would like to familiarize other departments or persons with the progress of this new approach.	0	1	2	3	4	5	[✓ 6]	7

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now			Somewhat true of me now		Very true of me now	

Circle one number for each item

19. I am concerned about evaluating my impact on students.	0	1	2	3	4	5	[✓ 6]	7
20. I would like to revise the innovation's approach.	0	1	2	3	4	5	[✓ 6]	7
21. I am preoccupied with things other than the innovation.	0	1	[✓ 2]	3	4	5	6	7
22. I would like to modify our use of the innovation based on the experiences of our students.	0	1	2	3	4	5	[✓ 6]	7
23. I spent little time thinking about the innovation.	0	1	[✓ 2]	3	4	5	6	7
24. I would like to excite my students about their part in this approach.	0	1	2	3	4	5	6	[✓ 7]
25. I would concerned about time spent working with nonacademic problems related to the innovation.	0	1	2	[✓ 3]	4	5	6	7
26. I would like to know what the use of the innovation will require in the immediate future.	0	1	[✓ 2]	3	4	5	6	7
27. I would like to coordinate my efforts with others to maximize the innovation's effects.	0	1	2	3	4	5	[✓ 6]	7
28. I would like to have more information on time and energy commitments required by the innovation.	0	1	[✓ 2]	3	4	5	6	7
29. I would like to know what other faculty are doing in this area.	0	1	2	3	[✓ 4]	5	6	7
30. Currently, other priorities prevent me from focusing my attention on the innovation.	0	1	[✓ 2]	3	4	5	6	7
31. I would like to determine how to supplement, enhance, or replace the innovation.	0	1	2	3	4	5	[✓ 6]	7
32. I would like to use feedback from students to change the program.	0	1	2	3	4	5	[✓ 6]	7
33. I would like to know how my role will change when I am using the innovation.	0	1	2	3	4	[✓ 5]	6	7
34. Coordination of tasks and people is taking too much of my time.	0	[✓ 1]	2	3	4	5	6	7
35. I would like to know how the innovation is better than what we have now.	0	[✓ 1]	2	3	4	5	6	7

Stages of Concern Quick Scoring Device

SoCQ 075

1	7
2	2
3	3
4	1
5	7
6	5
7	3
8	1
9	4
10	6
11	6
12	1
13	2
14	5
15	6
16	1
17	5
18	6

A

Date: 2-20-16

Site: Pre SS#: A

Innovation: T/E DBL

B

Stage 0	1	2	3	4	5	6
3 3	6 5	7 3	4 1	1 7	5 7	2 2
12 1	14 5	13 2	8 1	11 6	10 6	9 4
21 2	15 6	17 5	16 1	19 6	18 6	20 6
23 2	26 2	28 2	25 3	24 7	27 6	22 6
30 2	35 1	33 5	34 1	32 6	29 4	31 6

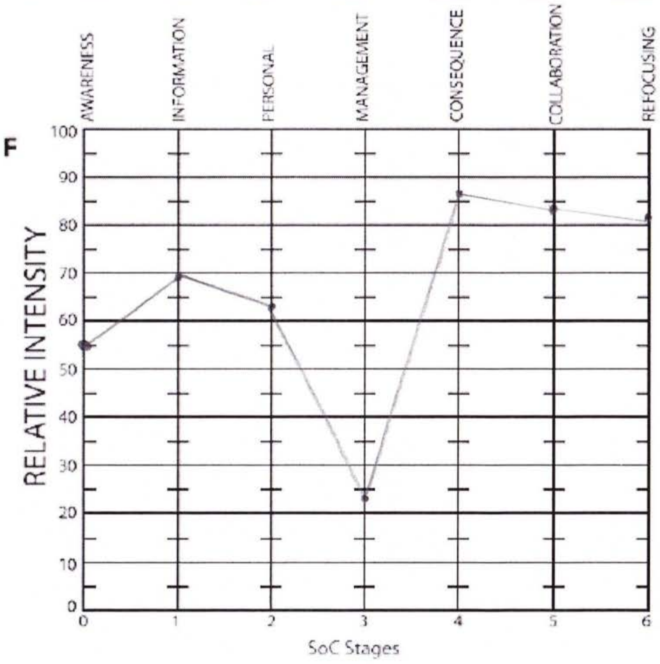
Raw Score Totals **C**	10	19	17	7	32	29	24
Percentile Scores **E**	55	69	63	23	86	84	81

D

Five Item Raw Scale Score Total	Percentiles for: Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
0	0	5	5	2	1	1	1
1	1	12	12	5	1	2	2
2	2	16	14	7	1	3	3
3	4	19	17	9	2	3	5
4	7	23	21	11	2	4	6
5	14	27	25	15	3	5	9
6	22	30	28	18	3	7	11
7	31	34	31	23	4	9	14
8	40	37	35	27	5	10	17
9	48	40	39	30	5	12	20
10	55	43	41	34	7	14	22
11	61	45	45	39	8	16	26
12	69	48	48	43	9	19	30
13	75	51	52	47	11	22	34
14	81	54	55	52	13	25	38
15	87	57	57	56	16	28	42
16	91	60	59	60	19	31	47
17	94	63	63	65	21	36	52
18	96	66	67	69	24	40	57
19	97	69	70	73	27	44	60
20	98	72	72	77	30	48	65
21	99	75	76	80	33	52	69
22	99	80	78	83	38	55	73
23	99	84	80	85	43	59	77
24	99	88	83	88	48	64	81
25	99	90	85	90	54	68	84
26	99	91	87	92	59	72	87
27	99	93	89	94	63	76	90
28	99	95	91	95	66	80	92
29	99	96	92	97	71	84	94
30	99	97	94	97	76	88	96
31	99	98	95	98	82	91	97
32	99	99	96	98	86	93	98
33	99	99	96	99	90	95	99
34	99	99	97	99	92	97	99
35	99	99	99	99	96	98	99

Concerns Based Systems International

F



19	6
20	6
21	2
22	6
23	2
24	7
25	3
26	2
27	6
28	2
29	4
30	2
31	6
32	6
33	5
34	1
35	1

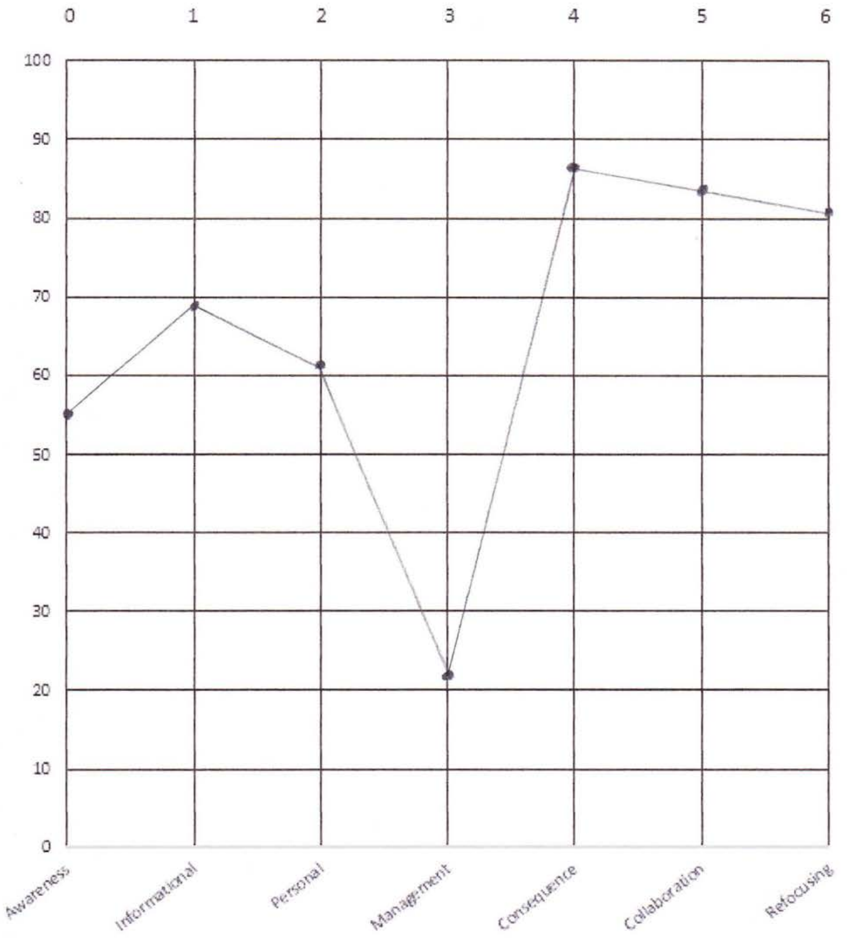
Wells Re-Make of Scoring Device Fall 2011

Stages of Concern Profile Pre

Date: 2-20-16

Participant Code: A

Innovation: T/EDBL



Post

Stages of Concern Questionnaire

Name (optional): A

The purpose of this questionnaire is to determine what people who are using or thinking about using various programs are concerned about at various times during the adoption process.

The items were developed from typical responses of school and college teachers who ranged from no knowledge at all about various programs to many years' experience using them. Therefore, **many of the items on this questionnaire may appear to be of little relevance or irrelevant to you at this time**. For the completely irrelevant items, please circle "0" on the scale. Other items will represent those concerns you do have, in varying degrees of intensity, and should be marked higher on the scale.

For example:

This statement is very true of me at this time.	0	1	2	3	4	5	6	[✓ 7]
This statement is somewhat true of me now.	0	1	2	3	[✓ 4]	5	6	7
This statement is not at all true of me at this time.	0	1	[✓ 2]	3	4	5	6	7
This statement seems irrelevant to me.	[✓ 0]	1	2	3	4	5	6	7

Please respond to the items in terms of **your present concerns**, or how you feel about your involvement with **this** innovation. We do not hold to any one definition of the innovation so please think of it in terms of your own perception of what it involves. Phrases such as "this approach" and "the new system" all refer to the same innovation. Remember to respond to each item in terms of your present concerns about your involvement or potential involvement with the innovation.

Thank you for taking time to complete this task.

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now		Somewhat true of me now			Very true of me now	

Circle one number for each item

1. I am concerned about students' attitudes toward the innovation.	0	1	2	3	4	5	[✓ 6]	7
2. I now know of some other approaches that might work better.	0	1	2	3	4	5	[✓ 6]	7
3. I am more concerned about another innovation.	[✓ 0]	1	2	3	4	5	6	7
4. I am concerned about not having enough time to organize myself each day.	0	1	[✓ 2]	3	4	5	6	7
5. I would like to help other faculty in their use of the innovation.	0	1	[✓ 2]	3	4	5	6	7
6. I have a very limited knowledge of the innovation.	0	1	[✓ 2]	3	4	5	6	7
7. I would like to know the effect of reorganization on my professional status.	[✓ 0]	1	2	3	4	5	6	7
8. I am concerned about conflict between my interests and my responsibilities.	0	1	[✓ 2]	3	4	5	6	7
9. I am concerned about revising my use of the innovation.	0	1	[✓ 2]	3	4	5	6	7
10. I would like to develop working relationships with both our faculty and outside faculty using this innovation.	0	1	2	3	4	[✓ 5]	6	7
11. I am concerned about how the innovation affects students.	0	1	2	3	4	5	[✓ 6]	7
12. I am not concerned about the innovation at this time.	0	[✓ 1]	2	3	4	5	6	7
13. I would like to know who will make the decisions in the new system.	[✓ 0]	1	2	3	4	5	6	7
14. I would like to discuss the possibility of using the innovation.	[✓ 0]	1	2	3	4	5	6	7
15. I would like to know what resources are available if we decide to adopt the innovation.	[✓ 0]	1	2	3	4	5	6	7
16. I am concerned about my inability to manage all that the innovation requires.	0	1	[✓ 2]	3	4	5	6	7
17. I would like to know how my teaching or administration is supposed to change.	0	1	[✓ 2]	3	4	5	6	7
18. I would like to familiarize other departments or persons with the progress of this new approach.	0	1	2	~~[✓ 3]~~	4	[✓ 5]	6	7

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now		Somewhat true of me now			Very true of me now	

Circle one number for each item

19. I am concerned about evaluating my impact on students.	0	1	2	3	4	5	6	[✓ 7]
20. I would like to revise the innovation's approach.	0	1	[✓ 2]	3	4	5	6	7
21. I am preoccupied with things other than the innovation.	0	1	2	[✓ 3]	4	5	6	7
22. I would like to modify our use of the innovation based on the experiences of our students.	0	1	[✓ 2]	3	4	5	6	7
23. I spent little time thinking about the innovation.	0	1	[✓ 2]	3	4	5	6	7
24. I would like to excite my students about their part in this approach.	0	1	2	3	4	5	[✓ 6]	7
25. I would concerned about time spent working with nonacademic problems related to the innovation.	0	1	[✓ 2]	3	4	5	6	7
26. I would like to know what the use of the innovation will require in the immediate future.	0	1	[✓ 2]	3	4	5	6	7
27. I would like to coordinate my efforts with others to maximize the innovation's effects.	0	1	~~[✓ 2]~~	3	[✓ 4]	5	6	7
28. I would like to have more information on time and energy commitments required by the innovation.	0	1	[✓ 2]	3	4	5	6	7
29. I would like to know what other faculty are doing in this area.	0	1	2	3	4	[✓ 5]	6	7
30. Currently, other priorities prevent me from focusing my attention on the innovation.	0	1	[✓ 2]	3	4	5	6	7
31. I would like to determine how to supplement, enhance, or replace the innovation.	0	1	2	3	[✓ 4]	5	6	7
32. I would like to use feedback from students to change the program.	[✓ 0]	1	2	3	4	5	6	7
33. I would like to know how my role will change when I am using the innovation.	0	1	2	[✓ 3]	4	5	6	7
34. Coordination of tasks and people is taking too much of my time.	0	1	[✓ 2]	3	4	5	6	7
35. I would like to know how the innovation is better than what we have now.	0	1	[✓ 2]	3	4	5	6	7

Stages of Concern Quick Scoring Device

SoCQ 075

1	6
2	6
3	0
4	2
5	2
6	2
7	0
8	2
9	2
10	5
11	6
12	1
13	0
14	0
15	0
16	2
17	2
18	5

A

Date: 4-22-16
Site: Post SS#: A
Innovation: T/EDBL

B

Stage 0		1		2		3		4		5		6	
3	0	6	6	7	0	4	2	1	6	5	2	2	6
12	1	14	0	13	0	8	2	11	6	10	5	9	2
21	3	15	0	17	2	16	2	19	7	18	5	20	2
23	2	26	2	28	2	25	2	24	6	27	4	22	2
30	2	35	2	33	3	34	2	32	0	29	5	31	4

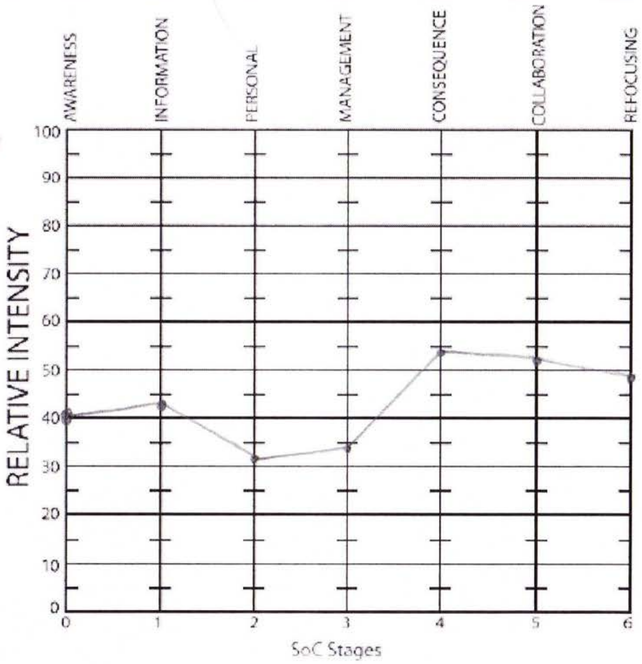
		0	1	2	3	4	5	6
Raw Score Totals	**C**	8	10	7	10	25	21	16
Percentile Scores	**E**	40	43	31	34	54	52	47

D

Five Item Raw Scale Score Total	Percentiles for						
	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
0	0	5	5	2	1	1	1
1	1	12	12	5	1	2	2
2	2	16	14	7	1	3	3
3	4	19	17	9	2	3	5
4	7	23	21	11	2	4	6
5	14	27	25	15	3	5	9
6	22	30	28	18	3	7	11
7	31	34	31	23	4	9	14
8	40	37	35	27	5	10	17
9	48	40	39	30	5	12	20
10	55	43	41	34	7	14	22
11	61	45	45	39	8	16	26
12	69	48	48	43	9	19	30
13	75	51	52	47	11	22	34
14	81	54	55	52	13	25	38
15	87	57	57	56	16	28	42
16	91	60	59	60	19	31	47
17	94	63	63	65	21	36	52
18	96	66	67	69	24	40	57
19	97	69	70	73	27	44	60
20	98	72	72	77	30	48	65
21	99	75	76	80	33	52	69
22	99	80	78	83	38	55	73
23	99	84	80	85	43	59	77
24	99	88	83	88	46	64	81
25	99	90	85	90	54	68	84
26	99	91	87	92	59	72	87
27	99	93	89	94	63	76	90
28	99	95	91	95	66	80	92
29	99	96	92	97	71	84	94
30	99	97	94	97	76	88	96
31	99	98	95	98	82	91	97
32	99	99	96	98	86	93	98
33	99	99	96	99	90	95	99
34	99	99	97	99	92	97	99
35	99	99	98	99	96	98	99

Concerns Based Systems International

F



19	7
20	2
21	3
22	2
23	2
24	6
25	2
26	2
27	4
28	2
29	5
30	2
31	4
32	0
33	3
34	2
35	2

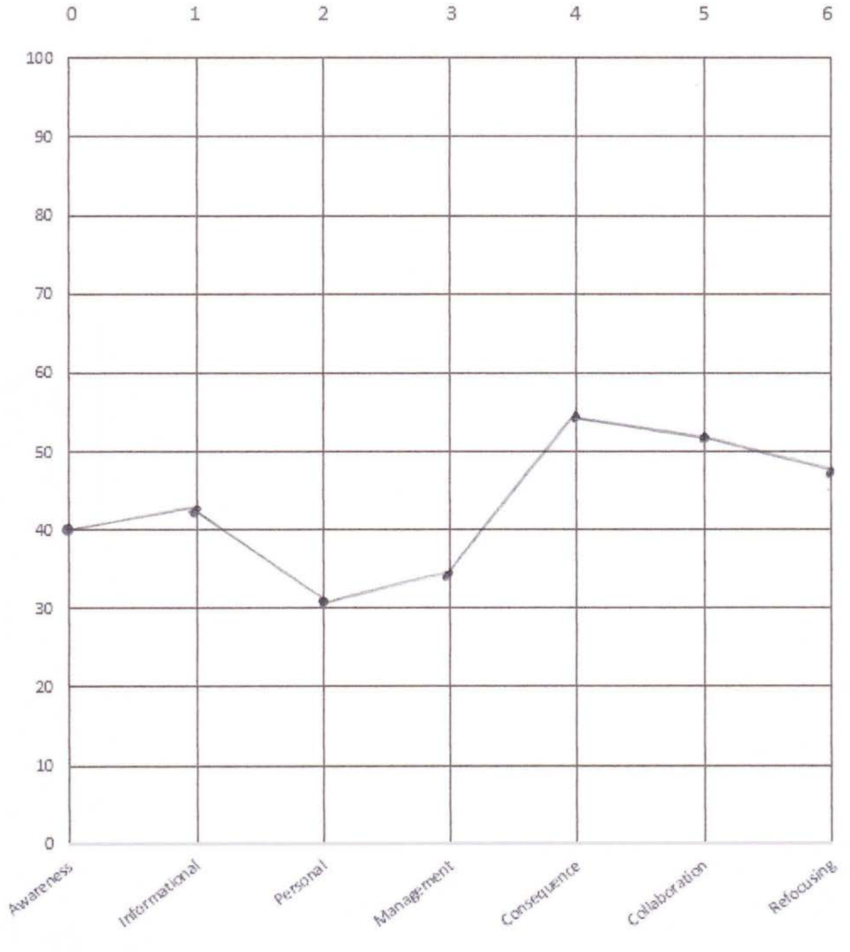
Wells: Re-Make of Scoring Device Fall 2011

Stages of Concern Profile Post

Date: __________

Participant Code: A

Innovation: T/E DBL



Pre

Stages of Concern Questionnaire

Name (optional): B

The purpose of this questionnaire is to determine what people who are using or thinking about using various programs are concerned about at various times during the adoption process.

The items were developed from typical responses of school and college teachers who ranged from no knowledge at all about various programs to many years' experience using them. Therefore, **many of the items on this questionnaire may appear to be of little relevance or irrelevant to you at this time**. For the completely irrelevant items, please circle "0" on the scale. Other items will represent those concerns you do have, in varying degrees of intensity, and should be marked higher on the scale.

For example:

This statement is very true of me at this time.	0	1	2	3	4	5	6	[✓ 7]
This statement is somewhat true of me now.	0	1	2	3	[✓ 4]	5	6	7
This statement is not at all true of me at this time.	0	1	[✓ 2]	3	4	5	6	7
This statement seems irrelevant to me.	[✓ 0]	1	2	3	4	5	6	7

Please respond to the items in terms of **your present concerns**, or how you feel about your involvement with **this** innovation. We do not hold to any one definition of the innovation so please think of it in terms of your own perception of what it involves. Phrases such as "this approach" and "the new system" all refer to the same innovation. Remember to respond to each item in terms of your present concerns about your involvement or potential involvement with the innovation.

Thank you for taking time to complete this task.

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now			Somewhat true of me now		Very true of me now	

Circle one number for each item

1. I am concerned about students' attitudes toward the innovation.	0	1	2	3	4	5	6	[✓ 7]
2. I now know of some other approaches that might work better.	0	1	2	3	[✓ 4]	5	6	7
3. I am more concerned about another innovation.	0	1	[✓ 2]	3	4	5	6	7
4. I am concerned about not having enough time to organize myself each day.	0	1	2	3	4	5	6	[✓ 7]
5. I would like to help other faculty in their use of the innovation.	0	1	2	3	[✓ 4]	5	6	7
6. I have a very limited knowledge of the innovation.	0	1	2	3	[✓ 4]	5	6	7
7. I would like to know the effect of reorganization on my professional status.	0	1	2	3	4	5	[✓ 6]	7
8. I am concerned about conflict between my interests and my responsibilities.	0	1	2	3	4	5	[✓ 6]	7
9. I am concerned about revising my use of the innovation.	0	1	2	3	[✓ 4]	5	6	7
10. I would like to develop working relationships with both our faculty and outside faculty using this innovation.	0	1	~~2~~	3	[✓ 4]	5	6	7
11. I am concerned about how the innovation affects students.	0	1	~~2~~	3	4	5	6	[✓ 7]
12. I am not concerned about the innovation at this time.	0	1	[✓ 2]	3	4	5	6	7
13. I would like to know who will make the decisions in the new system.	0	1	2	3	4	5	[✓ 6]	7
14. I would like to discuss the possibility of using the innovation.	0	1	2	3	[✓ 4]	5	6	7
15. I would like to know what resources are available if we decide to adopt the innovation.	0	1	2	3	4	[✓ 5]	6	7
16. I am concerned about my inability to manage all that the innovation requires.	0	1	2	3	4	[✓ 5]	6	7
17. I would like to know how my teaching or administration is supposed to change.	0	1	2	3	4	[✓ 5]	6	7
18. I would like to familiarize other departments or persons with the progress of this new approach.	0	1	2	3	[✓ 4]	5	6	7

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now			Somewhat true of me now		Very true of me now	

Circle one number for each item

19. I am concerned about evaluating my impact on students.	0	1	2	3	4	5	6	[✓ 7]
20. I would like to revise the innovation's approach.	0	1	2	3	[✓ 4]	5	6	7
21. I am preoccupied with things other than the innovation.	0	1	2	3	~~4~~	5	[✓ 6]	7
22. I would like to modify our use of the innovation based on the experiences of our students.	0	1	2	3	4	[✓ 5]	6	7
23. I spent little time thinking about the innovation.	0	1	2	3	[✓ 4]	5	6	7
24. I would like to excite my students about their part in this approach.	0	1	2	3	4	5	6	[✓ 7]
25. I would concerned about time spent working with nonacademic problems related to the innovation.	0	1	2	3	[✓ 4]	5	6	7
26. I would like to know what the use of the innovation will require in the immediate future.	0	1	2	3	[✓ 4]	5	6	7
27. I would like to coordinate my efforts with others to maximize the innovation's effects.	0	1	2	3	[✓ 4]	5	6	7
28. I would like to have more information on time and energy commitments required by the innovation.	0	1	2	3	4	[✓ 5]	6	7
29. I would like to know what other faculty are doing in this area.	0	1	2	3	[✓ 4]	5	6	7
30. Currently, other priorities prevent me from focusing my attention on the innovation.	0	1	2	3	4	5	[✓ 6]	7
31. I would like to determine how to supplement, enhance, or replace the innovation.	0	1	2	3	[✓ 4]	5	6	7
32. I would like to use feedback from students to change the program.	0	1	2	3	4	5	[✓ 6]	7
33. I would like to know how my role will change when I am using the innovation.	0	1	2	3	4	[✓ 5]	6	7
34. Coordination of tasks and people is taking too much of my time.	0	1	2	3	4	5	6	[✓ 7]
35. I would like to know how the innovation is better than what we have now.	0	1	2	3	4	[✓ 5]	6	7

Stages of Concern Quick Scoring Device

SoCQ 075

1	7
2	4
3	2
4	7
5	4
6	4
7	6
8	6
9	4
10	4
11	7
12	2
13	6
14	4
15	5
16	5
17	5
18	4

A

Date: 2-20-16

Site: Pre SS#: B

Innovation: T/E DBL

B

Stage 0	1	2	3	4	5	6
3 2	6 4	7 6	4 7	1 7	5 4	2 4
12 2	14 4	13 6	8 6	11 7	10 4	9 4
21 6	15 5	17 5	16 5	19 7	18 4	20 4
23 4	26 4	28 5	25 4	24 7	27 4	22 5
30 6	35 5	33 5	34 7	32 6	29 4	31 4

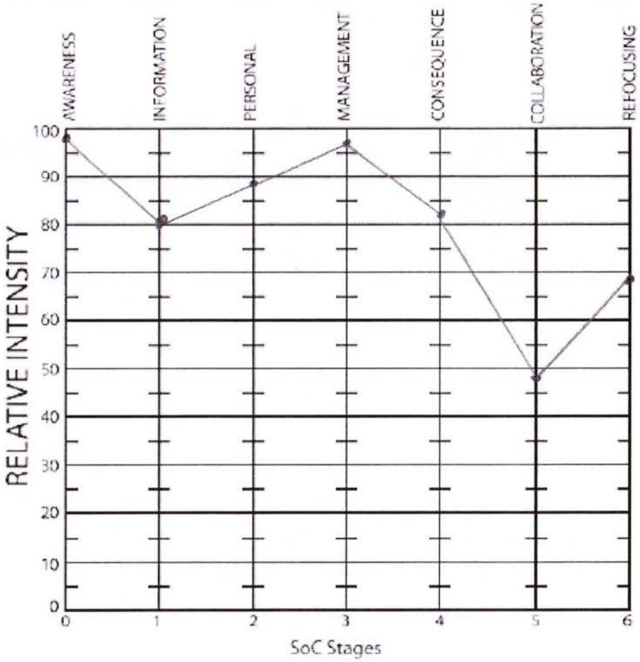
Raw Score Totals	**C**	20	22	27	29	34	20	21
Percentile Scores	**E**	98	80	89	97	92	48	69

D

Five Item Raw Scale Score Total	Percentiles for:						
	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
0	0	5	5	2	1	1	1
1	1	12	12	5	1	2	2
2	2	16	14	7	1	3	3
3	4	19	17	9	2	3	5
4	7	23	21	11	2	4	6
5	14	27	25	15	3	5	9
6	22	30	28	18	3	7	11
7	31	34	31	23	4	9	14
8	40	37	35	27	5	10	17
9	48	40	39	30	5	12	20
10	55	43	41	34	7	14	22
11	61	45	45	39	8	16	26
12	69	48	48	43	9	19	30
13	75	51	52	47	11	22	34
14	81	54	55	52	13	25	38
15	87	57	57	56	16	28	42
16	91	60	59	60	19	31	47
17	94	63	63	65	21	36	52
18	96	66	67	69	24	40	57
19	97	69	70	73	27	44	60
20	98	72	72	77	30	48	65
21	99	75	76	80	33	52	69
22	99	80	78	83	38	55	73
23	99	84	80	85	43	59	77
24	99	88	83	88	48	64	81
25	99	90	85	90	54	68	84
26	99	91	87	92	59	72	87
27	99	93	89	94	63	76	90
28	99	95	91	95	66	80	92
29	99	96	92	97	71	84	94
30	99	97	94	97	76	88	96
31	99	98	95	98	82	91	97
32	99	99	96	98	86	93	98
33	99	99	96	99	90	95	99
34	99	99	97	99	92	97	99
35	99	99	99	99	96	98	99

Concerns Based Systems International

F



19	7
20	4
21	6
22	5
23	4
24	7
25	4
26	4
27	4
28	5
29	4
30	6
31	4
32	6
33	5
34	7
35	5

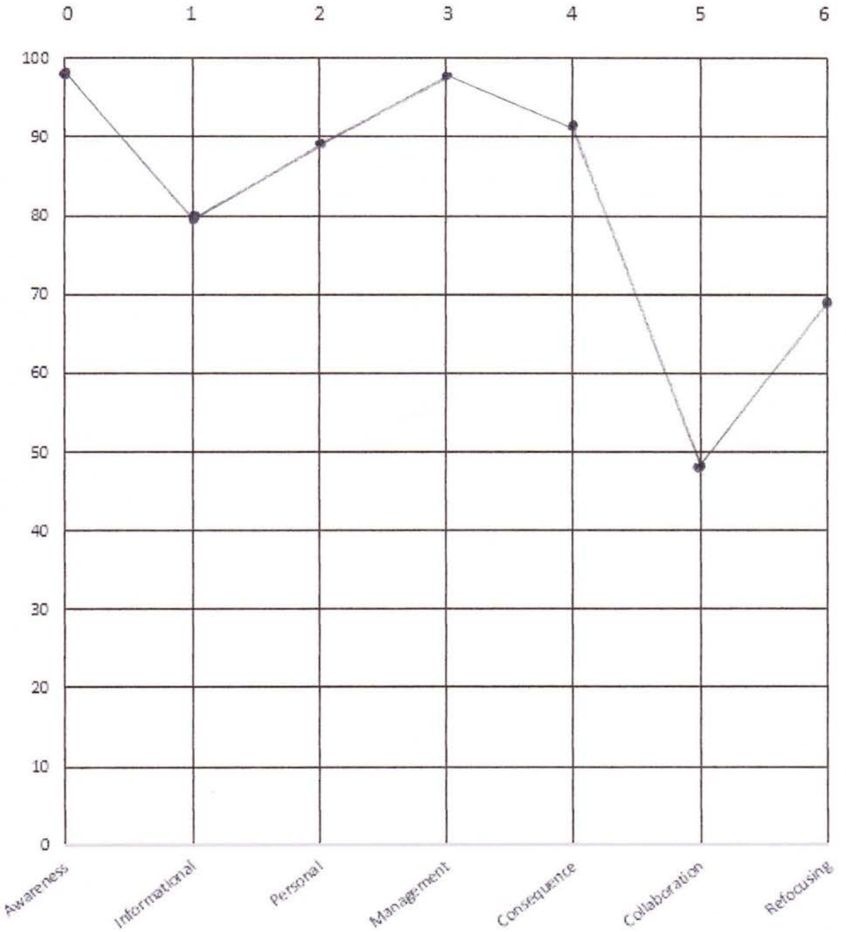
Wells Re-Make of Scoring Device Fall 2011

Stages of Concern Profile

Date: 2-20-16

Participant Code: B

Innovation: T/EDBL



Post

Stages of Concern Questionnaire

Name (optional): B

The purpose of this questionnaire is to determine what people who are using or thinking about using various programs are concerned about at various times during the adoption process.

The items were developed from typical responses of school and college teachers who ranged from no knowledge at all about various programs to many years' experience using them. Therefore, **many of the items on this questionnaire may appear to be of little relevance or irrelevant to you at this time**. For the completely irrelevant items, please circle "0" on the scale. Other items will represent those concerns you do have, in varying degrees of intensity, and should be marked higher on the scale.

For example:

This statement is very true of me at this time.	0	1	2	3	4	5	6	[✓ 7]
This statement is somewhat true of me now.	0	1	2	3	[✓ 4]	5	6	7
This statement is not at all true of me at this time.	0	1	[✓ 2]	3	4	5	6	7
This statement seems irrelevant to me.	[✓ 0]	1	2	3	4	5	6	7

Please respond to the items in terms of **your present concerns**, or how you feel about your involvement with **this** innovation. We do not hold to any one definition of the innovation so please think of it in terms of your own perception of what it involves. Phrases such as "this approach" and "the new system" all refer to the same innovation. Remember to respond to each item in terms of your present concerns about your involvement or potential involvement with the innovation.

Thank you for taking time to complete this task.

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now			Somewhat true of me now		Very true of me now	

Circle one number for each item

1. I am concerned about students' attitudes toward the innovation.	0	1	2	3	4	[✓ 5]	6	7
2. I now know of some other approaches that might work better.	0	1	[✓ 2]	3	4	5	6	7
3. I am more concerned about another innovation.	[✓ 0]	1	2	3	4	5	6	7
4. I am concerned about not having enough time to organize myself each day.	0	1	2	3	4	5	6	[✓ 7]
5. I would like to help other faculty in their use of the innovation.	0	1	2	3	4	[✓ 5]	6	7
6. I have a very limited knowledge of the innovation.	0	1	2	[✓ 3]	4	5	6	7
7. I would like to know the effect of reorganization on my professional status.	0	1	2	3	4	5	[✓ 6]	7
8. I am concerned about conflict between my interests and my responsibilities.	0	1	2	3	4	5	[✓ 6]	7
9. I am concerned about revising my use of the innovation.	0	1	2	[✓ 3]	4	5	6	7
10. I would like to develop working relationships with both our faculty and outside faculty using this innovation.	0	1	2	3	4	[✓ 5]	6	7
11. I am concerned about how the innovation affects students.	0	1	2	3	4	[✓ 5]	6	7
12. I am not concerned about the innovation at this time.	0	1	[✓ 2]	3	4	5	6	7
13. I would like to know who will make the decisions in the new system.	0	1	2	[✓ 3]	4	5	6	7
14. I would like to discuss the possibility of using the innovation.	0	1	2	[✓ 3]	4	5	6	7
15. I would like to know what resources are available if we decide to adopt the innovation.	0	1	2	3	4	[✓ 5]	6	7
16. I am concerned about my inability to manage all that the innovation requires.	0	1	2	3	4	5	[✓ 6]	7
17. I would like to know how my teaching or administration is supposed to change.	0	1	2	3	4	5	[✓ 6]	7
18. I would like to familiarize other departments or persons with the progress of this new approach.	0	1	2	[✓ 3]	4	5	6	7

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now			Somewhat true of me now		Very true of me now	

Circle one number for each item

19. I am concerned about evaluating my impact on students.	0	1	2	3	4	5	[✓ 6]	7
20. I would like to revise the innovation's approach.	0	1	2	[✓ 3]	4	5	6	7
21. I am preoccupied with things other than the innovation.	0	1	2	3	4	5	[✓ 6]	7
22. I would like to modify our use of the innovation based on the experiences of our students.	0	1	2	3	[✓ 4]	5	6	7
23. I spent little time thinking about the innovation.	0	1	2	3	[✓ 4]	5	6	7
24. I would like to excite my students about their part in this approach.	0	1	2	3	4	5	[✓ 6]	7
25. I would concerned about time spent working with nonacademic problems related to the innovation.	0	1	2	3	4	5	[✓ 6]	7
26. I would like to know what the use of the innovation will require in the immediate future.	0	1	2	3	4	5	[✓ 6]	7
27. I would like to coordinate my efforts with others to maximize the innovation's effects.	0	1	2	3	[✓ 4]	5	6	7
28. I would like to have more information on time and energy commitments required by the innovation.	0	1	2	3	4	[✓ 5]	6	7
29. I would like to know what other faculty are doing in this area.	0	1	2	[✓ 3]	4	5	6	7
30. Currently, other priorities prevent me from focusing my attention on the innovation.	0	1	2	3	4	[✓ 5]	6	7
31. I would like to determine how to supplement, enhance, or replace the innovation.	0	1	2	[✓ 3]	4	5	6	7
32. I would like to use feedback from students to change the program.	0	1	2	3	[✓ 4]	5	6	7
33. I would like to know how my role will change when I am using the innovation.	0	1	2	3	[✓ 4]	5	6	7
34. Coordination of tasks and people is taking too much of my time.	0	1	2	3	4	5	[✓ 6]	7
35. I would like to know how the innovation is better than what we have now.	0	1	2	[✓ 3]	4	5	6	7

Stages of Concern Quick Scoring Device

SoCQ 075

5	1
2	2
0	3
7	4
5	5
3	6
6	7
6	8
3	9
5	10
5	11
2	12
3	13
3	14
5	15
6	16
6	17
3	18

A

Date: 4-29-16

Site: Post SS#: B

Innovation: T/EDBL

B

Stage 0	1	2	3	4	5	6
3 0	6 3	7 6	4 7	1 5	5 5	2 2
12 2	14 3	13 3	8 6	11 5	10 5	9 3
21 6	15 5	17 6	16 6	19 6	18 3	20 3
23 4	26 6	28 5	25 6	24 6	27 4	22 4
30 5	35 3	33 4	34 6	32 4	29 3	31 3

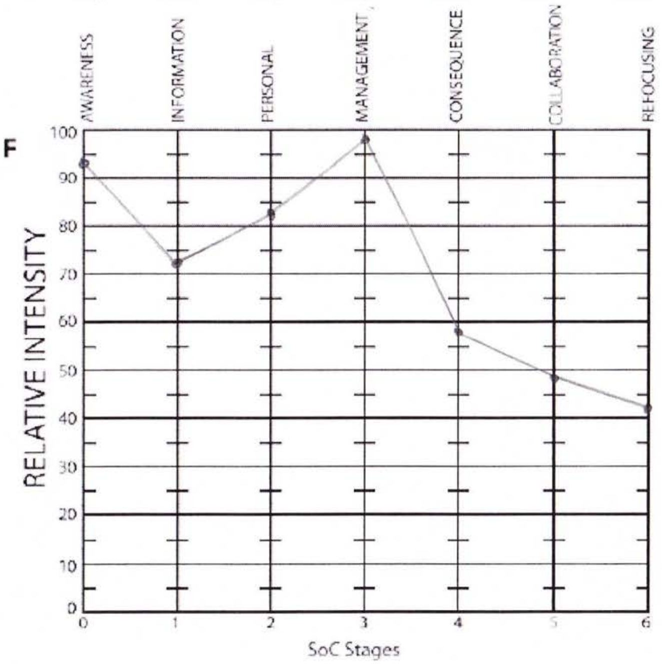
Raw Score Totals **C**	17	20	24	31	26	20	15
Percentile Scores **E**	94	72	83	98	59	48	42

D

Five Item Raw Scale Score Total	Percentiles for:						
	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
0	0	5	5	2	1	1	1
1	1	12	12	5	1	2	2
2	2	16	14	7	1	3	3
3	4	19	17	9	2	3	5
4	7	23	21	11	2	4	6
5	14	27	25	15	3	5	9
6	22	30	28	18	3	7	11
7	31	34	31	23	4	9	14
8	40	37	35	27	5	10	17
9	48	40	39	30	5	12	20
10	55	43	41	34	7	14	22
11	61	45	45	39	8	16	26
12	69	48	48	43	9	19	30
13	75	51	52	47	11	22	34
14	81	54	55	52	13	25	38
15	87	57	57	56	16	28	42
16	91	60	59	60	19	31	47
17	94	63	63	65	21	36	52
18	96	66	67	69	24	40	57
19	97	69	70	73	27	44	60
20	98	72	72	77	30	48	65
21	99	75	76	80	33	52	69
22	99	80	78	83	38	55	73
23	99	84	80	85	43	59	77
24	99	85	83	88	48	64	81
25	99	90	85	90	54	68	84
26	99	91	87	92	59	72	87
27	99	93	89	94	63	76	90
28	99	95	91	95	66	80	92
29	99	96	92	97	71	84	94
30	99	97	94	97	76	88	96
31	99	98	95	98	82	91	97
32	99	99	96	98	86	93	98
33	99	99	96	99	90	95	99
34	99	99	97	99	92	97	99
35	99	99	99	99	96	98	99

Concerns Based Systems International

F

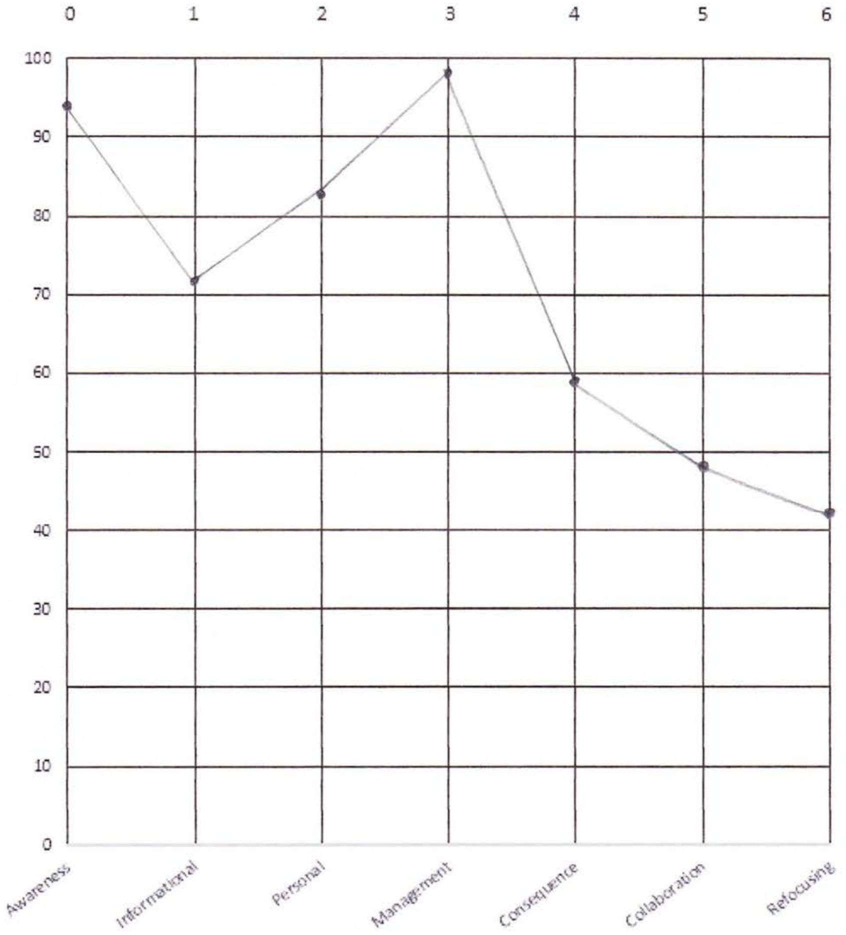


19	6
20	3
21	6
22	4
23	4
24	6
25	6
26	6
27	4
28	5
29	3
30	5
31	3
32	4
33	4
34	6
35	3

Wells Re-Make of Scoring Device Fall 2011

Stages of Concern Profile Post

Date: 4-29-16
Participant Code: B
Innovation: T/EDBL



Pre

Stages of Concern Questionnaire

Name (optional): C

The purpose of this questionnaire is to determine what people who are using or thinking about using various programs are concerned about at various times during the adoption process.

The items were developed from typical responses of school and college teachers who ranged from no knowledge at all about various programs to many years' experience using them. Therefore, **many of the items on this questionnaire may appear to be of little relevance or irrelevant to you at this time**. For the completely irrelevant items, please circle "0" on the scale. Other items will represent those concerns you do have, in varying degrees of intensity, and should be marked higher on the scale.

For example:

This statement is very true of me at this time.	0	1	2	3	4	5	6	[✓ 7]
This statement is somewhat true of me now.	0	1	2	3	[✓ 4]	5	6	7
This statement is not at all true of me at this time.	0	1	[✓ 2]	3	4	5	6	7
This statement seems irrelevant to me.	[✓ 0]	1	2	3	4	5	6	7

Please respond to the items in terms of **your present concerns**, or how you feel about your involvement with **this** innovation. We do not hold to any one definition of the innovation so please think of it in terms of your own perception of what it involves. Phrases such as "this approach" and "the new system" all refer to the same innovation. Remember to respond to each item in terms of your present concerns about your involvement or potential involvement with the innovation.

Thank you for taking time to complete this task.

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now		Somewhat true of me now			Very true of me now	

Circle one number for each item

1. I am concerned about students' attitudes toward the innovation.	0	1	2	3	4	5	6	[✓ 7]
2. I now know of some other approaches that might work better.	0	[✓ 1]	2	3	4	5	6	7
3. I am more concerned about another innovation.	0	[✓ 1]	2	3	4	5	6	7
4. I am concerned about not having enough time to organize myself each day.	0	1	2	3	[✓ 4]	5	6	7
5. I would like to help other faculty in their use of the innovation.	0	1	2	3	4	[✓ 5]	6	7
6. I have a very limited knowledge of the innovation.	0	1	2	3	[✓ 4]	5	6	7
7. I would like to know the effect of reorganization on my professional status.	0	1	2	3	4	[✓ 5]	6	7
8. I am concerned about conflict between my interests and my responsibilities.	0	1	2	3	4	[✓ 5]	6	7
9. I am concerned about revising my use of the innovation.	0	1	2	3	[✓ 4]	5	6	7
10. I would like to develop working relationships with both our faculty and outside faculty using this innovation.	0	1	2	3	4	5	[✓ 6]	7
11. I am concerned about how the innovation affects students.	0	1	2	3	4	5	[✓ 6]	7
12. I am not concerned about the innovation at this time.	0	1	[✓ 2]	3	4	5	6	7
13. I would like to know who will make the decisions in the new system.	0	1	2	3	4	5	[✓ 6]	7
14. I would like to discuss the possibility of using the innovation.	0	1	2	3	4	5	[✓ 6]	7
15. I would like to know what resources are available if we decide to adopt the innovation.	0	1	2	3	4	5	[✓ 6]	7
16. I am concerned about my inability to manage all that the innovation requires.	0	1	2	3	4	5	[✓ 6]	7
17. I would like to know how my teaching or administration is supposed to change.	0	1	2	3	4	5	[✓ 6]	7
18. I would like to familiarize other departments or persons with the progress of this new approach.	0	1	2	3	4	[✓ 5]	6	7

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now			Somewhat true of me now		Very true of me now	

Circle one number for each item

19. I am concerned about evaluating my impact on students.	0	1	2	3	4	5	[✓ 6]	7
20. I would like to revise the innovation's approach.	0	1	2	[✓ 3]	4	5	6	7
21. I am preoccupied with things other than the innovation.	0	1	2	[✓ 3]	4	5	6	7
22. I would like to modify our use of the innovation based on the experiences of our students.	0	1	2	3	4	[✓ 5]	6	7
23. I spent little time thinking about the innovation.	0	1	2	3	4	[✓ 5]	6	7
24. I would like to excite my students about their part in this approach.	0	1	2	3	4	5	[✓ 6]	7
25. I would concerned about time spent working with nonacademic problems related to the innovation.	0	1	2	3	4	5	[✓ 6]	7
26. I would like to know what the use of the innovation will require in the immediate future.	0	1	2	3	4	5	[✓ 6]	7
27. I would like to coordinate my efforts with others to maximize the innovation's effects.	0	1	2	3	4	5	[✓ 6]	7
28. I would like to have more information on time and energy commitments required by the innovation.	0	1	2	3	4	5	[✓ 6]	7
29. I would like to know what other faculty are doing in this area.	0	1	2	3	4	5	[✓ 6]	7
30. Currently, other priorities prevent me from focusing my attention on the innovation.	0	1	2	3	[✓ 4]	5	6	7
31. I would like to determine how to supplement, enhance, or replace the innovation.	0	1	[✓ 2]	3	4	5	6	7
32. I would like to use feedback from students to change the program.	0	1	2	3	4	[✓ 5]	6	7
33. I would like to know how my role will change when I am using the innovation.	0	1	2	3	4	5	[✓ 6]	7
34. Coordination of tasks and people is taking too much of my time.	0	1	2	[✓ 3]	4	5	6	7
35. I would like to know how the innovation is better than what we have now.	0	1	2	3	4	5	[✓ 6]	7

Stages of Concern Quick Scoring Device

SoCQ 075

1	7
2	1
3	1
4	4
5	5
6	4
7	5
8	5
9	4
10	6
11	6
12	2
13	6
14	6
15	6
16	6
17	6
18	5
19	6
20	3
21	3
22	5
23	5
24	6
25	6
26	6
27	6
28	6
29	6
30	4
31	2
32	5
33	6
34	3
35	6

A

Date: 2-20-16

Site: Pre SS# C

Innovation: T/E DBL

B

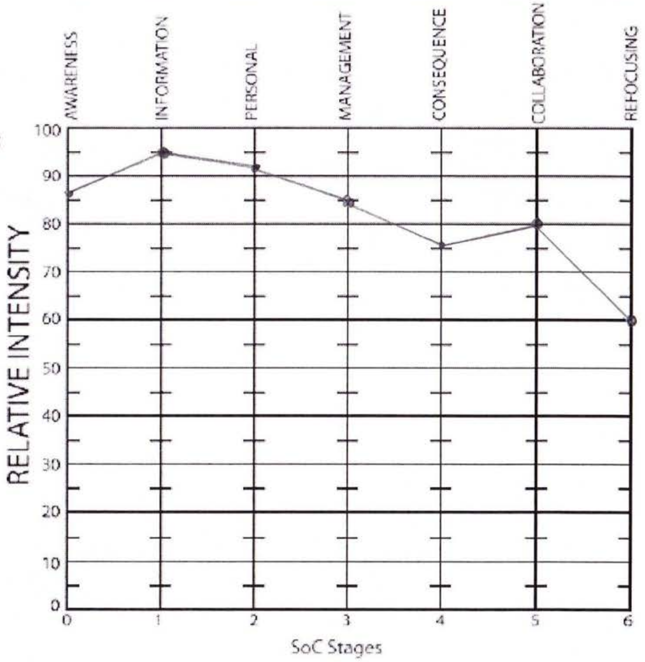
Stage	0	1	2	3	4	5	6
	3 1	6 4	7 5	4 4	1 7	5 5	2 5
	12 2	14 6	13 6	8 5	11 6	10 6	9 4
	21 3	15 6	17 6	16 6	19 6	18 5	20 3
	23 5	26 6	28 6	25 5	24 6	27 6	22 5
	30 4	35 6	33 6	34 3	32 5	29 6	31 2
Raw Score Totals **C**	15	28	29	23	30	28	19
Percentile Scores **E**	87	95	92	85	76	80	60

D

Five Item Raw Scale Score Total	Percentiles for:						
	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
0	0	5	5	2	1	1	1
1	1	12	12	5	1	2	2
2	2	16	14	7	1	3	3
3	4	19	17	9	2	3	5
4	7	23	21	11	2	4	6
5	14	27	25	15	3	5	9
6	22	30	28	18	3	7	11
7	31	34	31	23	4	9	14
8	40	37	35	27	5	10	17
9	48	40	39	30	5	12	20
10	55	43	41	34	7	14	22
11	61	45	45	39	8	16	26
12	69	48	48	43	9	19	30
13	75	51	52	47	11	22	34
14	81	54	55	52	13	25	38
15	87	57	57	56	16	28	42
16	91	60	59	60	19	31	47
17	94	63	63	65	21	36	52
18	96	66	67	69	24	40	57
19	97	69	70	73	27	44	60
20	98	72	72	77	30	48	65
21	99	75	76	80	33	52	69
22	99	80	78	83	38	55	73
23	99	84	80	85	43	59	77
24	99	88	83	88	48	64	81
25	99	90	85	90	54	68	84
26	99	91	87	92	59	72	87
27	99	93	89	94	63	76	90
28	99	95	91	95	66	80	92
29	99	96	92	97	71	84	94
30	99	97	94	97	76	88	96
31	99	98	95	98	82	91	97
32	99	99	96	98	86	93	98
33	99	99	96	99	90	95	99
34	99	99	97	99	92	97	99
35	99	99	99	99	96	98	99

Concerns Based Systems International

F

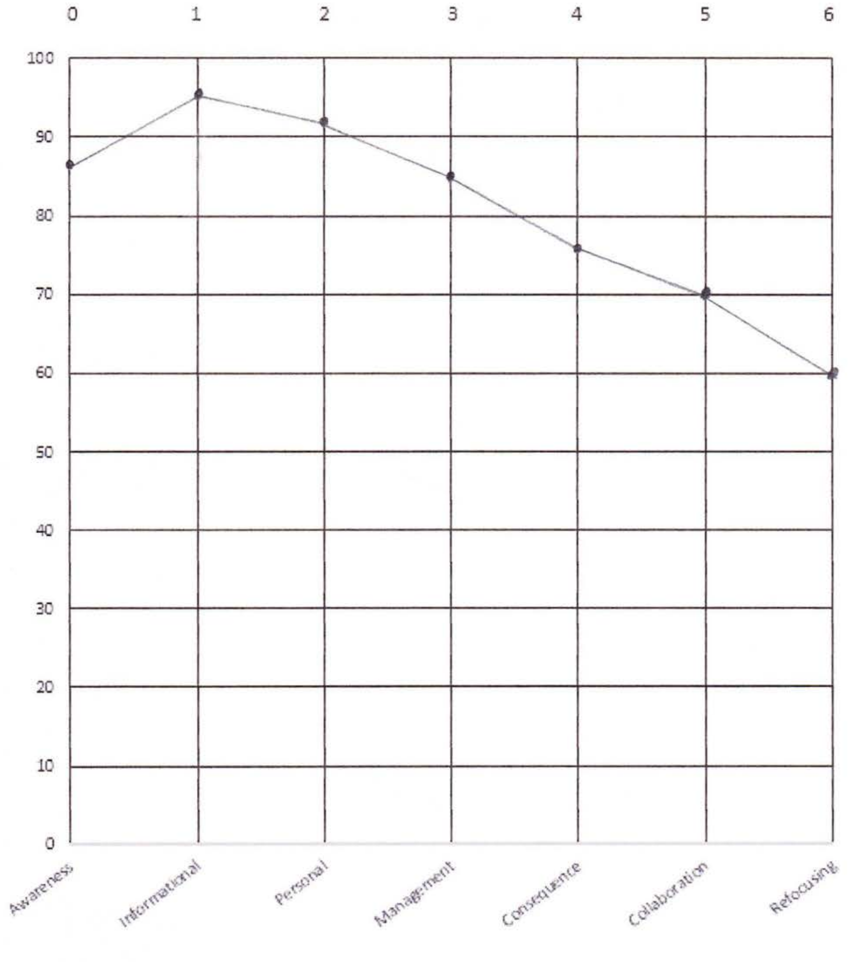


Stages of Concern Profile Pre

Date: 2-20-16

Participant Code: C

Innovation: T/EDBL



Post

Stages of Concern Questionnaire

Name (optional): C

The purpose of this questionnaire is to determine what people who are using or thinking about using various programs are concerned about at various times during the adoption process.

The items were developed from typical responses of school and college teachers who ranged from no knowledge at all about various programs to many years' experience using them. Therefore, **many of the items on this questionnaire may appear to be of little relevance or irrelevant to you at this time**. For the completely irrelevant items, please circle "0" on the scale. Other items will represent those concerns you do have, in varying degrees of intensity, and should be marked higher on the scale.

For example:

This statement is very true of me at this time.	0	1	2	3	4	5	6	[✓ 7]
This statement is somewhat true of me now.	0	1	2	3	[✓ 4]	5	6	7
This statement is not at all true of me at this time.	0	1	[✓ 2]	3	4	5	6	7
This statement seems irrelevant to me.	[✓ 0]	1	2	3	4	5	6	7

Please respond to the items in terms of **your present concerns**, or how you feel about your involvement with **this** innovation. We do not hold to any one definition of the innovation so please think of it in terms of your own perception of what it involves. Phrases such as "this approach" and "the new system" all refer to the same innovation. Remember to respond to each item in terms of your present concerns about your involvement or potential involvement with the innovation.

Thank you for taking time to complete this task.

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now			Somewhat true of me now		Very true of me now	

Circle one number for each item

1. I am concerned about students' attitudes toward the innovation.	0	1	2	3	4	5	[✓ 6]	7
2. I now know of some other approaches that might work better.	0	1	2	3	4	5	[✓ 6]	7
3. I am more concerned about another innovation.	0	1	[✓ 2]	3	4	5	6	7
4. I am concerned about not having enough time to organize myself each day.	0	1	2	3	[✓ 4]	5	6	7
5. I would like to help other faculty in their use of the innovation.	0	1	2	3	4	[✓ 5]	6	7
6. I have a very limited knowledge of the innovation.	0	1	2	[✓ 3]	4	5	6	7
7. I would like to know the effect of reorganization on my professional status.	0	1	2	3	4	[✓ 5]	6	7
8. I am concerned about conflict between my interests and my responsibilities.	0	1	[✓ 2]	3	4	5	6	7
9. I am concerned about revising my use of the innovation.	0	1	[✓ 2]	3	4	5	6	7
10. I would like to develop working relationships with both our faculty and outside faculty using this innovation.	0	1	2	3	4	5	[✓ 6]	7
11. I am concerned about how the innovation affects students.	0	1	2	3	4	5	[✓ 6]	7
12. I am not concerned about the innovation at this time.	0	[✓ 1]	2	3	4	5	6	7
13. I would like to know who will make the decisions in the new system.	0	1	2	3	4	5	[✓ 6]	7
14. I would like to discuss the possibility of using the innovation.	0	1	2	3	4	5	[✓ 6]	7
15. I would like to know what resources are available if we decide to adopt the innovation.	0	1	2	3	4	5	[✓ 6]	7
16. I am concerned about my inability to manage all that the innovation requires.	0	1	2	[✓ 3]	4	5	6	7
17. I would like to know how my teaching or administration is supposed to change.	0	1	2	3	4	[✓ 5]	6	7
18. I would like to familiarize other departments or persons with the progress of this new approach.	0	1	2	3	4	[✓ 5]	6	7

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now			Somewhat true of me now		Very true of me now	

Circle one number for each item

19. I am concerned about evaluating my impact on students.	0	1	2	3	4	5	[✓ 6]	7
20. I would like to revise the innovation's approach.	0	[✓ 1]	2	3	4	5	6	7
21. I am preoccupied with things other than the innovation.	0	1	[✓ 2]	3	4	5	6	7
22. I would like to modify our use of the innovation based on the experiences of our students.	0	1	2	3	[✓ 4]	5	6	7
23. I spent little time thinking about the innovation.	0	[✓ 1]	2	3	4	5	6	7
24. I would like to excite my students about their part in this approach.	0	1	2	3	4	5	[✓ 6]	7
25. I would concerned about time spent working with nonacademic problems related to the innovation.	0	1	2	3	[✓ 4]	5	6	7
26. I would like to know what the use of the innovation will require in the immediate future.	0	1	2	3	4	5	[✓ 6]	7
27. I would like to coordinate my efforts with others to maximize the innovation's effects.	0	1	2	3	4	5	[✓ 6]	7
28. I would like to have more information on time and energy commitments required by the innovation.	0	1	2	3	4	5	[✓ 6]	7
29. I would like to know what other faculty are doing in this area.	0	1	2	3	4	[✓ 5]	6	7
30. Currently, other priorities prevent me from focusing my attention on the innovation.	0	1	[✓ 2]	3	4	5	6	7
31. I would like to determine how to supplement, enhance, or replace the innovation.	0	1	[✓ 2]	3	4	5	6	7
32. I would like to use feedback from students to change the program.	0	1	2	3	4	[✓ 5]	6	7
33. I would like to know how my role will change when I am using the innovation.	0	1	2	3	4	5	[✓ 6]	7
34. Coordination of tasks and people is taking too much of my time.	0	1	2	[✓ 3]	4	5	6	7
35. I would like to know how the innovation is better than what we have now.	0	1	2	3	4	[✓ 5]	6	7

Stages of Concern Quick Scoring Device

SoCQ 075

6	1	19	6
6	2	20	1
2	3	21	2
4	4	22	4
5	5	23	1
3	6	24	6
5	7	25	4
2	8	26	6
2	9	27	6
6	10	28	6
6	11	29	5
1	12	30	2
6	13	31	2
6	14	32	5
6	15	33	6
3	16	34	3
5	17	35	5
5	18		

Post

A

Date: 4-23-16
Site: Post SS#: C
Innovation: T/E DBL

B

Stage 0	1	2	3	4	5	6
3 2	6 3	7 5	4 4	1 6	5 5	2 6
12 1	14 6	13 6	8 2	11 6	10 6	9 2
21 2	15 6	17 5	16 3	19 6	18 5	20 1
23 1	26 6	28 6	25 4	24 6	27 6	22 4
30 2	35 5	33 6	34 3	32 5	29 5	31 2

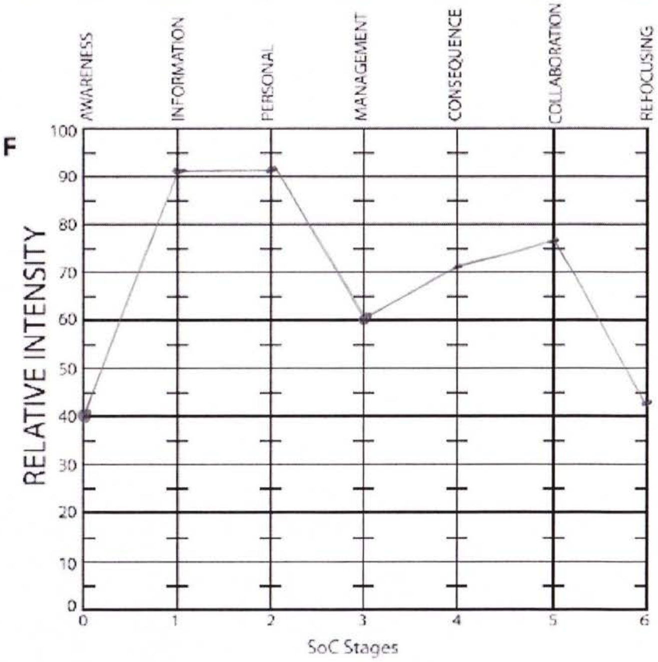
Raw Score Totals	**C**	8	26	28	16	29	27	15
Percentile Scores	**E**	40	91	91	60	71	76	42

D

Free Item Raw Scale Score Total	Percentiles for:						
	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
0	0	5	5	2	1	1	1
1	1	12	12	5	1	2	2
2	2	16	14	7	1	3	3
3	4	19	17	9	2	3	5
4	7	23	21	11	2	4	6
5	14	27	25	15	3	5	9
6	22	30	28	18	3	7	11
7	31	34	31	23	4	9	14
8	40	37	35	27	5	10	17
9	48	40	39	30	5	12	20
10	55	43	41	34	7	14	22
11	61	45	45	39	8	16	26
12	69	48	48	43	9	19	30
13	75	51	52	47	11	22	34
14	81	54	55	52	13	25	38
15	87	57	57	56	16	28	42
16	91	60	59	60	19	31	47
17	94	63	63	65	21	36	52
18	96	66	67	69	24	40	57
19	97	69	70	73	27	44	60
20	98	72	72	77	30	48	65
21	99	75	76	80	33	52	69
22	99	80	78	83	38	55	73
23	99	84	80	85	43	59	77
24	99	88	83	88	48	64	81
25	99	90	85	90	54	68	84
26	99	91	87	92	59	72	87
27	99	93	89	94	63	76	90
28	99	95	91	95	66	80	92
29	99	96	92	97	71	84	94
30	99	97	94	97	76	88	96
31	99	98	95	98	82	91	97
32	99	99	96	98	86	93	98
33	99	99	96	99	90	95	99
34	99	99	97	99	92	97	99
35	99	99	98	99	96	98	99

Concerns Based Systems International

F



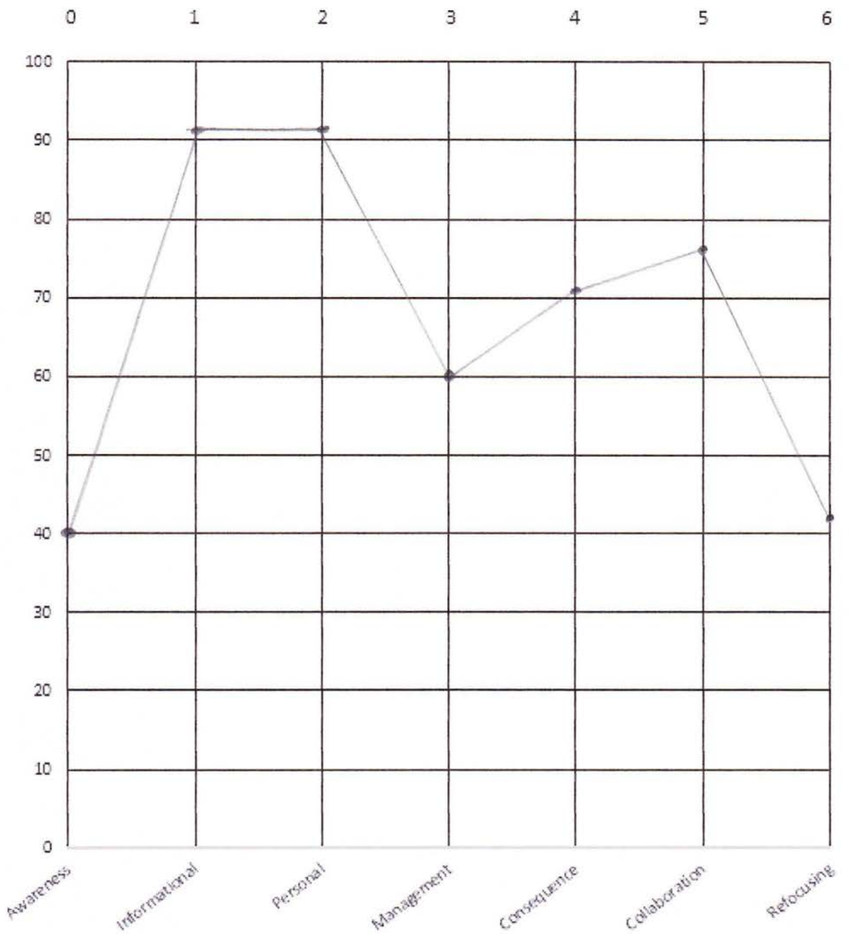
Wells Re-Make of Scoring Device Fall 2011

Stages of Concern Profile Post

Date: 4-23-16

Participant Code: C

Innovation: T/E DBL



Pre

Stages of Concern Questionnaire

Participant Code: D

The purpose of this questionnaire is to determine what people who are using or thinking about using various programs are concerned about at various times during the adoption process.

The items were developed from typical responses of school and college teachers who ranged from no knowledge at all about various programs to many years' experience using them. Therefore, **many of the items on this questionnaire may appear to be of little relevance or irrelevant to you at this time**. For the completely irrelevant items, please circle "0" on the scale. Other items will represent those concerns you do have, in varying degrees of intensity, and should be marked higher on the scale.

For example:

This statement is very true of me at this time.	0	1	2	3	4	5	6	[✓ 7]
This statement is somewhat true of me now.	0	1	2	3	[✓ 4]	5	6	7
This statement is not at all true of me at this time.	0	1	[✓ 2]	3	4	5	6	7
This statement seems irrelevant to me.	[✓ 0]	1	2	3	4	5	6	7

Please respond to the items in terms of **your present concerns**, or how you feel about your involvement with **this** innovation. We do not hold to any one definition of the innovation so please think of it in terms of your own perception of what it involves. Phrases such as "this approach" and "the new system" all refer to the same innovation. Remember to respond to each item in terms of your present concerns about your involvement or potential involvement with the innovation.

Thank you for taking time to complete this task.

D

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now			Somewhat true of me now		Very true of me now	

Circle one number for each item

1. I am concerned about students' attitudes toward the innovation.	0	1	2	[✓ 3]	4	5	6	7
2. I now know of some other approaches that might work better.	0	[✓ 1]	2	3	4	5	6	7
3. I am more concerned about another innovation.	0	[✓ 1]	2	3	4	5	6	7
4. I am concerned about not having enough time to organize myself each day.	0	1	2	3	4	5	6	[✓ 7]
5. I would like to help other faculty in their use of the innovation.	0	[✓ 1]	2	3	4	5	6	7
6. I have a very limited knowledge of the innovation.	0	1	2	3	4	5	[✓ 6]	7
7. I would like to know the effect of reorganization on my professional status.	[✓ 0]	1	2	3	4	5	6	7
8. I am concerned about conflict between my interests and my responsibilities.	0	[✓ 1]	2	3	4	5	6	7
9. I am concerned about revising my use of the innovation.	0	[✓ 1]	2	3	4	5	6	7
10. I would like to develop working relationships with both our faculty and outside faculty using this innovation.	0	[✓ 1]	2	3	4	5	6	7
11. I am concerned about how the innovation affects students.	0	1	2	3	4	5	[✓ 6]	7
12. I am not concerned about the innovation at this time.	0	[✓ 1]	2	3	4	5	6	7
13. I would like to know who will make the decisions in the new system.	[✓ 0]	1	2	3	4	5	6	7
14. I would like to discuss the possibility of using the innovation.	0	[✓ 1]	2	3	4	5	6	7
15. I would like to know what resources are available if we decide to adopt the innovation.	0	1	2	3	[✓ 4]	5	6	7
16. I am concerned about my inability to manage all that the innovation requires.	0	1	2	3	4	5	6	[✓ 7]
17. I would like to know how my teaching or administration is supposed to change.	0	1	2	3	4	5	[✓ 6]	7
18. I would like to familiarize other departments or persons with the progress of this new approach.	0	[✓ 1]	2	3	4	5	6	7

D

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now		Somewhat true of me now			Very true of me now	

Circle one number for each item

19. I am concerned about evaluating my impact on students.	0	1	2	3	[✓ 4]	5	6	7
20. I would like to revise the innovation's approach.	0	[✓ 1]	2	3	4	5	6	7
21. I am preoccupied with things other than the innovation.	0	1	2	3	[✓ 4]	5	6	7
22. I would like to modify our use of the innovation based on the experiences of our students.	0	[✓ 1]	2	3	4	5	6	7
23. I spent little time thinking about the innovation.	0	1	2	3	[✓ 4]	5	6	7
24. I would like to excite my students about their part in this approach.	0	1	2	3	4	5	6	[✓ 7]
25. I would concerned about time spent working with nonacademic problems related to the innovation.	0	1	2	3	4	5	6	[✓ 7]
26. I would like to know what the use of the innovation will require in the immediate future.	0	1	2	3	4	5	6	[✓ 7]
27. I would like to coordinate my efforts with others to maximize the innovation's effects.	0	[✓ 1]	2	3	4	5	6	7
28. I would like to have more information on time and energy commitments required by the innovation.	0	1	2	3	4	5	6	[✓ 7]
29. I would like to know what other faculty are doing in this area.	0	1	2	3	4	5	6	[✓ 7]
30. Currently, other priorities prevent me from focusing my attention on the innovation.	0	1	2	3	[✓ 4]	5	6	7
31. I would like to determine how to supplement, enhance, or replace the innovation.	0	[✓ 1]	2	3	4	5	6	7
32. I would like to use feedback from students to change the program.	0	[✓ 1]	2	3	4	5	6	7
33. I would like to know how my role will change when I am using the innovation.	0	1	2	3	4	5	6	[✓ 7]
34. Coordination of tasks and people is taking too much of my time.	0	[✓ 1]	2	3	4	5	6	7
35. I would like to know how the innovation is better than what we have now.	0	1	2	3	4	5	6	[✓ 7]

Stages of Concern Quick Scoring Device

SoCQ 075

1	3
2	1
3	1
4	7
5	1
6	6
7	0
8	1
9	1
10	1
11	6
12	1
13	0
14	1
15	4
16	7
17	6
18	1

A

Date: 3-19-16

Site: Pre SS#: D

Innovation: T/EDBL

B

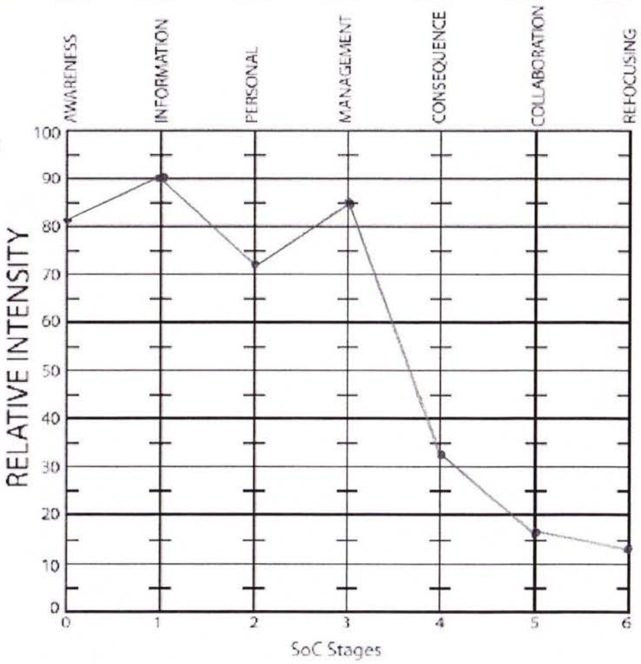
Stage 0	1	2	3	4	5	6
3 1	6 6	7 0	4 7	1 3	5 1	2 1
12 1	14 1	13 0	8 1	11 6	10 1	9 1
21 4	15 4	17 6	16 7	19 4	18 1	20 1
23 4	26 7	28 7	25 7	24 7	27 1	22 1
30 4	35 7	33 7	34 1	32 1	29 7	31 1
C Raw Score Totals						
14	25	20	23	21	11	5
E Percentile Scores						
81	90	72	85	33	16	9

D

Five Item Raw Scale Score Total	Percentiles for: Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
0	0	5	5	2	1	1	1
1	1	12	12	5	1	2	2
2	2	16	14	7	1	3	3
3	4	19	17	9	2	3	5
4	7	23	21	11	2	4	6
5	14	27	25	15	3	5	9
6	22	30	28	18	3	7	11
7	31	34	31	23	4	9	15
8	40	37	35	27	5	10	17
9	48	40	39	30	5	12	20
10	55	43	41	34	7	14	22
11	61	45	45	39	8	16	26
12	69	48	48	43	9	19	30
13	75	51	52	47	11	22	34
14	81	54	55	52	13	25	38
15	87	57	57	56	16	28	42
16	91	60	59	60	19	31	47
17	94	63	63	65	21	36	52
18	96	66	67	69	24	40	57
19	97	69	70	73	27	44	60
20	98	72	72	77	30	48	65
21	99	75	76	80	33	52	69
22	99	80	78	83	38	55	73
23	99	84	80	85	43	59	77
24	99	88	83	88	48	64	81
25	99	90	85	90	54	68	84
26	99	91	87	92	59	72	87
27	99	93	89	94	63	76	90
28	99	95	91	95	66	80	92
29	99	96	92	97	71	84	94
30	99	97	94	97	76	88	96
31	99	98	95	98	82	91	97
32	99	99	96	98	86	93	98
33	99	99	96	99	90	95	99
34	99	99	97	99	92	97	99
35	99	99	99	99	96	98	99

Concerns Based Systems International

F



19	4
20	1
21	4
22	1
23	4
24	7
25	7
26	7
27	1
28	7
29	7
30	4
31	1
32	1
33	7
34	1
35	7

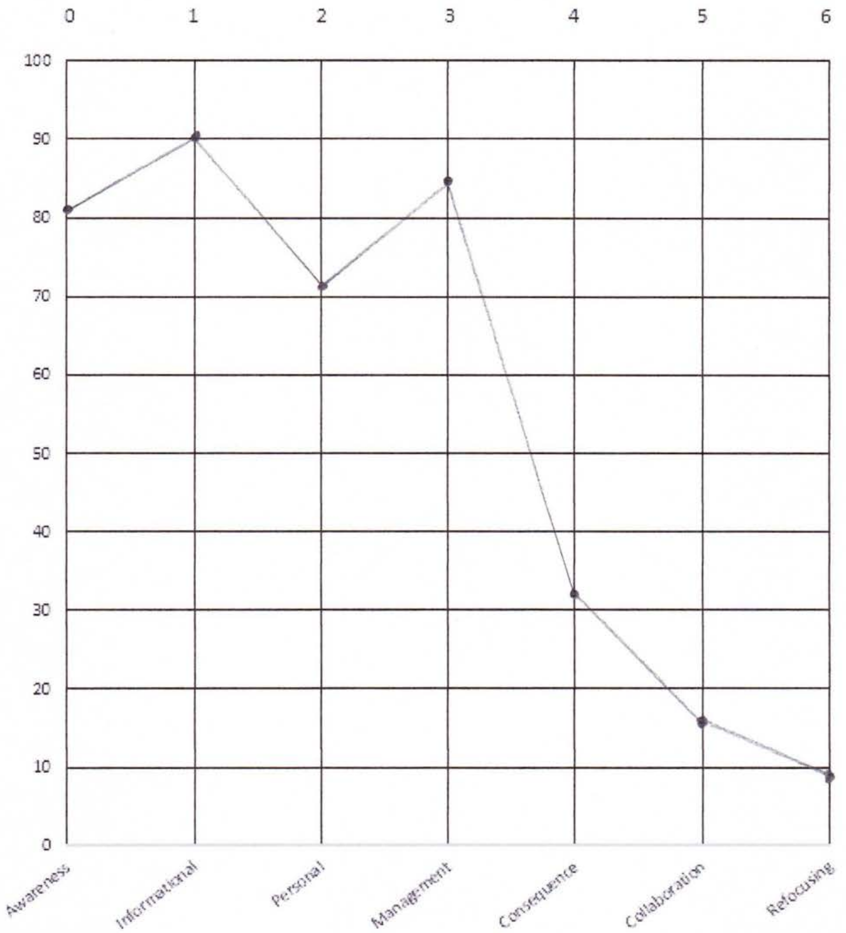
Wells Re-Make of Scoring Device Fall 2011

Stages of Concern Profile Pre

Date:

Participant Code: D

Innovation: T/EDBL



Post

Stages of Concern Questionnaire

Name (optional): D - Innovation is Technological / Engineering Design Based Learni (T/E D

The purpose of this questionnaire is to determine what people who are using or thinking about using various programs are concerned about at various times during the adoption process.

The items were developed from typical responses of school and college teachers who ranged from no knowledge at all about various programs to many years' experience using them. Therefore, **many of the items on this questionnaire may appear to be of little relevance or irrelevant to you at this time**. For the completely irrelevant items, please circle "0" on the scale. Other items will represent those concerns you do have, in varying degrees of intensity, and should be marked higher on the scale.

For example:

This statement is very true of me at this time.	0	1	2	3	4	5	6	[✓ 7]
This statement is somewhat true of me now.	0	1	2	3	[✓ 4]	5	6	7
This statement is not at all true of me at this time.	0	1	[✓ 2]	3	4	5	6	7
This statement seems irrelevant to me.	[✓ 0]	1	2	3	4	5	6	7

Please respond to the items in terms of **your present concerns**, or how you feel about your involvement with **this** innovation. We do not hold to any one definition of the innovation so please think of it in terms of your own perception of what it involves. Phrases such as "this approach" and "the new system" all refer to the same innovation. Remember to respond to each item in terms of your present concerns about your involvement or potential involvement with the innovation.

Thank you for taking time to complete this task.

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now			Somewhat true of me now		Very true of me now	

Circle one number for each item

1. I am concerned about students' attitudes toward the innovation.	0	[✓ 1]	2	3	4	5	6	7
2. I now know of some other approaches that might work better.	0	[✓ 1]	2	3	4	5	6	7
3. I am more concerned about another innovation.	0	[✓ 1]	2	3	4	5	6	7
4. I am concerned about not having enough time to organize myself each day.	0	[✓ 1]	2	3	4	5	6	7
5. I would like to help other faculty in their use of the innovation.	0	1	2	3	[✓ 4]	5	6	7
6. I have a very limited knowledge of the innovation.	0	[✓ 1]	2	3	4	5	6	7
7. I would like to know the effect of reorganization on my professional status.	[✓ 0]	1	2	3	4	5	6	7
8. I am concerned about conflict between my interests and my responsibilities.	0	[✓ 1]	2	3	4	5	6	7
9. I am concerned about revising my use of the innovation.	0	[✓ 1]	2	3	4	5	6	7
10. I would like to develop working relationships with both our faculty and outside faculty using this innovation.	0	1	2	3	[✓ 4]	5	6	7
11. I am concerned about how the innovation affects students.	0	[✓ 1]	2	3	4	5	6	7
12. I am not concerned about the innovation at this time.	0	~~[✓ 1]~~	2 RCH	3	[✓ 4]	5	6	7
13. I would like to know who will make the decisions in the new system.	[✓ 0]	1	2	3	4	5	6	7
14. I would like to discuss the possibility of using the innovation.	0	[✓ 1]	2	3	4	5	6	7
15. I would like to know what resources are available if we decide to adopt the innovation.	0	1	2	3	[✓ 4]	5	6	7
16. I am concerned about my inability to manage all that the innovation requires.	0	[✓ 1]	2	3	4	5	6	7
17. I would like to know how my teaching or administration is supposed to change.	0	[✓ 1]	2	3	4	5	6	7
18. I would like to familiarize other departments or persons with the progress of this new approach.	0	1	2	3	[✓ 4]	5	6	7

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now			Somewhat true of me now		Very true of me now	

Circle one number for each item

19. I am concerned about evaluating my impact on students.	0	[✓ 1]	2	3	4	5	6	7
20. I would like to revise the innovation's approach.	0	[✓ 1]	2	3	4	5	6	7
21. I am preoccupied with things other than the innovation.	0	[✓ 1]	2	3	4	5	6	7
22. I would like to modify our use of the innovation based on the experiences of our students.	0	[✓ 1]	2	3	4	5	6	7
23. I spent little time thinking about the innovation.	0	[✓ 1]	2	3	4	5	6	7
24. I would like to excite my students about their part in this approach.	0	1	2	3	4	5	6	[✓ 7]
25. I would concerned about time spent working with nonacademic problems related to the innovation.	0	[✓ 1]	2	3	4	5	6	7
26. I would like to know what the use of the innovation will require in the immediate future.	0	1	2	3	[✓ 4]	5	6	7
27. I would like to coordinate my efforts with others to maximize the innovation's effects.	0	1	2	3	[✓ 4]	5	6	7
28. I would like to have more information on time and energy commitments required by the innovation.	0	[✓ 1]	2	3	4	5	6	7
29. I would like to know what other faculty are doing in this area.	0	1	2	3	[✓ 4]	5	6	7
30. Currently, other priorities prevent me from focusing my attention on the innovation.	0	[✓ 1]	2	3	4	5	6	7
31. I would like to determine how to supplement, enhance, or replace the innovation.	0	[✓ 1]	2	3	4	5	6	7
32. I would like to use feedback from students to change the program.	0	[✓ 1]	2	3	4	5	6	7
33. I would like to know how my role will change when I am using the innovation.	0	[✓ 1]	2	3	4	5	6	7
34. Coordination of tasks and people is taking too much of my time.	0	[✓ 1]	2	3	4	5	6	7
35. I would like to know how the innovation is better than what we have now.	0	[✓ 1]	2	3	4	5	6	7

Stages of Concern Quick Scoring Device

SoCQ 075

1	1
2	1
3	1
4	1
5	4
6	1
7	0
8	1
9	1
10	4
11	1
12	4
13	0
14	1
15	4
16	1
17	1
18	4

A

Date: 4-29-16
Site: Post SS#: D
Innovation: T/EDBL

B

Stage 0	1	2	3	4	5	6
3 1	6 1	7 0	4 1	1 1	5 4	2 1
12 4	14 1	13 0	8 1	11 1	10 4	9 1
21 1	15 4	17 1	16 1	19 1	18 4	20 1
23 1	26 4	28 1	25 1	24 7	27 4	22 1
30 1	35 1	33 1	34 1	32 1	29 4	31 1

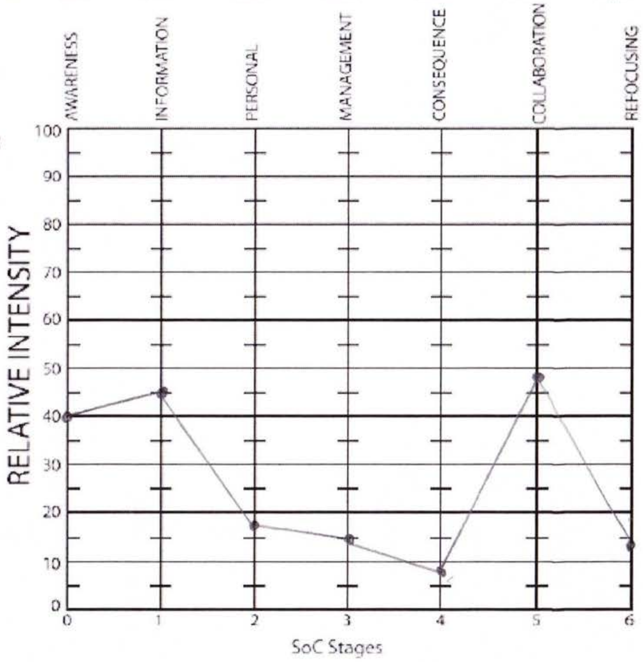
		0	1	2	3	4	5	6
Raw Score Totals	**C**	8	11	3	5	11	20	5
Percentile Scores	**E**	40	45	17	15	8	48	9

D

Five Item Raw Scale Score Total	Percentiles for:						
	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
0	0	5	5	2	1	1	1
1	1	12	12	5	1	2	2
2	2	16	14	7	1	3	3
3	4	19	17	9	2	3	5
4	7	23	21	11	2	4	6
5	14	27	25	15	3	5	9
6	22	30	28	18	3	7	11
7	31	34	31	23	4	9	14
8	40	37	35	27	5	10	17
9	48	40	39	30	5	12	20
10	55	43	41	34	7	14	22
11	61	45	45	39	8	16	26
12	69	48	48	43	9	19	30
13	75	51	52	47	11	22	34
14	81	54	55	52	13	25	38
15	87	57	57	56	16	28	42
16	91	60	59	60	19	31	47
17	94	63	63	65	21	36	52
18	96	66	67	69	24	40	57
19	97	69	70	73	27	44	60
20	98	72	72	77	30	48	65
21	99	75	76	80	33	52	69
22	99	80	78	83	38	55	73
23	99	84	80	85	43	59	77
24	99	88	83	88	46	64	81
25	99	90	85	90	54	68	84
26	99	91	87	92	59	72	87
27	99	93	89	94	63	76	90
28	99	95	91	95	66	80	92
29	99	96	92	97	71	84	94
30	99	97	94	97	76	88	96
31	99	98	95	98	82	91	97
32	99	99	96	98	86	93	98
33	99	99	96	99	90	95	99
34	99	99	97	99	92	97	99
35	99	99	99	99	96	98	99

Concerns Based Systems International

F



19	1
20	1
21	1
22	1
23	1
24	7
25	1
26	4
27	4
28	1
29	4
30	1
31	1
32	1
33	1
34	1
35	1

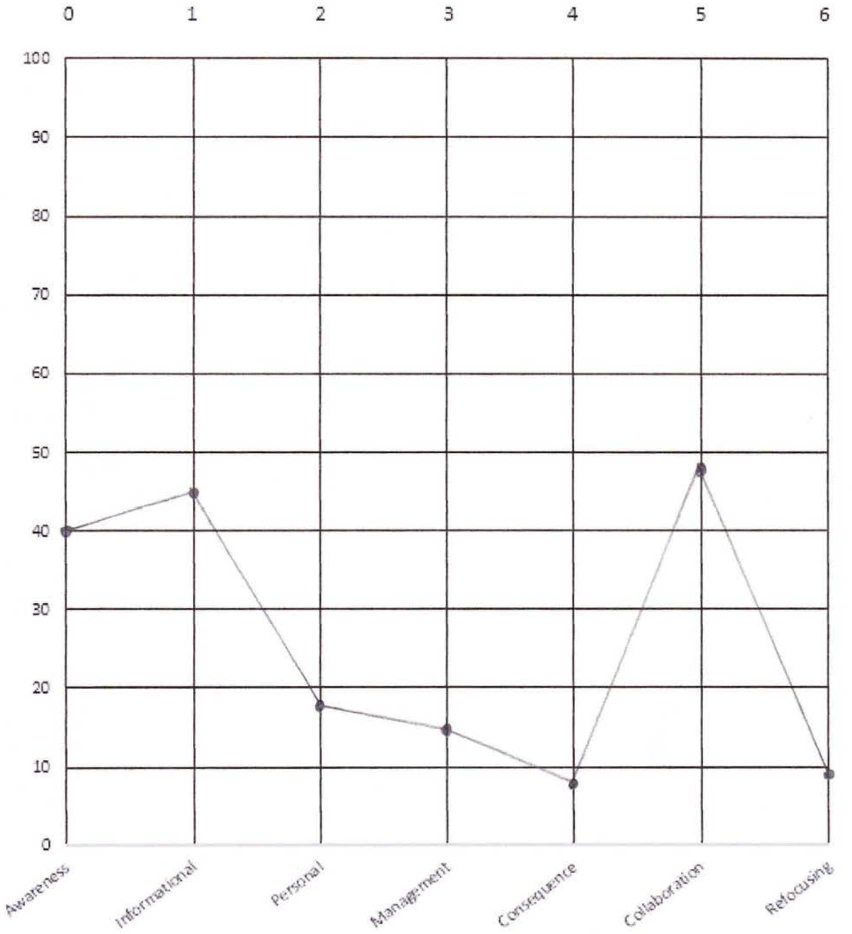
Wells Re-Make of Scoring Device Fall 2011

Stages of Concern Profile Post

Date: 4-29-16

Participant Code: D

Innovation: T/EDBL



Appendix L

T/E DBL Instructional Change Indicator and Lesson Assessment Rubric Analysis

Unit 1

T/E DBL Instructional Change Indicators (ICI)

Participant Code: A	Unit Title: Human Impact: Erosion							Grade Level: 5		
	Lesson 1		Lesson 2		Lesson 3		Lesson 4		Lesson 5	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Curriculum										
Objectives (action verb/measurable)	1	1		1		1		1		1
Change Assessment (0, 1, 2, 3)										
Science										
Formative	2	1		1		1		1		1
Summative	0	0		0		0		0		0
Technology/Engineering										
Formative	0	0		0		0		0		1
Summative	0	0		0		0		0		1
5E Instructional Design										
Engagement	1	1		0		0		0		0
Context/Scenario/Challenge										
Exploration	0	0		1		0		0		0
Concepts/Know/Need to Know										
Explanation	1	0		0		1		0		0
Understanding/Evidencing/Clarifying										
Elaboration	0	0		0		0		1		0
Knowledge Trans/Interpret Results/Extend Application										
Evaluation	1	0		0		0		0		1
Formative/Summative/Evidence										
Total Procedures	3	1		1		1		1		1
T/E DBL Phase Integrations										
Problem Identification	1	0		0		0		0		1
Need/Define/Formulation										
Ideation	0	0		0		0		0		0
Criteria/Brainstorm/Generate										
Research	0	0		1		1		0		0
Explore/Investigate/Examine										
Potential Solutions	0	0		0		0		1		0
Analyze/Visualize/Select										
Optimization	0	0		0		0		0		1
Experiment/Revisit/Construct										
Solution Evaluation	0	0		0		0		0		1
Test/Analyze/Retest										
Alterations	0	0		0		0		0		1
Identify/Redesign/Retest										
Learned Outcomes	0	0		0		0		0		1
Process/Iterations/Justify										
Total T/E DBL Phase Integration	1	0	0	1	0	1	0	1	0	5

Lesson Evaluation Key
Accomplished (3pts)
Developing (2pts)
Vague (1pt)

ICI Evaluation Key
0 = Absence of Variable
1 = Presence of Variable
2 = Assessment is linked to objectives
3 = Each objective is assessed

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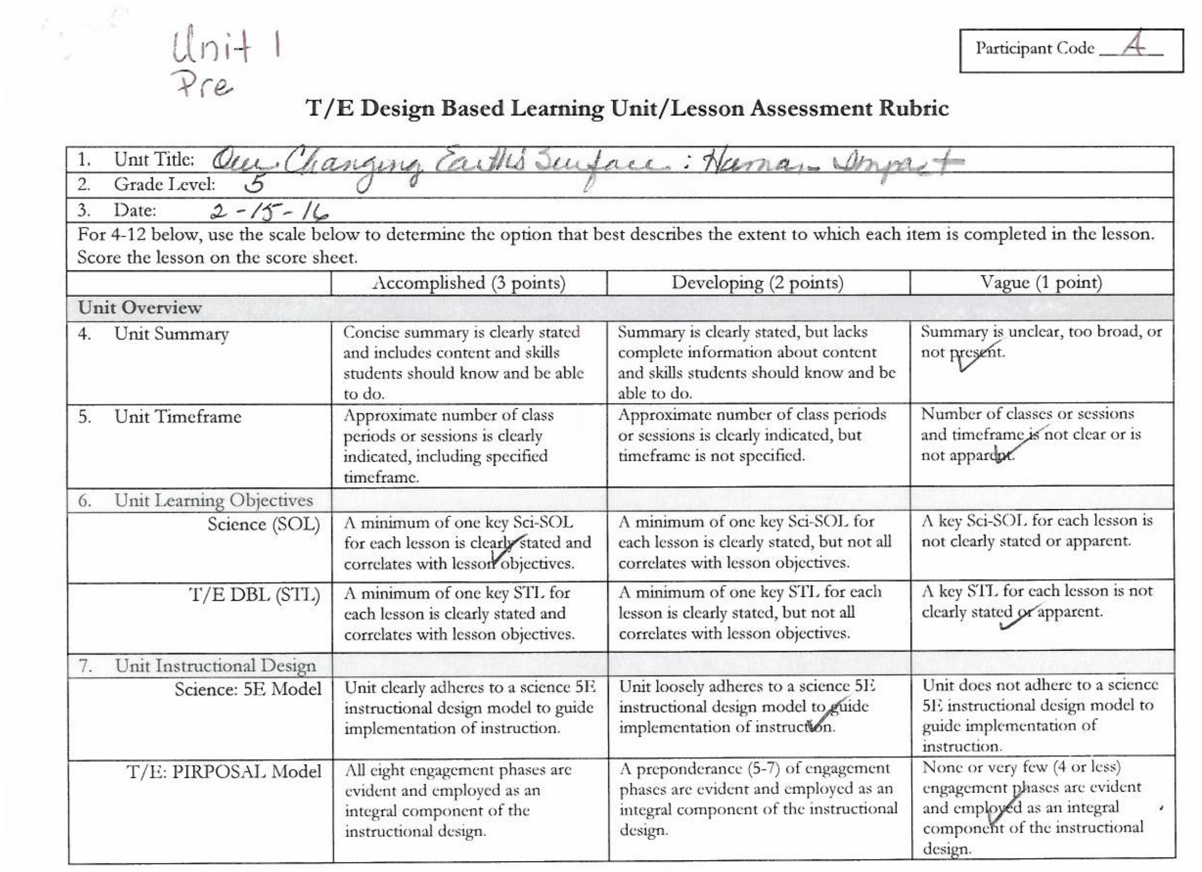

Unit 1
Pre

Participant Code A

T/E Design Based Learning Unit/Lesson Assessment Rubric

1. Unit Title: Our Changing Earth's Surface : Human Impact
2. Grade Level: 5
3. Date: 2-15-16

For 4-12 below, use the scale below to determine the option that best describes the extent to which each item is completed in the lesson. Score the lesson on the score sheet.

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Unit Overview			
4. Unit Summary	Concise summary is clearly stated and includes content and skills students should know and be able to do.	Summary is clearly stated, but lacks complete information about content and skills students should know and be able to do.	Summary is unclear, too broad, or not present. ✓
5. Unit Timeframe	Approximate number of class periods or sessions is clearly indicated, including specified timeframe.	Approximate number of class periods or sessions is clearly indicated, but timeframe is not specified.	Number of classes or sessions and timeframe is not clear or is not apparent. ✓
6. Unit Learning Objectives			
Science (SOL)	A minimum of one key Sci-SOL for each lesson is clearly stated and correlates with lesson objectives. ✓	A minimum of one key Sci-SOL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key Sci-SOL for each lesson is not clearly stated or apparent.
T/E DBL (STL)	A minimum of one key STL for each lesson is clearly stated and correlates with lesson objectives.	A minimum of one key STL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key STL for each lesson is not clearly stated or apparent. ✓
7. Unit Instructional Design			
Science: 5E Model	Unit clearly adheres to a science 5E instructional design model to guide implementation of instruction.	Unit loosely adheres to a science 5E instructional design model to guide implementation of instruction. ✓	Unit does not adhere to a science 5E instructional design model to guide implementation of instruction.
T/E: PIRPOSAL Model	All eight engagement phases are evident and employed as an integral component of the instructional design.	A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design.	None or very few (4 or less) engagement phases are evident and employed as an integral component of the instructional design. ✓

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	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Lesson Plans			
8. Title	The lesson title is brief, and creatively summarizes the theme of the lesson. ✓	The lesson title is brief, but does not capture the theme of the lesson.	The lesson title is too long or too short, and does not capture the theme of the lesson
9. Learning Objectives	Action verbs used to clearly specify observable student outcomes. Stated to measure high order thinking/learning skills.	Action verbs specify observable student outcomes, but not stated to measure high order thinking/learning skills.	Observable student outcomes not clear, and not stated to measure higher order thinking/learning skills.
Science SOLs		✓	
Technology SOLs			✓
10. Instructional Design			
Science 5E Model	Thorough planning is evidenced through carefully constructed opportunities for students to engage in inquiry through active, hands-on exploration. Connection between all phases is explicit. Provides excellent opportunities for students to apply and expand their understanding, generate and explore questions, analyze data, and report findings. Appropriate assessment process measures student understanding of concepts and skills.	Provides adequate constructed opportunities for students to engage in inquiry through active, hands-on exploration. Phases are related, but connections are not explicit. Provides opportunities for students to expand their understanding, analyze data, and report findings. Adequate evidence of an appropriate assessment process to measure student understanding of concepts and skills.	Minimal and/or inappropriate opportunities for students to engage in inquiry through active, hands-on exploration. Phases have no obvious connections. Provides little opportunity for students to expand on existing knowledge. Final assessment is vague or absent. ✓
T/E PIRPOSAL Model	Continuous, active student-centered approach that is fluid and fully integrated in the instructional design, intentionally teaches targeted science content, and promotes convergent and divergent questioning.	Active student-centered approach that is reflected but not fully integrated in the instructional design, and teaches minimal science content.	Completed, inactive teacher-centered approach. ✓
11. Assessment: Science	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative		✓	
Summative			✓
12. Assessment: Technology/Engineering	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			✓
Summative			✓

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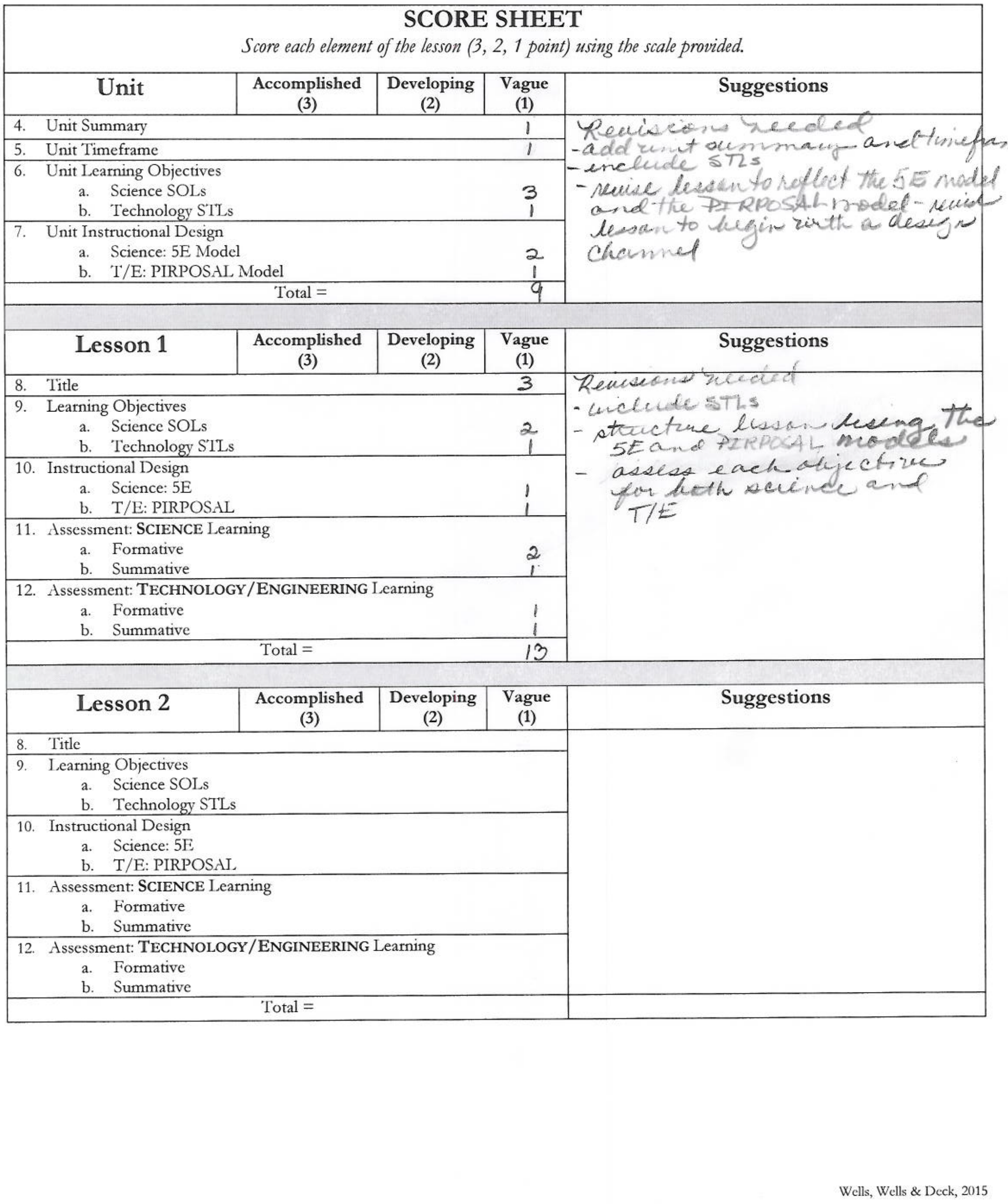

SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
4. Unit Summary			1	Revisions needed -add unit summary and timeframe -include STLs -revise lesson to reflect the 5E model and the ~~PI~~ RPOSAL model - revise lesson to begin with a design channel
5. Unit Timeframe			1	
6. Unit Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			1	
7. Unit Instructional Design				
a. Science: 5E Model			2	
b. T/E: PIRPOSAL Model			1	
Total =			9	

Lesson 1	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	Revisions needed - include STLs - structure lesson using the 5E and PIRPOSAL models - assess each objective for both science and T/E
9. Learning Objectives				
a. Science SOLs			2	
b. Technology STLs			1	
10. Instructional Design				
a. Science: 5E			1	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			1	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			1	
b. Summative			1	
Total =			13	

Lesson 2	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title				
9. Learning Objectives				
a. Science SOLs				
b. Technology STLs				
10. Instructional Design				
a. Science: 5E				
b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning				
a. Formative				
b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative				
b. Summative				
Total =				

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Lesson 3	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 4	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 5	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

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Lesson 9	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 10	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Rating: *Circle the letter indicating the range of scores to determine individual section ratings.*

Unit Overview

Sum from items 4 – 7 = [✓ A.] 0-15 Points (Revisions needed)
B. 16-18 Points (Implement without revisions)

Lesson Plans

Sum from items 9 – 12 = [✓ A.] 7-24 points (Revisions needed)
B. 25-30 points (Implement without revisions)

Overall Unit Rating

Circle one:
[✓ A.] Unit must be revised (additional comments required)
B. Unit can be implemented as written
C. Unit is an exemplar

Additional Comments

Use rubric as a guide to help redesign unit plan

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Anita Deck
Evaluator's Signature

2-15-16
Date

Unit/Lesson –Interrater Feedback Log

Following the assessment of the unit and lessons, use this log to indicate the major strengths (provide 3) and the major suggestions (provide 3) for improvement.

Unit Overview

Strengths	Suggestions
1. Unit targets SOL 5.7	1. Can use graphic organizer for pre- and post-test
2. Includes a suggestion for activating prior knowledge	2. Use of graphing organizer
3. Graphic organizers included	3. Introduces new vocabulary

Lesson 1

Strengths	Suggestions
1. Uses examples familar to students	1. Develop design Challenge
2. Compares/contrasts human harm/help	2. Use graphic organizer as pre-/post-test
3. Fosters student collaboration	3. Use graphic organizer as an assessment

Lesson 2

Strengths	Suggestions
1.	1.
2.	2.
3.	3.

Lesson 3

Strengths	Suggestions
1.	1.
2.	2.
3.	3.

Lesson 4

Strengths	Suggestions
1.	1.
2.	2.
3.	3.

Lesson 5

Strengths	Suggestions
1.	1.
2.	2.
3.	3.

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Unit 1
Post

Participant Code A

T/E Design Based Learning Unit/Lesson Assessment Rubric

1. Unit Title: Human Impact = Erosion
2. Grade Level: 5
3. Date: 3-7-16

For 4-12 below, use the scale below to determine the option that best describes the extent to which each item is completed in the lesson. Score the lesson on the score sheet.

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Unit Overview			
4. Unit Summary	[✓ Concise summary is clearly stated and includes content and skills students should know and be able to do.]	Summary is clearly stated, but lacks complete information about content and skills students should know and be able to do.	Summary is unclear, too broad, or not present
5. Unit Timeframe	[✓ Approximate number of class periods or sessions is clearly indicated, including specified timeframe.]	Approximate number of class periods or sessions is clearly indicated, but timeframe is not specified.	Number of classes or sessions and timeframe is not clear or is not apparent.
6. Unit Learning Objectives			
Science (SOL)	[✓ A minimum of one key Sci-SOL for each lesson is clearly stated and correlates with lesson objectives.]	A minimum of one key Sci-SOL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key Sci-SOL for each lesson is not clearly stated or apparent.
T/E DBL (STL)	A minimum of one key STL for each lesson is clearly stated and correlates with lesson objectives.	[✓ A minimum of one key STL for each lesson is clearly stated, but not all correlates with lesson objectives.]	A key STL for each lesson is not clearly stated or apparent.
7. Unit Instructional Design			
Science: 5E Model	[✓ Unit clearly adheres to a science 5E instructional design model to guide implementation of instruction.]	Unit loosely adheres to a science 5E instructional design model to guide implementation of instruction.	Unit does not adhere to a science 5E instructional design model to guide implementation of instruction.
T/E: PIRPOSAL Model	All eight engagement phases are evident and employed as an integral component of the instructional design.	A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design.	[✓ None or very few (4 or less) engagement phases are evident and employed as an integral component of the instructional design.]

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	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Lesson Plans			
8. Title	The lesson title is brief, and creatively summarizes the theme of the lesson.	The lesson title is brief, but does not capture the theme of the lesson.	The lesson title is too long or too short, and does not capture the theme of the lesson
9. Learning Objectives	Action verbs used to clearly specify observable student outcomes. Stated to measure high order thinking/learning skills.	Action verbs specify observable student outcomes, but not stated to measure high order thinking/learning skills.	Observable student outcomes not clear, and not stated to measure higher order thinking/learning skills.
Science SOLs			
Technology SOLs			
10. Instructional Design			
Science 5E Model	Thorough planning is evidenced through carefully constructed opportunities for students to engage in inquiry through active, hands-on exploration. Connection between all phases is explicit. Provides excellent opportunities for students to apply and expand their understanding, generate and explore questions, analyze data, and report findings. Appropriate assessment process measures student understanding of concepts and skills.	Provides adequate constructed opportunities for students to engage in inquiry through active, hands-on exploration. Phases are related, but connections are not explicit. Provides opportunities for students to expand their understanding, analyze data, and report findings. Adequate evidence of an appropriate assessment process to measure student understanding of concepts and skills.	Minimal and/or inappropriate opportunities for students to engage in inquiry through active, hands-on exploration. Phases have no obvious connections. Provides little opportunity for students to expand on existing knowledge. Final assessment is vague or absent.
T/E PIRPOSAL Model	Continuous, active student-centered approach that is fluid and fully integrated in the instructional design, intentionally teaches targeted science content, and promotes convergent and divergent questioning.	Active student-centered approach that is reflected but not fully integrated in the instructional design, and teaches minimal science content.	Completed, inactive teacher-centered approach.
11. Assessment: Science	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			
12. Assessment: Technology/Engineering	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			

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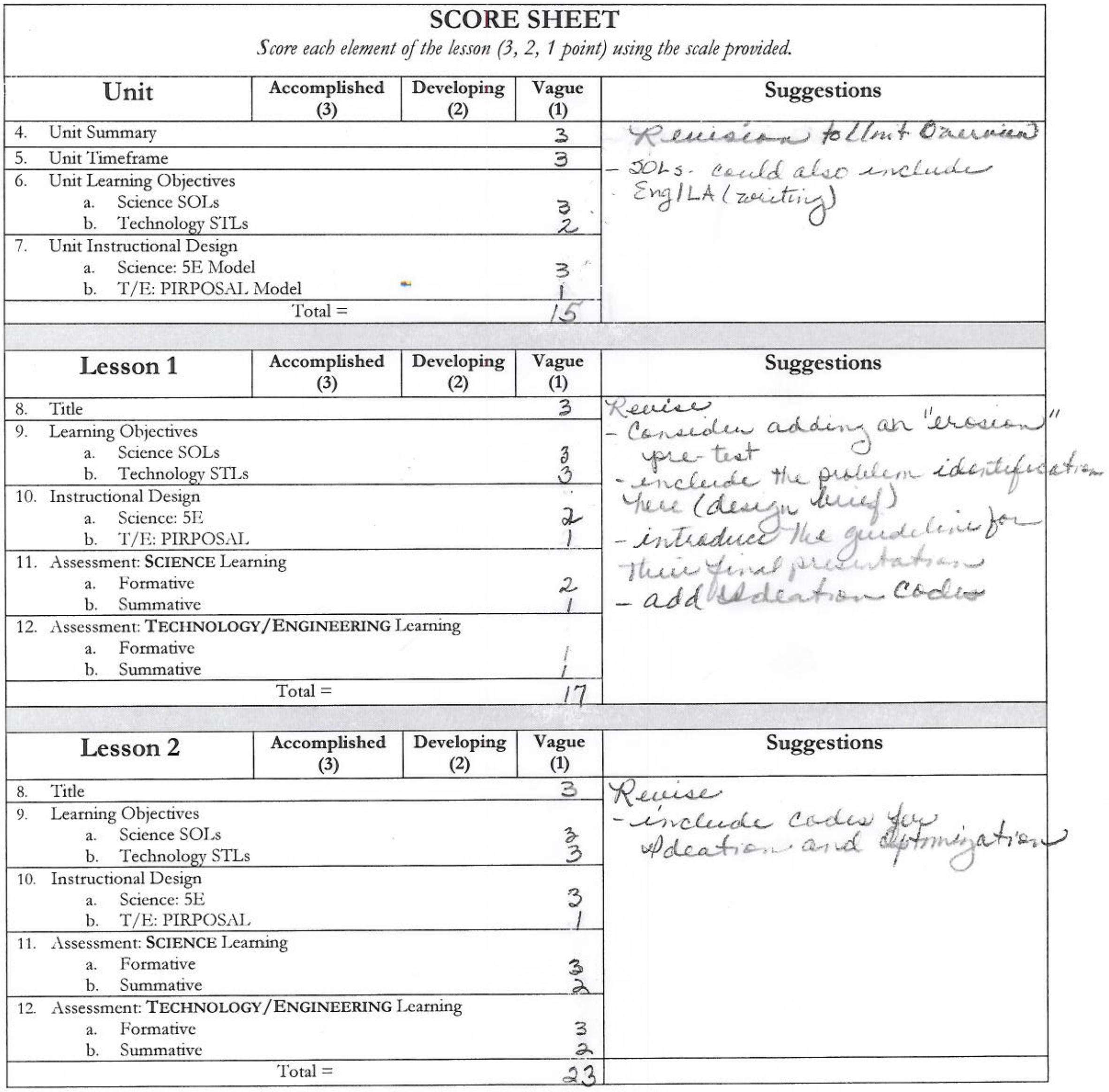

SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
4. Unit Summary			3	Revision to Unit Overview – SOLs. could also include Eng/LA (writing)
5. Unit Timeframe			3	
6. Unit Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			2	
7. Unit Instructional Design				
a. Science: 5E Model			3	
b. T/E: PIRPOSAL Model			1	
Total =			15	

Lesson 1	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	Revise – Consider adding an "erosion" pre-test - include the problem identification here (design brief) – introduce the guideline for their final presentation – add ideation codes
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			2	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			1	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			1	
b. Summative			1	
Total =			17	

Lesson 2	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	Revise -include codes for ideation and optimization
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			2	
Total =			23	

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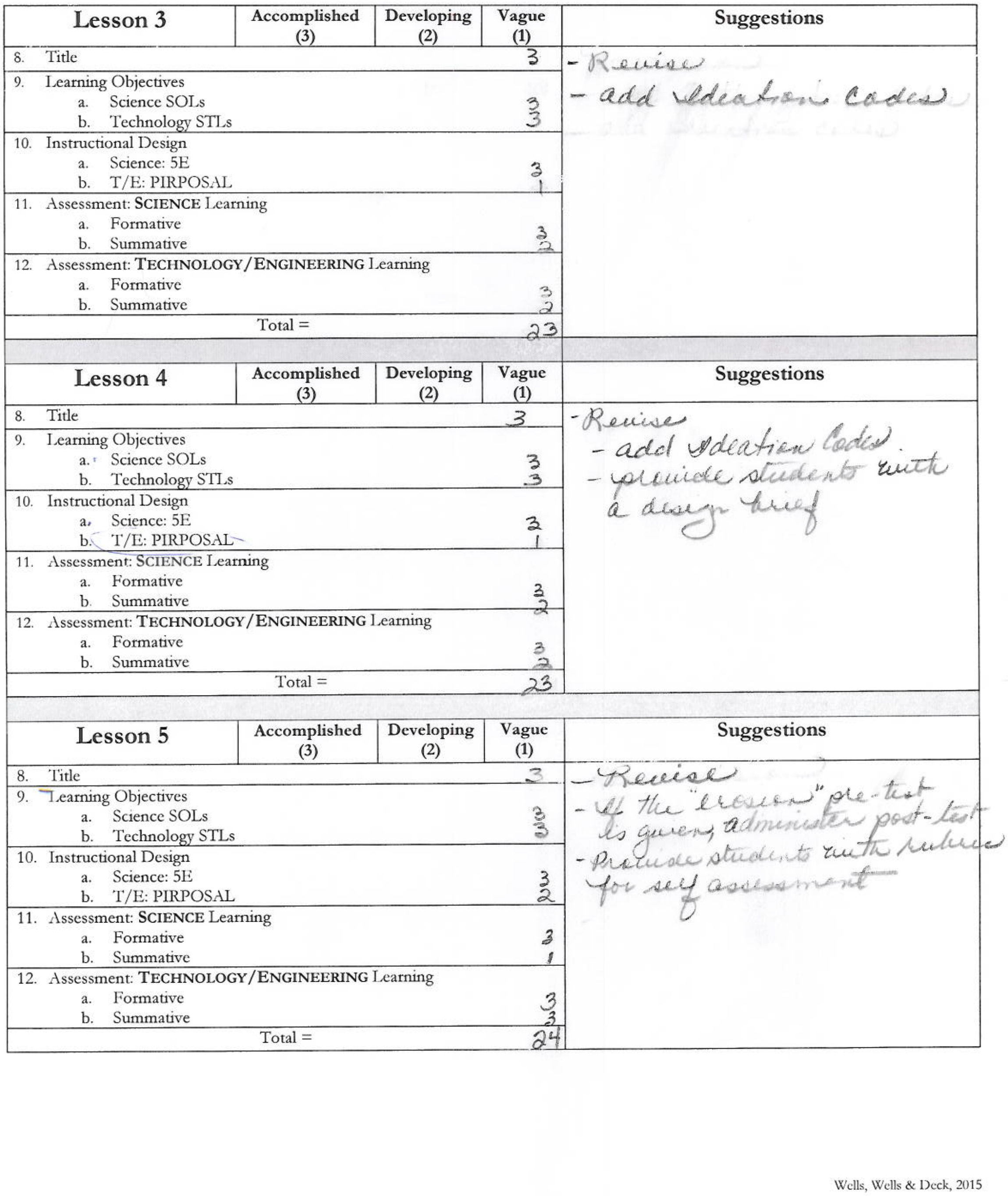

Lesson 3	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Revise - add Ideation Codes
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			2	
Total =			23	

Lesson 4	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Revise - add Ideation Codes - provide students with a design brief
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			2	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			2	
Total =			23	

Lesson 5	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Revise - If the "erosion" pre-test is given, administer post-test - Provide students with rubrics for self assessment
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			1	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total =			24	

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Lesson 9	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 10	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Rating: *Circle the letter indicating the range of scores to determine individual section ratings.*

Unit Overview

Sum from items 4 – 7 =
A. 0-15 Points (Revisions needed)
B. 16-18 Points (Implement without revisions)

Lesson Plans

Sum from items 9 – 12 =
[✓ A.] 7-24 points (Revisions needed)
B. 25-30 points (Implement without revisions)

Overall Unit Rating

Circle one:
[✓ A.] Unit must be revised (additional comments required)
B. Unit can be implemented as written
C. Unit is an exemplar

Additional Comments

Lessons need revisions to fully address instructional design and T/E learning issues. See suggestions for details

Wells, Wells & Deck, 2015

Anita Deck 3-7-16

Evaluator's Signature *Date*

Unit/Lesson –Interrater Feedback Log

Following the assessment of the unit and lessons, use this log to indicate the major strengths (provide 3) and the major suggestions (provide 3) for improvement.

Unit Overview

Strengths	Suggestions
1. Measurable objectives 2. Thorough materials list 3. Key goals achievable in lessons	1. Include addition SOLs (eg, Eng/LA) 2. Add a pre and post test targeting 3. the SOL to Assessment list

Lesson 1

Strengths	Suggestions
1. Begins with engaging activity 2. Effective use a question map 3. Student data collection	1. Add codes for ideation 2. Introduce design brief to provide 3. context introduce presentation guidelines 4. Erosion pre-test

Lesson 2

Strengths	Suggestions
1. Students experience phenomenon first-hand 2. Student data Collection 3. Use of discourse	1. Include Ideation and Optimization Codes 2. Smaller working groups (2-3) 3. Encourage students to use their journal to record their questions

Lesson 3

Strengths	Suggestions
1. Use of discourse 2. Connecting Lesson 1 and 3 activities 3. Compare/contrast human impact on erosion (harm/help)	1. Have students discuss (in their groups) their comparison of their school 2. grounds observations and their land 3. model investigation, then share out

Lesson 4

Strengths	Suggestions
1. Design challenge included 2. Students draw/sketch possible solutions 3. Student testing	1. Provide students with design brief 2. Provide rubric for self-assessment 3. Add Ideation Codes

Lesson 5

Strengths	Suggestions
1. Student presentation 2. Students pose questions to 3. presenters	1. Erosion post-test 2. Have students self-assess presentation 3.

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Unit Z

T/E DBL Instructional Change Indicators (ICI)

Participant Code: A	Unit Title: Sound Insulating Properties							Grade Level: 5		
	Lesson 1		Lesson 2		Lesson 3		Lesson 4		Lesson 5	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Curriculum										
Objectives (action verb/measurable)	1	1	1	1	1	1	1	1	1	1
Change Assessment (0, 1, 2, 3)										
Science										
Formative	2	3	3	3	2	3	2	3	2	3
Summative	0	3	1	3	2	3	1	3	0	3
Technology/ Engineering										
Formative	2	3	3	3	3	3	3	3	3	3
Summative	0	3	3	3	3	3	3	3	3	3
5E Instructional Design										
Engagement	1	1	0	0	0	0	0	0	0	0
Context/ Scenario/ Challenge										
Exploration	0	0	1	1	0	0	0	0	0	0
Concepts/ Know/ Need to Know										
Explanation	0	0	0	0	1	1	0	0	0	0
Understanding/ Evidencing/ Clarifying										
Elaboration	0	0	0	0	0	0	1	1	0	0
Knowledge Trans/ Interpret Results/ Extend Application										
Evaluation	0	0	0	0	0	0	0	0	1	1
Formative/ Summative/ Evidence										
Total Procedures	1	1	1	1	1	1	1	1	1	1
T/E DBL Phase Integrations										
Problem Identification	1	1	1	1	1	1	1	1	1	1
Need/ Define/ Formulation										
Ideation	0	1	1	1	1	1	1	1	1	1
Criteria/ Brainstorm/ Generate										
Research	1	0	1	1	1	1	1	1	0	0
Explore/ Investigate/ Examine										
Potential Solutions	0	0	0	0	1	1	1	1	1	1
Analyze/ Visualize/ Select										
Optimization	0	0	1	1	0	0	1	1	1	1
Experiment/ Revisit/ Construct										
Solution Evaluation	0	0	0	0	0	0	1	1	1	1
Test/ Analyze/ Retest										
Alterations	0	0	0	0	0	0	1	1	1	1
Identify/ Redesign/ Retest										
Learned Outcomes	0	0	0	0	0	0	0	0	1	1
Process/ Iterations/ Justify										
Total T/E DBL Phase Integration	2	2	4	5	4	4	7	7	7	7

Lesson Evaluation Key
Accomplished (3pts)
Developing (2pts)
Vague (1pt)

ICI Evaluation Key
0 = Absence of Variable
1 = Presence of Variable
2 = Assessment is linked to objectives
3 = Each objective is assessed

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Participant Code A

Unit 2
Pre

T/E Design Based Learning Unit/Lesson Assessment Rubric

1. Unit Title: Sound Insulating Properties of Different Materials
2. Grade Level: 5
3. Date: 4-7-2016

For 4-12 below, use the scale below to determine the option that best describes the extent to which each item is completed in the lesson. Score the lesson on the score sheet.

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Unit Overview			
4. Unit Summary	Concise summary is clearly stated and includes content and skills students should know and be able to do.	[✓ Summary is clearly stated, but lacks complete information about content and skills students should know and be able to do.]	Summary is unclear, too broad, or not present.
5. Unit Timeframe	[✓ Approximate number of class periods or sessions is clearly indicated, including specified timeframe.]	Approximate number of class periods or sessions is clearly indicated, but timeframe is not specified.	Number of classes or sessions and timeframe is not clear or is not apparent.
6. Unit Learning Objectives			
Science (SOL)	[✓ A minimum of one key Sci-SOL for each lesson is clearly stated and correlates with lesson objectives.]	A minimum of one key Sci-SOL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key Sci-SOL for each lesson is not clearly stated or apparent.
T/E DBL (STL)	[✓ A minimum of one key STL for each lesson is clearly stated and correlates with lesson objectives.]	A minimum of one key STL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key STL for each lesson is not clearly stated or apparent.
7. Unit Instructional Design			
Science: 5E Model	[✓ Unit clearly adheres to a science 5E instructional design model to guide implementation of instruction.]	Unit loosely adheres to a science 5E instructional design model to guide implementation of instruction.	Unit does not adhere to a science 5E instructional design model to guide implementation of instruction.
T/E: PIRPOSAL Model	[✓ All eight engagement phases are evident and employed as an integral component of the instructional design.]	A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design.	None or very few (4 or less) engagement phases are evident and employed as an integral component of the instructional design.

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	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Lesson Plans			
8. Title	The lesson title is brief, and creatively summarizes the theme of the lesson.	The lesson title is brief, but does not capture the theme of the lesson.	The lesson title is too long or too short, and does not capture the theme of the lesson
9. Learning Objectives	Action verbs used to clearly specify observable student outcomes. Stated to measure high order thinking/learning skills.	Action verbs specify observable student outcomes, but not stated to measure high order thinking/learning skills.	Observable student outcomes not clear, and not stated to measure higher order thinking/learning skills.
Science SOLs			
Technology SOLs			
10. Instructional Design			
Science 5E Model	Thorough planning is evidenced through carefully constructed opportunities for students to engage in inquiry through active, hands-on exploration. Connection between all phases is explicit. Provides excellent opportunities for students to apply and expand their understanding, generate and explore questions, analyze data, and report findings. Appropriate assessment process measures student understanding of concepts and skills.	Provides adequate constructed opportunities for students to engage in inquiry through active, hands-on exploration. Phases are related, but connections are not explicit. Provides opportunities for students to expand their understanding, analyze data, and report findings. Adequate evidence of an appropriate assessment process to measure student understanding of concepts and skills.	Minimal and/or inappropriate opportunities for students to engage in inquiry through active, hands-on exploration. Phases have no obvious connections. Provides little opportunity for students to expand on existing knowledge. Final assessment is vague or absent.
T/E PIRPOSAL Model	Continuous, active student-centered approach that is fluid and fully integrated in the instructional design, intentionally teaches targeted science content, and promotes convergent and divergent questioning.	Active student-centered approach that is reflected but not fully integrated in the instructional design, and teaches minimal science content.	Completed, inactive teacher-centered approach.
11. Assessment: Science	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			
12. Assessment: Technology/Engineering	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			

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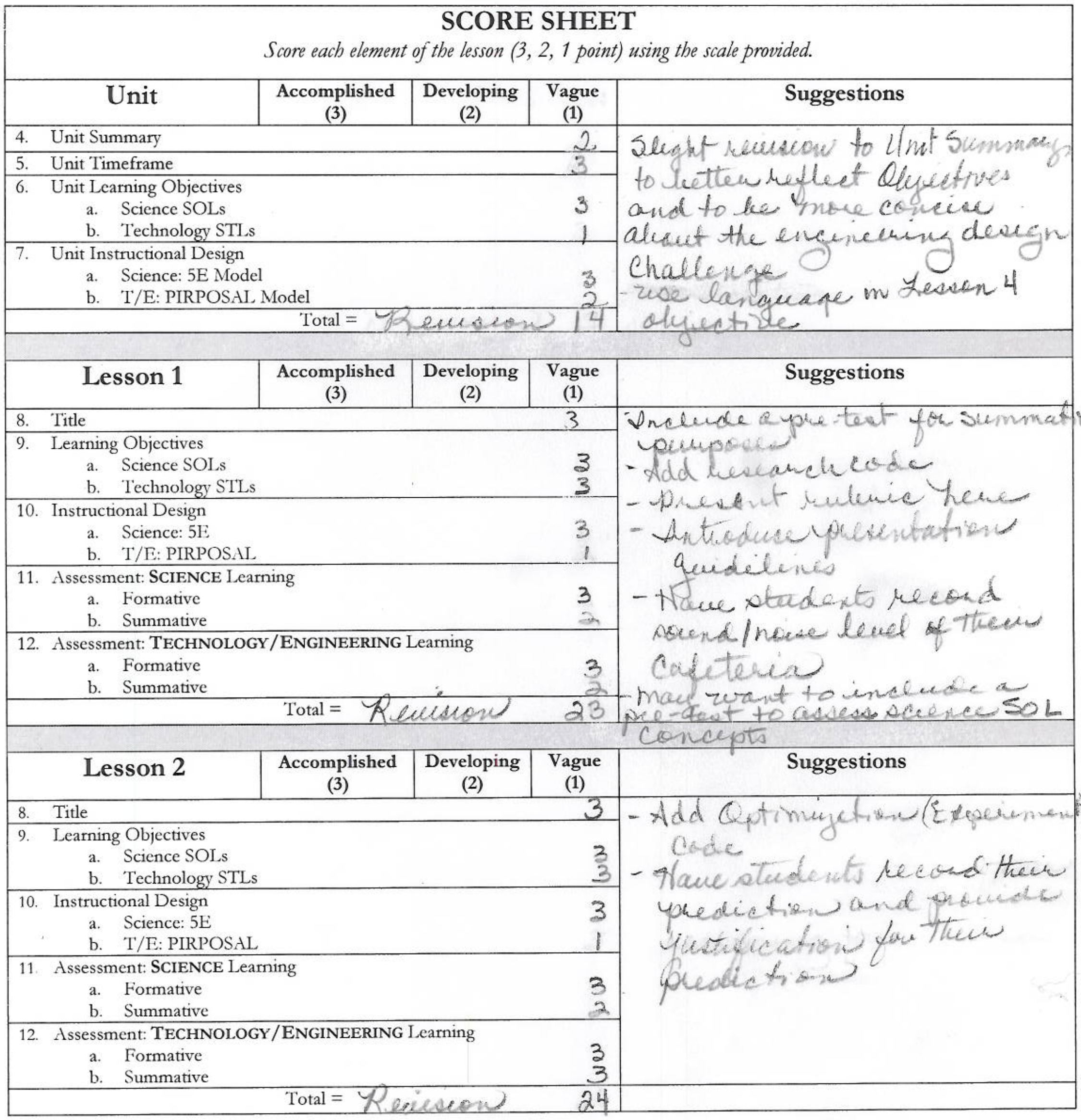

SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
4. Unit Summary			2	Slight revision to Unit Summary to better reflect Objectives and to be more concise about the engineering design Challenge - use language in Lesson 4 objective
5. Unit Timeframe			3	
6. Unit Learning Objectives a. Science SOLs b. Technology STLs			 3 1	
7. Unit Instructional Design a. Science: 5E Model b. T/E: PIRPOSAL Model			 3 2	
Total = Revision			14	

Lesson 1	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	Include a pre-test for summative purposes - Add research code - present rubric here - Introduce presentation guidelines - Have students record sound/noise level of their Cafeteria - may want to include a pre-test to assess science SOL concepts
9. Learning Objectives a. Science SOLs b. Technology STLs			 3 3	
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL			 3 1	
11. Assessment: **SCIENCE** Learning a. Formative b. Summative			 3 2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative			 3 2	
Total = Revision			23	

Lesson 2	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Add Optimization (Experiment) Code - Have students record their prediction and provide justification for their prediction
9. Learning Objectives a. Science SOLs b. Technology STLs			 3 3	
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL			 3 1	
11. Assessment: **SCIENCE** Learning a. Formative b. Summative			 3 2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative			 3 3	
Total = Revision			24	

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Lesson 3	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Capture brainstorming ideas about the characteristics of a good insulator on white board or a place visible in the classroom
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
	Total = Revision		24	

Lesson 4	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- use the word "design" instead of "create" - May want to use the VISTA engineering model if you need a visual for students - NASA materials use the word "limits". May want to introduce "constraints" and "criteria"
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
	Total = No Revision		25	

Lesson 5	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	If a pre-test is used, administer a post-test for a summative assessment of science SOL Example - How does sound travel through a solid, liquid, or gas? or/ What are some characteristics of sound insulating materials?
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
	Total = No Revision		25	

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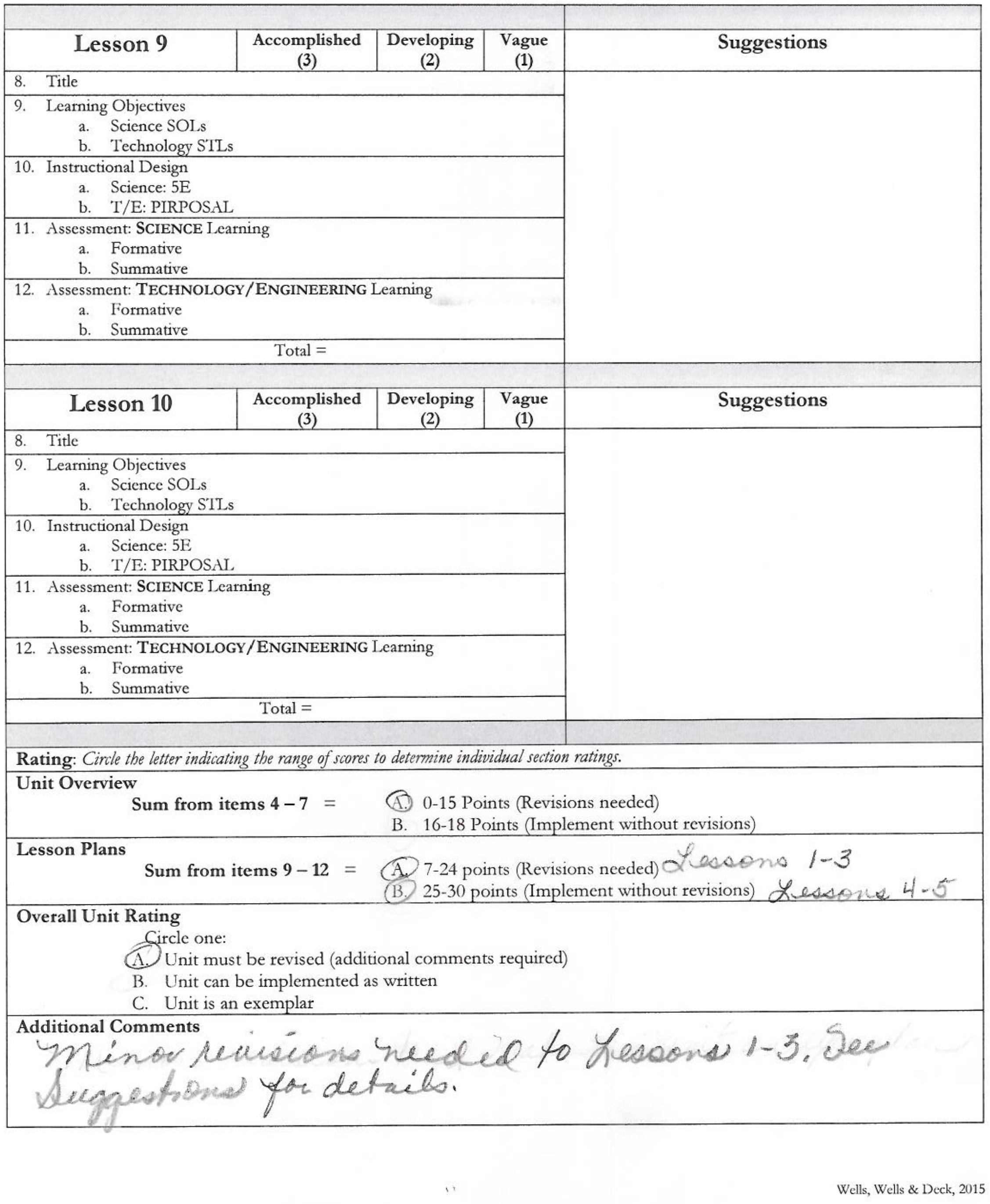

Lesson 9	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 10	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Rating: *Circle the letter indicating the range of scores to determine individual section ratings.*

Unit Overview

Sum from items 4 – 7 =
[✓ A.] 0-15 Points (Revisions needed)
B. 16-18 Points (Implement without revisions)

Lesson Plans

Sum from items 9 – 12 =
[✓ A.] 7-24 points (Revisions needed) Lessons 1-3
[✓ B.] 25-30 points (Implement without revisions) Lessons 4-5

Overall Unit Rating

Circle one:
[✓ A.] Unit must be revised (additional comments required)
B. Unit can be implemented as written
C. Unit is an exemplar

Additional Comments

Minor revisions needed to Lessons 1-3. See Suggestions for details.

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Anita Deck 4-10-16

Evaluator's Signature *Date*

Unit/Lesson –Interrater Feedback Log

Following the assessment of the unit and lessons, use this log to indicate the major strengths (provide 3) and the major suggestions (provide 3) for improvement.

Unit Overview

Strengths	Suggestions
1. Key Goals	1. Use language in Lesson 4
2. Objectives	2. objective to include in
3. Assessments	3. Summary

Lesson 1

Strengths	Suggestions
1. Engage with relevant activities	1. Include a pre-test
2. Use of video clips	2. Present rubric here
3. Introduction of design brief	3. Introduce presentation guidelines

Lesson 2

Strengths	Suggestions
1. Ear protectors experiment	1. Have students record predictions
2. Student predictions	2. Have students write justification
3. Having students justify their predictions	3. for predictions

Lesson 3

Strengths	Suggestions
1. Discourse	1. Capture brainstorming ideas
2. Sharing information	2.
3. Evaluating materials	3.

Lesson 4

Strengths	Suggestions
1. Using real science equipment	1. Introduce vocabulary –
2. Considering cost	2. "constraints" "criteria"
3. Active design	3.

Lesson 5

Strengths	Suggestions
1. Use of digital imaging	1. Administer post-test for
2. Presentation	2. summative – science
3. Self evaluation	3.

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Participant Code A

Unit 2
Post

T/E Design Based Learning Unit/Lesson Assessment Rubric

1. Unit Title:			
2. Grade Level:			
3. Date:			
For 4-12 below, use the scale below to determine the option that best describes the extent to which each item is completed in the lesson. Score the lesson on the score sheet.			
	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Unit Overview			
4. Unit Summary	Concise summary is clearly stated and includes content and skills students should know and be able to do. ✓	Summary is clearly stated, but lacks complete information about content and skills students should know and be able to do.	Summary is unclear, too broad, or not present.
5. Unit Timeframe	Approximate number of class periods or sessions is clearly indicated, including specified timeframe. ✓	Approximate number of class periods or sessions is clearly indicated, but timeframe is not specified.	Number of classes or sessions and timeframe is not clear or is not apparent.
6. Unit Learning Objectives			
Science (SOL)	A minimum of one key Sci-SOL for each lesson is clearly stated and correlates with lesson objectives. ✓	A minimum of one key Sci-SOL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key Sci-SOL for each lesson is not clearly stated or apparent.
T/E DBL (STL)	A minimum of one key STL for each lesson is clearly stated and correlates with lesson objectives. ✓	A minimum of one key STL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key STL for each lesson is not clearly stated or apparent.
7. Unit Instructional Design			
Science: 5E Model	Unit clearly adheres to a science 5E instructional design model to guide implementation of instruction. ✓	Unit loosely adheres to a science 5E instructional design model to guide implementation of instruction.	Unit does not adhere to a science 5E instructional design model to guide implementation of instruction.
T/E: PIRPOSAL Model	All eight engagement phases are evident and employed as an integral component of the instructional design.	A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design. ✓	None or very few (4 or less) engagement phases are evident and employed as an integral component of the instructional design.

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	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Lesson Plans			
8. Title	The lesson title is brief, and creatively summarizes the theme of the lesson.	The lesson title is brief, but does not capture the theme of the lesson.	The lesson title is too long or too short, and does not capture the theme of the lesson
9. Learning Objectives	Action verbs used to clearly specify observable student outcomes. Stated to measure high order thinking/learning skills.	Action verbs specify observable student outcomes, but not stated to measure high order thinking/learning skills.	Observable student outcomes not clear, and not stated to measure higher order thinking/learning skills.
Science SOLs			
Technology SOLs			
10. Instructional Design			
Science 5E Model	Thorough planning is evidenced through carefully constructed opportunities for students to engage in inquiry through active, hands-on exploration. Connection between all phases is explicit. Provides excellent opportunities for students to apply and expand their understanding, generate and explore questions, analyze data, and report findings. Appropriate assessment process measures student understanding of concepts and skills.	Provides adequate constructed opportunities for students to engage in inquiry through active, hands-on exploration. Phases are related, but connections are not explicit. Provides opportunities for students to expand their understanding, analyze data, and report findings. Adequate evidence of an appropriate assessment process to measure student understanding of concepts and skills.	Minimal and/or inappropriate opportunities for students to engage in inquiry through active, hands-on exploration. Phases have no obvious connections. Provides little opportunity for students to expand on existing knowledge. Final assessment is vague or absent.
T/E PIRPOSAL Model	Continuous, active student-centered approach that is fluid and fully integrated in the instructional design, intentionally teaches targeted science content, and promotes convergent and divergent questioning.	Active student-centered approach that is reflected but not fully integrated in the instructional design, and teaches minimal science content.	Completed, inactive teacher-centered approach.
11. Assessment: Science	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			
12. Assessment: Technology/Engineering	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			

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SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
4. Unit Summary			3	none
5. Unit Timeframe			3	
6. Unit Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
7. Unit Instructional Design				
a. Science: 5E Model			3	
b. T/E: PIRPOSAL Model			2	
Total = No revision			17	

Lesson 1	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	none
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total = No revision			25	

Lesson 2	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	none
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total = No Revision			26	

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Lesson 3	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	none
9. Learning Objectives a. Science SOLs b. Technology STLs			3 3	
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL			3 1	
11. Assessment: **SCIENCE** Learning a. Formative b. Summative			3 3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative			3 3	
Total =		No revision	25	

Lesson 4	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	none
9. Learning Objectives a. Science SOLs b. Technology STLs			3 3	
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL			3 2	
11. Assessment: **SCIENCE** Learning a. Formative b. Summative			3 3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative			3 3	
Total =	No Revision		26	

Lesson 5	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	none
9. Learning Objectives a. Science SOLs b. Technology STLs			3 3	
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL			3 2	
11. Assessment: **SCIENCE** Learning a. Formative b. Summative			3 3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative			3 3	
Total =	No Revision		26	

Lesson 9	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 10	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Rating: *Circle the letter indicating the range of scores to determine individual section ratings.*

Unit Overview

Sum from items 4 – 7 =
A. 0-15 Points (Revisions needed)
[✓ B.] 16-18 Points (Implement without revisions)

Lesson Plans

Sum from items 9 – 12 =
A. 7-24 points (Revisions needed)
[✓ B.] 25-30 points (Implement without revisions)

Overall Unit Rating

Circle one:
A. Unit must be revised (additional comments required)
[✓ B.] Unit can be implemented as written
C. Unit is an exemplar

Additional Comments

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Anita Deck 4-18-16

Evaluator's Signature *Date*

Unit/Lesson –Interrater Feedback Log

Following the assessment of the unit and lessons, use this log to indicate the major strengths (provide 3) and the major suggestions (provide 3) for improvement.

Unit Overview

Strengths	Suggestions
1. Concise summary	1. none
2. Measurable objectives	2.
3. Assessments	3.

Lesson 1

Strengths	Suggestions
1. Engagement with relevant activities	1. none
2. Use of video clips	2.
3. Introduction of design brief, rubric, and presentation guidelines	3.

Lesson 2

Strengths	Suggestions
1. Ear protectors experiment	1. none
2. Student predictions and justification	2.
3. Data collection	3.

Lesson 3

Strengths	Suggestions
1. Discourse	1. none
2. Information sharing	2.
3. Evaluation of insulating materials	3.

Lesson 4

Strengths	Suggestions
1. Students use real science equipment	1. none
2. Incorporation of cost of materials, budget	2.
3. Active design process	3.

Lesson 5

Strengths	Suggestions
1. Use of digital imaging	1. none
2. Student presentations	2.
3. Self-assessment	3.

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Unit 1

T/E DBL Instructional Change Indicators (ICI)

Participant Code: B	Unit Title: Invaders Attack							Grade Level: 4		
	Lesson 1		Lesson 2		Lesson 3		Lesson 4		Lesson 5	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Curriculum										
Objectives (action verb/measurable)	1	1	1	1	1	1	1	1		1
Change Assessment (0, 1, 2, 3)										
Science										
Formative	2	2	1	2	2	2	0	2		0
Summative	3	0	0	2	2	0	0	0		2
Technology/Engineering										
Formative	0	0	0	0	0	0	0	2		0
Summative	0	0	0	0	0	0	3	0		0
5E Instructional Design										
Engagement	0	0	0	0	0	0	1	1		0
Context/Scenario/Challenge										
Exploration	1	1	1	1	0	0	1	0		0
Concepts/Know/Need to Know										
Explanation	0	0	0	0	0	1	0	1		0
Understanding/Evidencing/Clarifying										
Elaboration	0	0	0	0	0	0	0	1		0
Knowledge Trans/Interpret Results/Extend Application										
Evaluation	0	0	0	0	1	0	1	0		1
Formative/Summative/Evidence										
Total Procedures	1	1	1	1	1	1	3	3		1
T/E DBL Phase Integrations										
Problem Identification	0	0	0	0	0	1	1	1		0
Need/Define/Formulation										
Ideation	0	0	0	0	0	1	1	1		0
Criteria/Brainstorm/Generate										
Research	0	0	0	0	0	0	1	0		0
Explore/Investigate/Examine										
Potential Solutions	0	0	0	0	0	0	1	1		0
Analyze/Visualize/Select										
Optimization	0	0	0	0	0	0	0	0		0
Experiment/Revisit/Construct										
Solution Evaluation	0	0	0	0	0	0	0	1		0
Test/Analyze/Retest										
Alterations	0	0	0	0	0	0	1	1		0
Identify/Redesign/Retest										
Learned Outcomes	0	0	0	0	0	0	0	0		1
Process/Iterations/Justify										
Total T/E DBL Phase Integration	0	0	0	0	0	2	5	5		1

Lesson Evaluation Key
Accomplished (3pts)
Developing (2pts)
Vague (1pt)

ICI Evaluation Key
0 = Absence of Variable
1 = Presence of Variable
2 = Assessment is linked to objectives
3 = Each objective is assessed

Wells, Wells & Deck, 2015

Participant Code B

Unit1
Pre

T/E Design Based Learning Unit/Lesson Assessment Rubric

1. Unit Title: Invasive Species: Identify, Research, and Manage
2. Grade Level: 4
3. Date: 2-15-16

For 4-12 below, use the scale below to determine the option that best describes the extent to which each item is completed in the lesson. Score the lesson on the score sheet.

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Unit Overview			
4. Unit Summary	Concise summary is clearly stated and includes content and skills students should know and be able to do.	Summary is clearly stated, but lacks complete information about content and skills students should know and be able to do.	Summary is unclear, too broad, or not present. ✓
5. Unit Timeframe	Approximate number of class periods or sessions is clearly indicated, including specified timeframe.	Approximate number of class periods or sessions is clearly indicated, but timeframe is not specified. ✓	Number of classes or sessions and timeframe is not clear or is not apparent.
6. Unit Learning Objectives			
Science (SOL)	A minimum of one key Sci-SOL for each lesson is clearly stated and correlates with lesson objectives.	A minimum of one key Sci-SOL for each lesson is clearly stated, but not all correlates with lesson objectives. ✓	A key Sci-SOL for each lesson is not clearly stated or apparent.
T/E DBL (STL)	A minimum of one key STL for each lesson is clearly stated and correlates with lesson objectives.	A minimum of one key STL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key STL for each lesson is not clearly stated ✓ or apparent.
7. Unit Instructional Design			
Science: 5E Model	Unit clearly adheres to a science 5E instructional design model to guide implementation of instruction.	Unit loosely adheres to a science 5E instructional design model to guide implementation of instruction. ✓	Unit does not adhere to a science 5E instructional design model to guide implementation of instruction.
T/E: PIRPOSAL Model	All eight engagement phases are evident and employed as an integral component of the instructional design.	A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design.	None or very few (4 or less) engagement phases are evident and employed as an integral component of the instructional design. ✓

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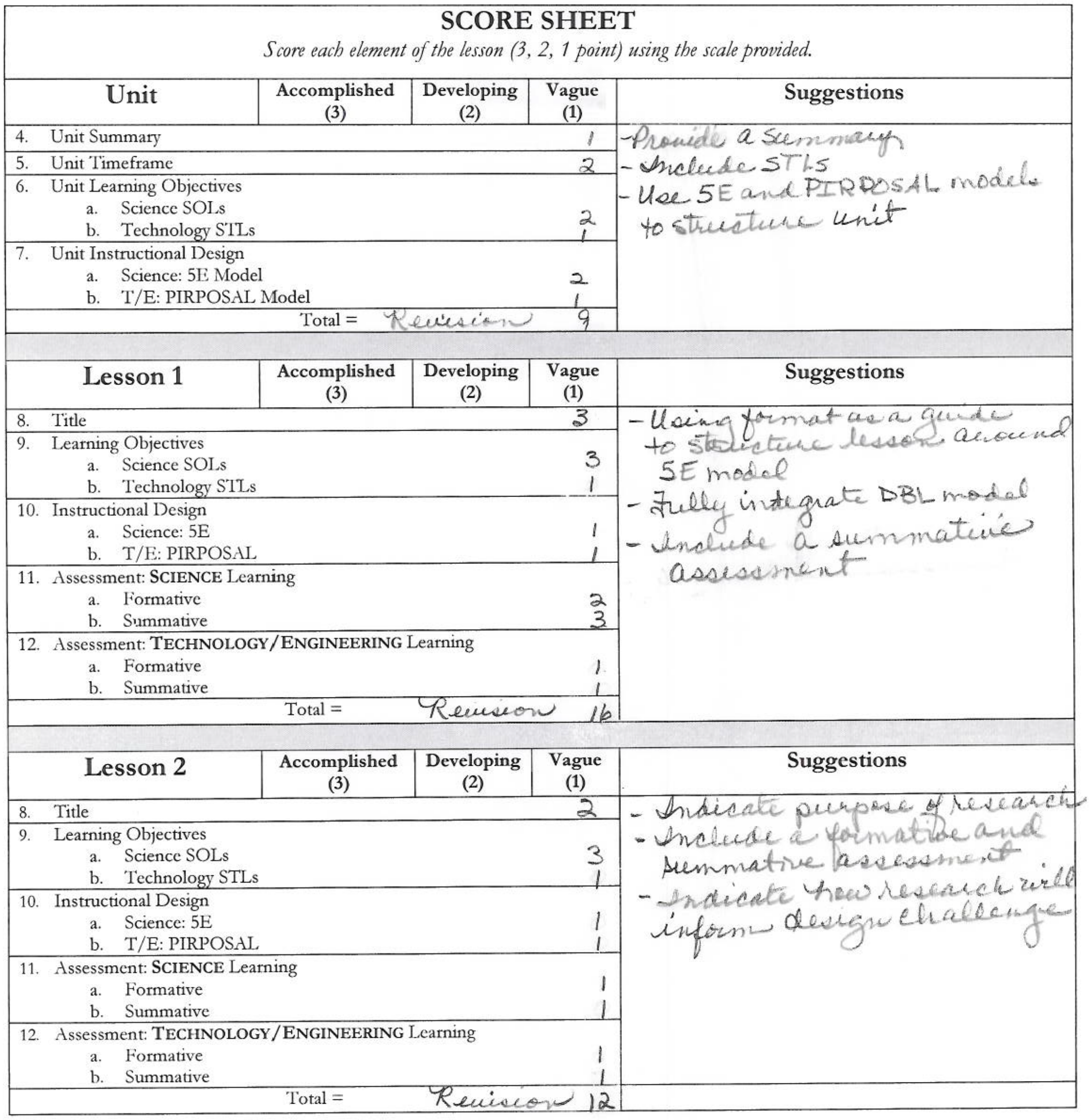

SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
4. Unit Summary			1	-Provide a summary - Include STLs - Use 5E and PIRPOSAL models to structure unit
5. Unit Timeframe			2	
6. Unit Learning Objectives				
a. Science SOLs			2	
b. Technology STLs			1	
7. Unit Instructional Design				
a. Science: 5E Model			2	
b. T/E: PIRPOSAL Model			1	
Total =	Revision		9	

Lesson 1	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Using format as a guide to structure lesson around 5E model - Fully integrate DBL model - Include a summative assessment
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			1	
10. Instructional Design				
a. Science: 5E			1	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			1	
b. Summative			1	
Total =	Revision		16	

Lesson 2	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			2	- Indicate purpose of research - Include a formative and summative assessment - Indicate how research will inform design challenge
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			1	
10. Instructional Design				
a. Science: 5E			1	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			1	
b. Summative			1	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			1	
b. Summative			1	
Total =	Revision		12	

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Lesson 3	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Structure lesson around 5E and PIRPOSAL models - include DBL and link assessment to objectives
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			1	
10. Instructional Design				
a. Science: 5E			1	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			1	
b. Summative			1	
Total =	Revision		15	

Lesson 4	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Strengthen instructional design - include science concepts and assessments - Strengthen T/E assessments
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			2	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			1	
b. Summative			1	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			2	
b. Summative			2	
Total =	Revision		19	

Lesson 5	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title				
9. Learning Objectives				
a. Science SOLs				
b. Technology STLs				
10. Instructional Design				
a. Science: 5E				
b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning				
a. Formative				
b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative				
b. Summative				
Total =				

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Evaluator's Signature Anita Deck *Date* 2-15-16

Unit/Lesson –Interrater Feedback Log

Following the assessment of the unit and lessons, use this log to indicate the major strengths (provide 3) and the major suggestions (provide 3) for improvement.

Unit Overview	
Strengths 1. No unit overview 2. 3.	Suggestions 1. Include a unit overview 2. Include a unit summary 3. Include STLS

Lesson 1	
Strengths 1. Using real plant materials 2. Student exploration 3. Pre assessment included	Suggestions 1. Fully integrate T/EDBL 2. Include summative assessment 3. Use 5E and PIRPOSAL models to structure lesson

Lesson 2	
Strengths 1. Introduction of vocabulary 2. Uses a variety of sources 3. Development of management plant	Suggestions 1. Indicate how research will inform 2. design Challenge 3. Include formative and summative assessments

Lesson 3	
Strengths 1. Original Management plan 2. Rubric used for assessment 3. Addresses SOL/science concept	Suggestions 1. Link objectives to assessment 2. 3.

Lesson 4	
Strengths 1. Presented design challenge 2. tied to real need 3. Links to management plan	Suggestions 1. Include science concepts and 2. assessment 3. Provide constraints and criteria

Lesson 5	
Strengths 1. 2. 3.	Suggestions 1. 2. 3.

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Participant Code B

Unit1
Post

T/E Design Based Learning Unit/Lesson Assessment Rubric

1. Unit Title: Invaders Attack
2. Grade Level: 4
3. Date: 3-22-15

For 4-12 below, use the scale below to determine the option that best describes the extent to which each item is completed in the lesson. Score the lesson on the score sheet.

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Unit Overview			
4. Unit Summary	Concise summary is clearly stated and includes content and skills students should know and be able to do.	[✓ Summary is clearly stated, but lacks complete information about content and skills students should know and be able to do.]	Summary is unclear, too broad, or not present.
5. Unit Timeframe	Approximate number of class periods or sessions is clearly indicated, including specified timeframe.	[✓ Approximate number of class periods or sessions is clearly indicated, but timeframe is not specified.]	Number of classes or sessions and timeframe is not clear or is not apparent.
6. Unit Learning Objectives			
Science (SOL)	A minimum of one key Sci-SOL for each lesson is clearly stated and correlates with lesson objectives.	[✓ A minimum of one key Sci-SOL for each lesson is clearly stated, but not all correlates with lesson objectives.]	A key Sci-SOL for each lesson is not clearly stated or apparent.
T/E DBL (STL)	A minimum of one key STL for each lesson is clearly stated and correlates with lesson objectives.	[✓ A minimum of one key STL for each lesson is clearly stated, but not all correlates with lesson objectives.]	A key STL for each lesson is not clearly stated or apparent.
7. Unit Instructional Design			
Science: 5E Model	Unit clearly adheres to a science 5E instructional design model to guide implementation of instruction.	[✓ Unit loosely adheres to a science 5E instructional design model to guide implementation of instruction.]	Unit does not adhere to a science 5E instructional design model to guide implementation of instruction.
T/E: PIRPOSAL Model	All eight engagement phases are evident and employed as an integral component of the instructional design.	A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design.	[✓ None or very few (4 or less) engagement phases are evident and employed as an integral component of the instructional design.]

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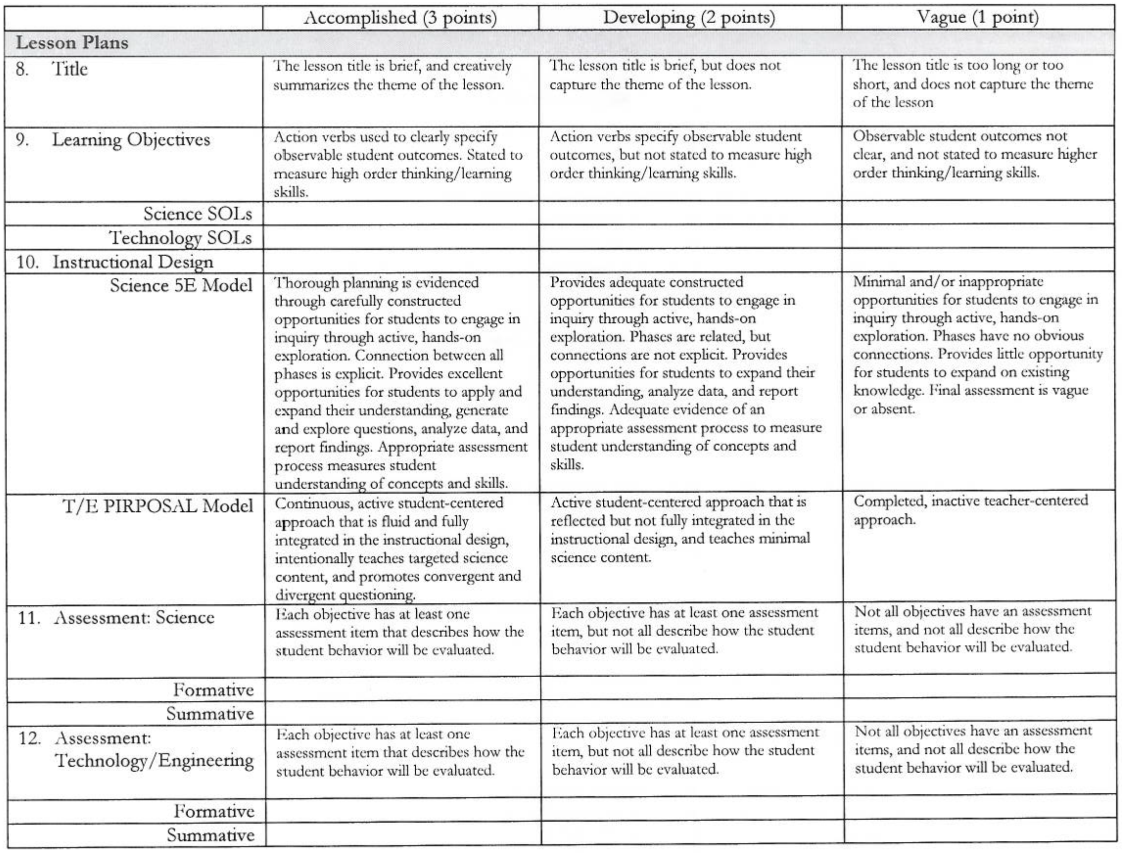

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Lesson Plans			
8. Title	The lesson title is brief, and creatively summarizes the theme of the lesson.	The lesson title is brief, but does not capture the theme of the lesson.	The lesson title is too long or too short, and does not capture the theme of the lesson
9. Learning Objectives	Action verbs used to clearly specify observable student outcomes. Stated to measure high order thinking/learning skills.	Action verbs specify observable student outcomes, but not stated to measure high order thinking/learning skills.	Observable student outcomes not clear, and not stated to measure higher order thinking/learning skills.
Science SOLs			
Technology SOLs			
10. Instructional Design			
Science 5E Model	Thorough planning is evidenced through carefully constructed opportunities for students to engage in inquiry through active, hands-on exploration. Connection between all phases is explicit. Provides excellent opportunities for students to apply and expand their understanding, generate and explore questions, analyze data, and report findings. Appropriate assessment process measures student understanding of concepts and skills.	Provides adequate constructed opportunities for students to engage in inquiry through active, hands-on exploration. Phases are related, but connections are not explicit. Provides opportunities for students to expand their understanding, analyze data, and report findings. Adequate evidence of an appropriate assessment process to measure student understanding of concepts and skills.	Minimal and/or inappropriate opportunities for students to engage in inquiry through active, hands-on exploration. Phases have no obvious connections. Provides little opportunity for students to expand on existing knowledge. Final assessment is vague or absent.
T/E PIRPOSAL Model	Continuous, active student-centered approach that is fluid and fully integrated in the instructional design, intentionally teaches targeted science content, and promotes convergent and divergent questioning.	Active student-centered approach that is reflected but not fully integrated in the instructional design, and teaches minimal science content.	Completed, inactive teacher-centered approach.
11. Assessment: Science	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			
12. Assessment: Technology/Engineering	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			

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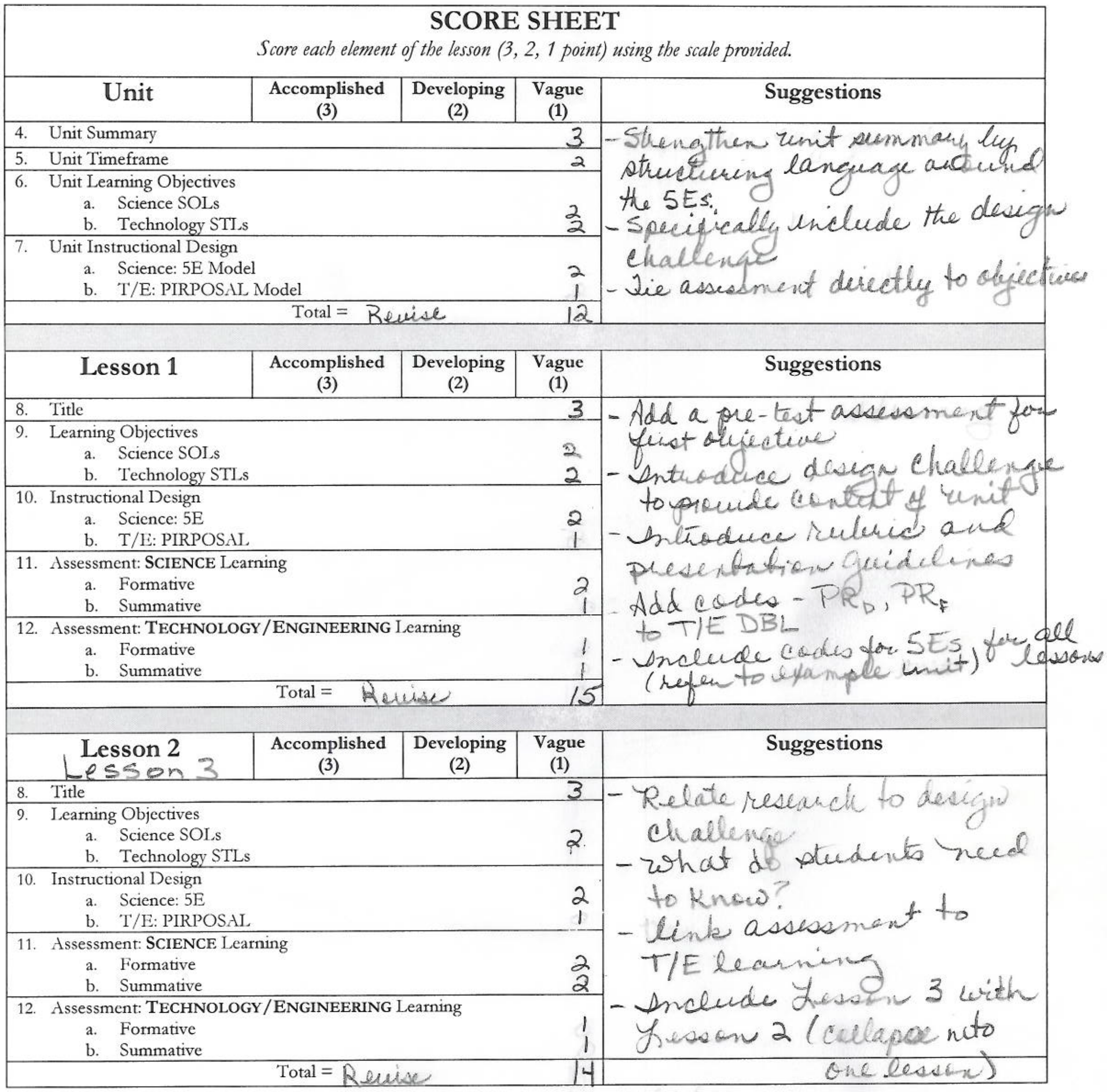

SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
4. Unit Summary			3	- Strengthen unit summary by structuring language around the 5Es. - Specifically include the design challenge - Tie assessment directly to objectives
5. Unit Timeframe			2	
6. Unit Learning Objectives				
a. Science SOLs			2	
b. Technology STLs			2	
7. Unit Instructional Design				
a. Science: 5E Model			2	
b. T/E: PIRPOSAL Model			1	
Total = Revise			12	

Lesson 1	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Add a pre-test assessment for first objective - Introduce design challenge to provide context of unit - Introduce rubric and presentation Guidelines - Add codes - PR_D, PR_F to T/E DBL - Include codes for 5Es for all lessons (refer to example unit)
9. Learning Objectives				
a. Science SOLs			2	
b. Technology STLs			2	
10. Instructional Design				
a. Science: 5E			2	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			1	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			1	
b. Summative			1	
Total = Revise			15	

Lesson 2 Lesson 3	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Relate research to design challenge - What do students need to know? - link assessment to T/E learning - Include Lesson 3 with Lesson 2 (collapse into one lesson)
9. Learning Objectives				
a. Science SOLs			2	
b. Technology STLs				
10. Instructional Design				
a. Science: 5E			2	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			1	
b. Summative			1	
Total = Revise			14	

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Lesson 3 (Lesson 4)	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	- Create question map with post-it questions - may want to move this to the engagement phase - Add codes I_B, I_G, PS_A, PS_V, PS_S to T/E DBL phases - Include codes for 5Es (refer to sample lesson)
9. Learning Objectives a. Science SOLs b. Technology STLs			2 1	
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL			2 1	
11. Assessment: **SCIENCE** Learning a. Formative b. Summative			2 1	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative			1 1	
Total = Revise			14	

Lesson 4 (Lesson 5)	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	- Include research component on insect traps - Allow time for testing, redesigning, and analysis - Discuss how the traps will be tested
9. Learning Objectives a. Science SOLs b. Technology STLs			2 2	
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL			3 2	
11. Assessment: **SCIENCE** Learning a. Formative b. Summative			2 1	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative			1 1	
Total = Revise			17	

Lesson 5 (Lesson 6)	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	- Allow time for students to present their traps to the class - Allow students to distribute traps around school campus for use - Have students self-assess using provided rubric - if a pre-test is given, administer post-test
9. Learning Objectives a. Science SOLs b. Technology STLs			3 2	
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL			2 1	
11. Assessment: **SCIENCE** Learning a. Formative b. Summative			1 2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative			1 1	
Total = Revise			13	

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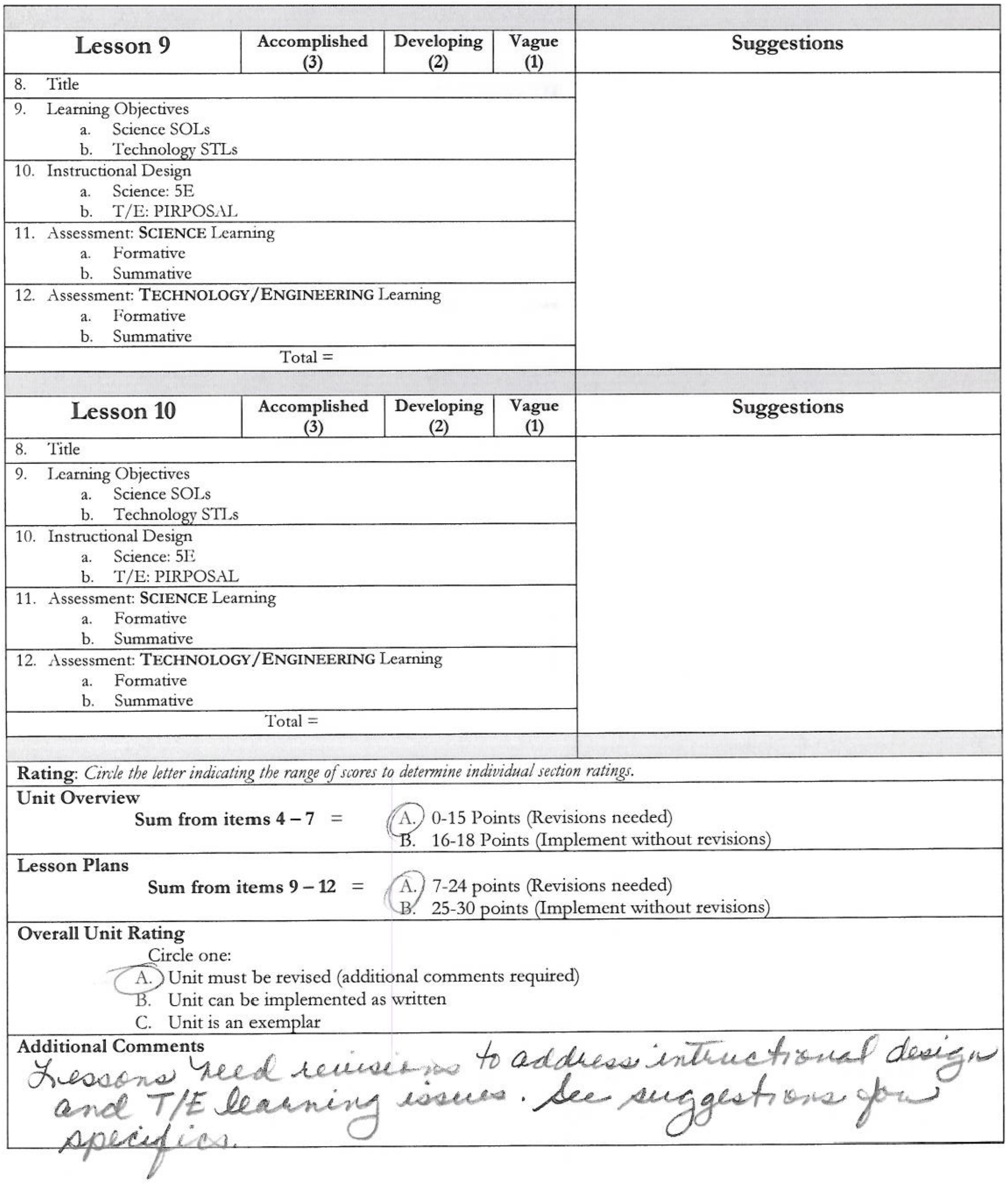

Lesson 9	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 10	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Rating: *Circle the letter indicating the range of scores to determine individual section ratings.*

Unit Overview

Sum from items 4 – 7 =
[✓ A.] 0-15 Points (Revisions needed)
B. 16-18 Points (Implement without revisions)

Lesson Plans

Sum from items 9 – 12 =
[✓ A.] 7-24 points (Revisions needed)
B. 25-30 points (Implement without revisions)

Overall Unit Rating

Circle one:
[✓ A.] Unit must be revised (additional comments required)
B. Unit can be implemented as written
C. Unit is an exemplar

Additional Comments

Lessons need revisions to address intructional design and T/E learning issues. See suggestions for specifics.

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Anita Deck — 3-7-16

Evaluator's Signature — *Date*

Unit/Lesson –Interrater Feedback Log

Following the assessment of the unit and lessons, use this log to indicate the major strengths (provide 3) and the major suggestions (provide 3) for improvement.

Unit Overview

Strengths	Suggestions
1. Time frame 2. Prior Knowledge 3. Measurable objectives	1. Combine lessons 2 and 3 2. Use specific language – design challenge 3. Delineate additional SOLs

Lesson 1

Strengths	Suggestions
1. Introduction of safety guidelines 2. Students are actively learning 3. Students collect data	1. Add a pre-test assessment 2. Introduce design challenge 3. Introduce rubric and presentation guidelines

Lesson 2

Strengths	Suggestions
1. Discourse 2. Mapping activity 3. Students use notebooks for data collection	1. Link assessment to T/E learning 2. Collapse Lesson 3 into Lesson 2 3. Relate research to design challenge

Lesson 3

Strengths	Suggestions
1. Students create their own questions 2. Student discussion 3. Specific information given about targeted insect	1. Create question map 2. Include addition codes in 3. T/E DBL phases

Lesson 4

Strengths	Suggestions
1. Students presented with design challenge 2. Discourse 3. Students actively designing	1. Include research component on 2. insect traps 3. Discuss how traps will be tested

Lesson 5

Strengths	Suggestions
1. Science concept summative assessment 2. 3. Use of graphic organizers	1. Student presentations of traps 2. Have students self assess using rubric 3. Administer post-test

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Unit 2

T/E DBL Instructional Change Indicators (ICI)

Participant Code: B	Unit Title: Plants in Space							Grade Level: 4		
	Lesson 1		Lesson 2		Lesson 3		Lesson 4		Lesson 5	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Curriculum										
Objectives (action verb/measurable)	1		1		1		1		1	
Change Assessment (0, 1, 2, 3)										
Science										
Formative	3	3	3	3	2	2	2	3	0	3
Summative	3	3	2	2	3	3	2	3	0	3
Technology/Engineering										
Formative	0	2	0	2	0	3	3	3	2	3
Summative	0	2	0	2	0	3	2	3	2	3
5E Instructional Design										
Engagement	1	1	0	0	0	0	0	0	0	0
Context/Scenario/Challenge										
Exploration	0	0	1	1	0	0	0	0	0	0
Concepts/Know/Need to Know										
Explanation	0	0	0	0	1	1	0	0	0	0
Understanding/Evidencing/Clarifying										
Elaboration	0	0	0	0	0	0	1	1	0	0
Knowledge Trans/Interpret Results/Extend Application										
Evaluation	0	0	0	0	0	0	0	0	1	1
Formative/Summative/Evidence										
Total Procedures	1	1	1	1	1	1	1	1	1	1
T/E DBL Phase Integrations										
Problem Identification	1	1	0	1	0	1	0	1	0	1
Need/Define/Formulation										
Ideation	0	1	1	1	0	1	1	1	0	1
Criteria/Brainstorm/Generate										
Research	0	1	1	1	0	1	0	1	0	1
Explore/Investigate/Examine										
Potential Solutions	0	1	0	1	1	1	1	1	0	1
Analyze/Visualize/Select										
Optimization	0	0	0	1	0	1	1	1	0	1
Experiment/Revisit/Construct										
Solution Evaluation	0	0	0	0	0	0	1	1	0	1
Test/Analyze/Retest										
Alterations	0	0	0	0	0	0	0	0	0	1
Identify/Redesign/Retest										
Learned Outcomes	0	1	0	0	0	0	0	0	0	1
Process/Iterations/Justify										
Total T/E DBL Phase Integration	1	5	2	5	1	5	4	6	0	8

Lesson Evaluation Key
Accomplished (3pts)
Developing (2pts)
Vague (1pt)

ICI Evaluation Key
0 = Absence of Variable
1 = Presence of Variable
2 = Assessment is linked to objectives
3 = Each objective is assessed

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Participant Code B

Unit 2
Pre

T/E Design Based Learning Unit/Lesson Assessment Rubric

1. Unit Title: Plants in Space
2. Grade Level: 4
3. Date: 4-5-16

For 4-12 below, use the scale below to determine the option that best describes the extent to which each item is completed in the lesson. Score the lesson on the score sheet.

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Unit Overview			
4. Unit Summary	Concise summary is clearly stated and includes content and skills students should know and be able to do.	[✓ Summary is clearly stated, but lacks complete information about content and skills students should know and be able to do.]	Summary is unclear, too broad, or not present.
5. Unit Timeframe	[✓ Approximate number of class periods or sessions is clearly indicated, including specified timeframe.]	Approximate number of class periods or sessions is clearly indicated, but timeframe is not specified.	Number of classes or sessions and timeframe is not clear or is not apparent.
6. Unit Learning Objectives			
Science (SOL)	[✓ A minimum of one key Sci-SOL for each lesson is clearly stated and correlates with lesson objectives.]	A minimum of one key Sci-SOL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key Sci-SOL for each lesson is not clearly stated or apparent.
T/E DBL (STL)	[✓ A minimum of one key STL for each lesson is clearly stated and correlates with lesson objectives.]	A minimum of one key STL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key STL for each lesson is not clearly stated or apparent.
7. Unit Instructional Design			
Science: 5E Model	[✓ Unit clearly adheres to a science 5E instructional design model to guide implementation of instruction.]	Unit loosely adheres to a science 5E instructional design model to guide implementation of instruction.	Unit does not adhere to a science 5E instructional design model to guide implementation of instruction.
T/E: PIRPOSAL Model	All eight engagement phases are evident and employed as an integral component of the instructional design.	[✓ A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design.]	None or very few (4 or less) engagement phases are evident and employed as an integral component of the instructional design.

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	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Lesson Plans			
8. Title	The lesson title is brief, and creatively summarizes the theme of the lesson.	The lesson title is brief, but does not capture the theme of the lesson.	The lesson title is too long or too short, and does not capture the theme of the lesson
9. Learning Objectives	Action verbs used to clearly specify observable student outcomes. Stated to measure high order thinking/learning skills.	Action verbs specify observable student outcomes, but not stated to measure high order thinking/learning skills.	Observable student outcomes not clear, and not stated to measure higher order thinking/learning skills.
Science SOLs			
Technology SOLs			
10. Instructional Design			
Science 5E Model	Thorough planning is evidenced through carefully constructed opportunities for students to engage in inquiry through active, hands-on exploration. Connection between all phases is explicit. Provides excellent opportunities for students to apply and expand their understanding, generate and explore questions, analyze data, and report findings. Appropriate assessment process measures student understanding of concepts and skills.	Provides adequate constructed opportunities for students to engage in inquiry through active, hands-on exploration. Phases are related, but connections are not explicit. Provides opportunities for students to expand their understanding, analyze data, and report findings. Adequate evidence of an appropriate assessment process to measure student understanding of concepts and skills.	Minimal and/or inappropriate opportunities for students to engage in inquiry through active, hands-on exploration. Phases have no obvious connections. Provides little opportunity for students to expand on existing knowledge. Final assessment is vague or absent.
T/E PIRPOSAL Model	Continuous, active student-centered approach that is fluid and fully integrated in the instructional design, intentionally teaches targeted science content, and promotes convergent and divergent questioning.	Active student-centered approach that is reflected but not fully integrated in the instructional design, and teaches minimal science content.	Completed, inactive teacher-centered approach.
11. Assessment: Science	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			
12. Assessment: Technology/Engineering	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			

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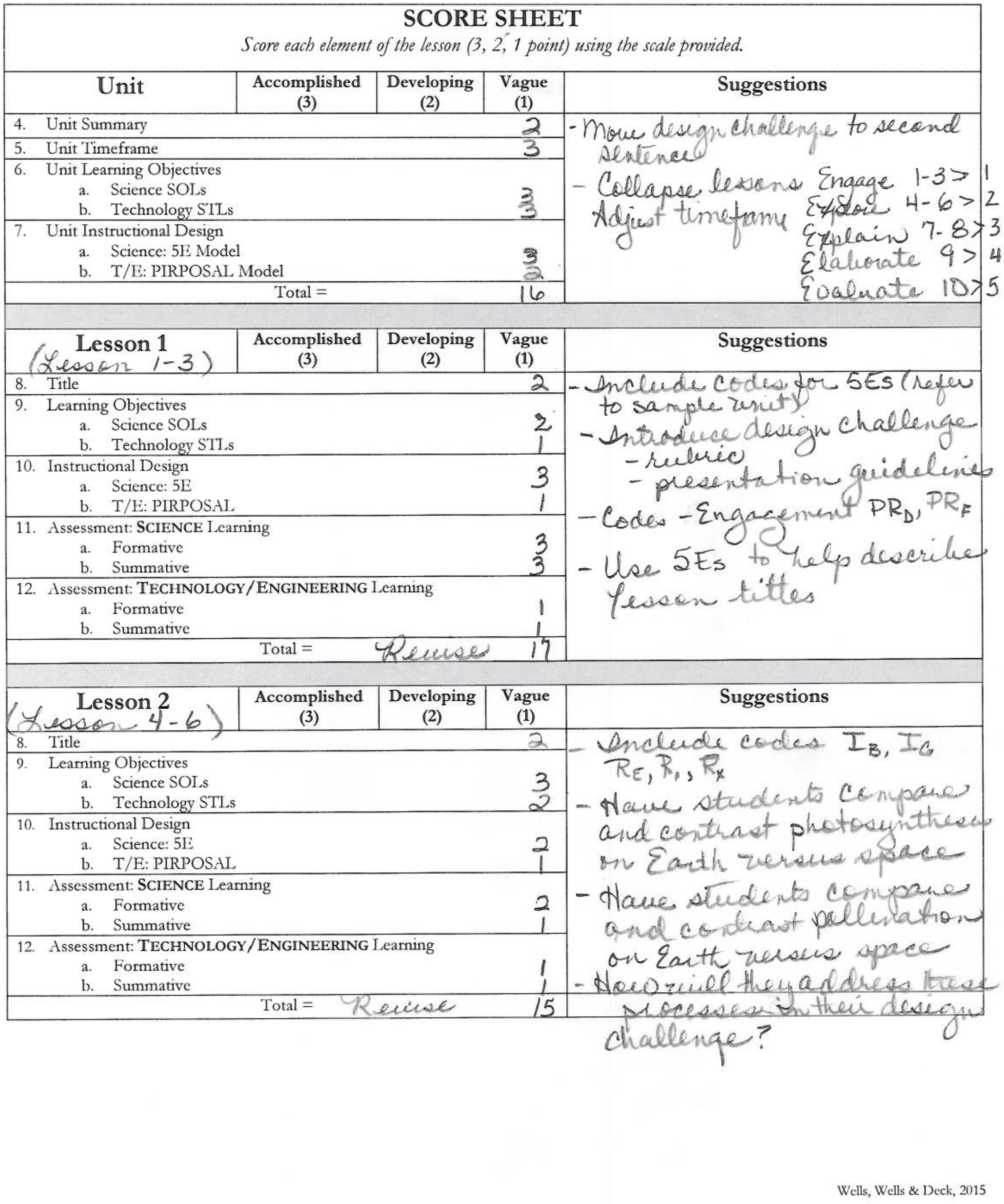

SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
4. Unit Summary			2	- Move design challenge to second sentence - Collapse lessons Engage 1-3 > 1 Adjust timefame Explore 4-6 > 2 Explain 7-8 > 3 Elaborate 9 > 4 Evaluate 10 > 5
5. Unit Timeframe			3	
6. Unit Learning Objectives a. Science SOLs b. Technology STLs			3 3	
7. Unit Instructional Design a. Science: 5E Model b. T/E: PIRPOSAL Model			3 2	
Total =			16	

Lesson 1 (Lesson 1-3)	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			2	- Include codes for 5Es (refer to sample unit) - Introduce design challenge - rubric - presentation guidelines - Codes - Engagement PR_D, PR_F - Use 5Es to help describe lesson titles
9. Learning Objectives a. Science SOLs b. Technology STLs			2 1	
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL			3 1	
11. Assessment: **SCIENCE** Learning a. Formative b. Summative			3 3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative			1 1	
Total =	Reuse		17	

Lesson 2 (Lesson 4-6)	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			2	- Include codes I_B, I_G R_E, R_I, R_X - Have students compare and contrast photosynthesis on Earth versus space - Have students compare and contrast pollination on Earth versus space - How will they address these processes in their design challenge?
9. Learning Objectives a. Science SOLs b. Technology STLs			3 2	
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL			2 1	
11. Assessment: **SCIENCE** Learning a. Formative b. Summative			2 1	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative			1 1	
Total =	Reuse		15	

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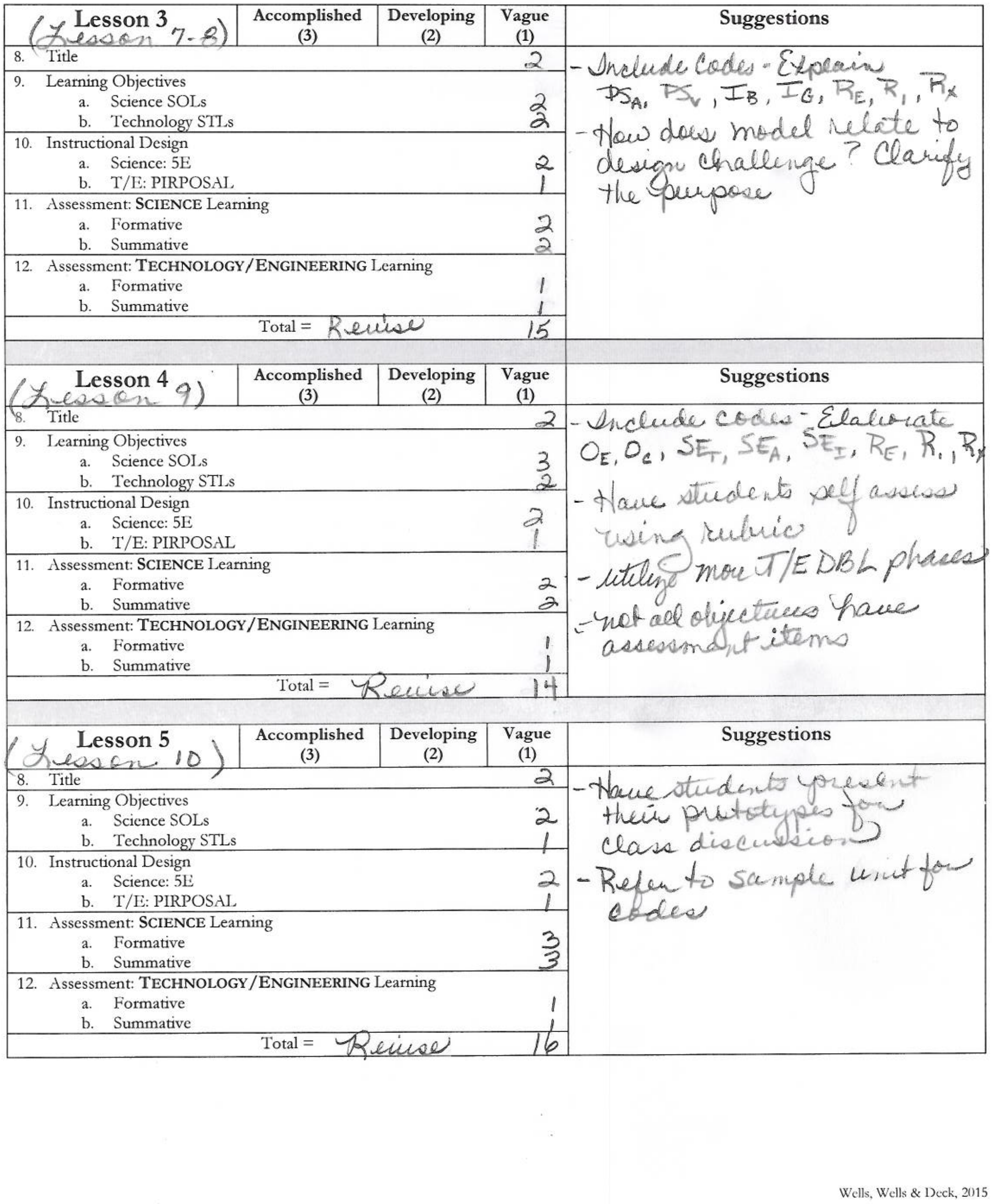

Lesson 3 (Lesson 7-8)	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			2	- Include Codes - Explain PS_A, PS_V, I_B, I_G, R_E, R_1, R_X - How does model relate to design challenge? Clarify the purpose
9. Learning Objectives				
a. Science SOLs			2	
b. Technology STLs			2	
10. Instructional Design				
a. Science: 5E			2	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			1	
b. Summative			1	
Total = Revise			15	

Lesson 4 (Lesson 9)	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			2	- Include codes - Elaborate O_E, O_C, SE_T, SE_A, SE_I, R_E, R_1, R_X - Have students self assess using rubric - utilize more T/E DBL phases - not all objectives have assessment items
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			2	
10. Instructional Design				
a. Science: 5E			2	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			1	
b. Summative			1	
Total = Revise			14	

Lesson 5 (Lesson 10)	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			2	- Have students present their prototypes for class discussion - Refer to sample unit for codes
9. Learning Objectives				
a. Science SOLs			2	
b. Technology STLs			1	
10. Instructional Design				
a. Science: 5E			2	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			1	
b. Summative			1	
Total = Revise			16	

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Lesson 9	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 10	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Rating: *Circle the letter indicating the range of scores to determine individual section ratings.*

Unit Overview

Sum from items 4 – 7 = A. 0-15 Points (Revisions needed)
[✓ B.] 16-18 Points (Implement without revisions)

Lesson Plans

Sum from items 9 – 12 = [✓ A.] 7-24 points (Revisions needed)
B. 25-30 points (Implement without revisions)

Overall Unit Rating

Circle one:
[✓ A.] Unit must be revised (additional comments required)
B. Unit can be implemented as written
C. Unit is an exemplar

Additional Comments

Lessons need some revisions to fully address instructional design and T/E learning issues. See suggestions for specifics.

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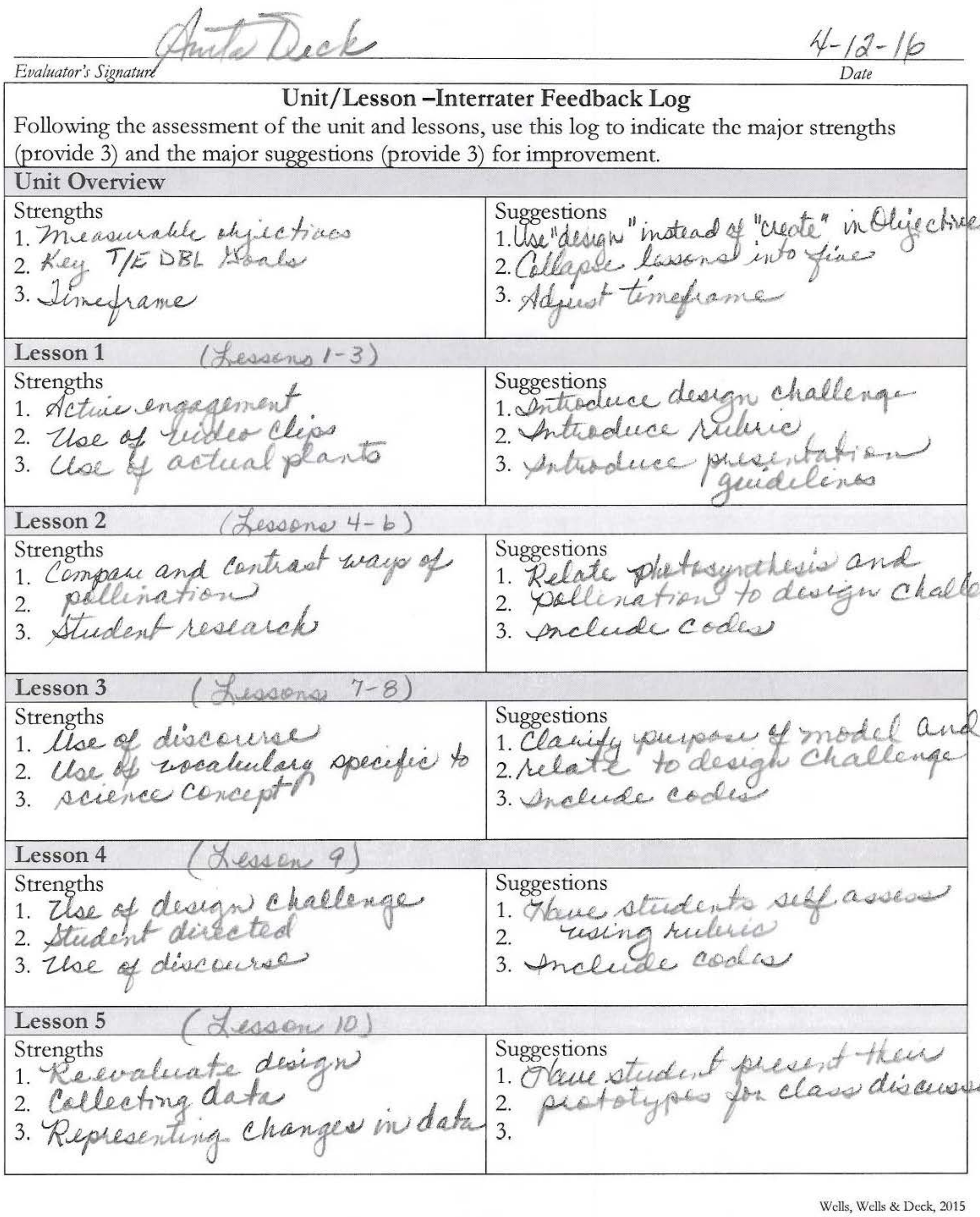

Anita Deck   4-12-16

Evaluator's Signature   *Date*

Unit/Lesson –Interrater Feedback Log

Following the assessment of the unit and lessons, use this log to indicate the major strengths (provide 3) and the major suggestions (provide 3) for improvement.

Unit Overview

Strengths	Suggestions
1. Measurable objectives	1. Use "design" instead of "create" in Objectives
2. Key T/E DBL Goals	2. Collapse lessons into five
3. Timeframe	3. Adjust timeframe

Lesson 1 (Lessons 1-3)

Strengths	Suggestions
1. Active engagement	1. Introduce design challenge
2. Use of video clips	2. Introduce rubric
3. Use of actual plants	3. Introduce presentation guidelines

Lesson 2 (Lessons 4-6)

Strengths	Suggestions
1. Compare and contrast ways of	1. Relate photosynthesis and
2. pollination	2. pollination to design challenge
3. Student research	3. Include codes

Lesson 3 (Lessons 7-8)

Strengths	Suggestions
1. Use of discourse	1. Clarify purpose of model and
2. Use of vocabulary specific to	2. relate to design challenge
3. science concept	3. Include codes

Lesson 4 (Lesson 9)

Strengths	Suggestions
1. Use of design challenge	1. Have students self assess
2. Student directed	2. using rubric
3. Use of discourse	3. Include codes

Lesson 5 (Lesson 10)

Strengths	Suggestions
1. Reevaluate design	1. Have student present their
2. Collecting data	2. prototypes for class discussion
3. Representing changes in data	3.

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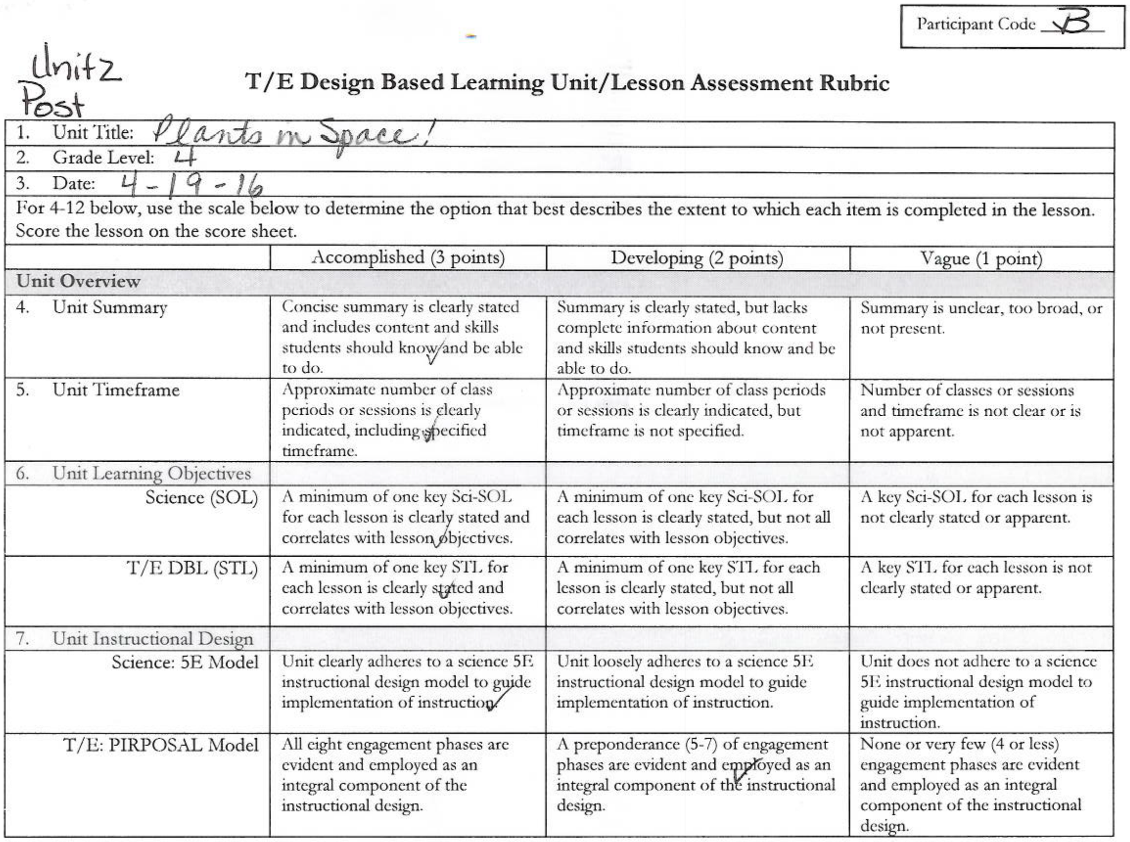


Participant Code B

Unit 2
Post

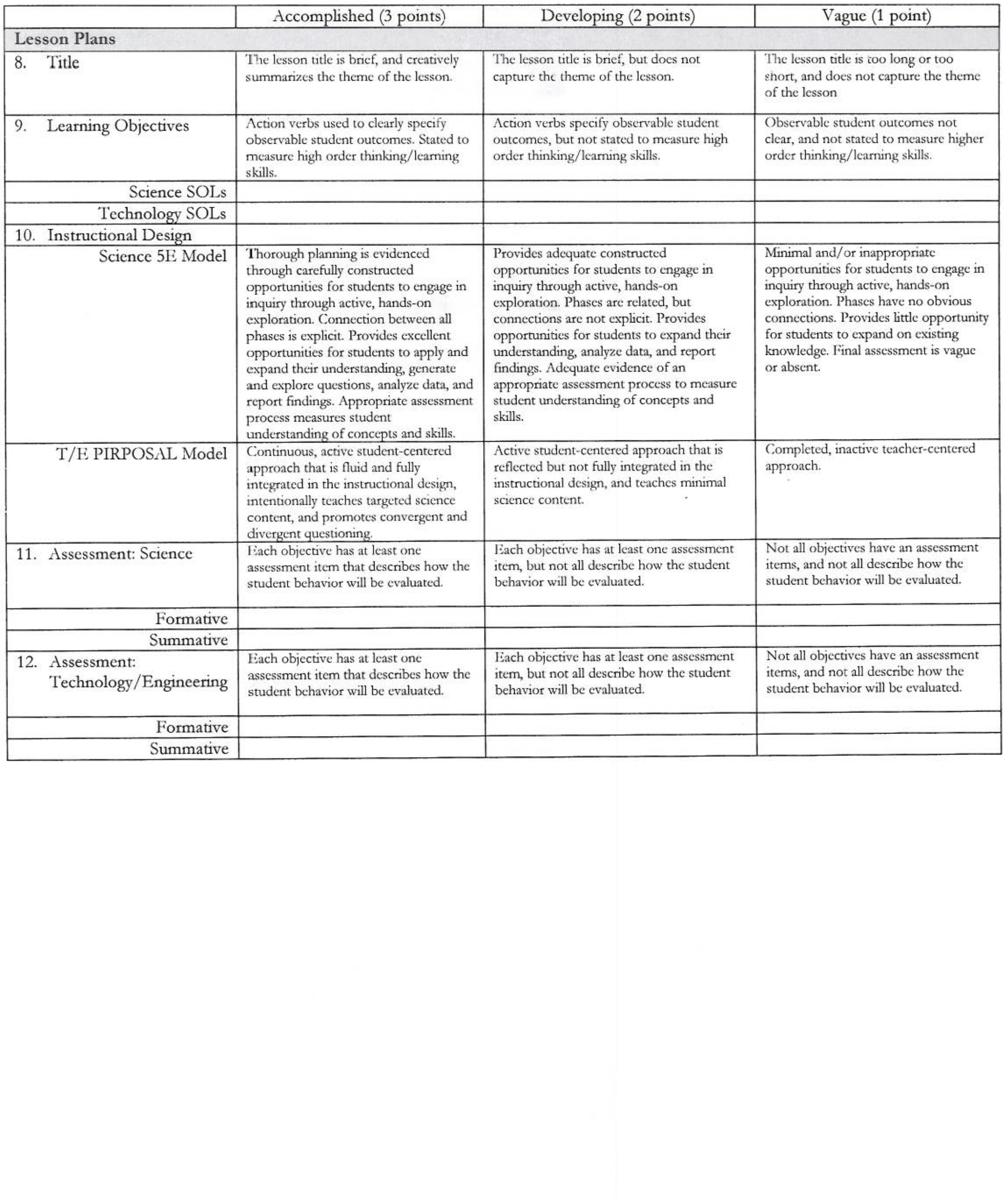
T/E Design Based Learning Unit/Lesson Assessment Rubric

1. Unit Title: Plants in Space!
2. Grade Level: 4
3. Date: 4-19-16

For 4-12 below, use the scale below to determine the option that best describes the extent to which each item is completed in the lesson. Score the lesson on the score sheet.

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Unit Overview			
4. Unit Summary	[✓ Concise summary is clearly stated and includes content and skills students should know and be able to do.]	Summary is clearly stated, but lacks complete information about content and skills students should know and be able to do.	Summary is unclear, too broad, or not present.
5. Unit Timeframe	[✓ Approximate number of class periods or sessions is clearly indicated, including specified timeframe.]	Approximate number of class periods or sessions is clearly indicated, but timeframe is not specified.	Number of classes or sessions and timeframe is not clear or is not apparent.
6. Unit Learning Objectives			
Science (SOL)	[✓ A minimum of one key Sci-SOL for each lesson is clearly stated and correlates with lesson objectives.]	A minimum of one key Sci-SOL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key Sci-SOL for each lesson is not clearly stated or apparent.
T/E DBL (STL)	[✓ A minimum of one key STL for each lesson is clearly stated and correlates with lesson objectives.]	A minimum of one key STL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key STL for each lesson is not clearly stated or apparent.
7. Unit Instructional Design			
Science: 5E Model	[✓ Unit clearly adheres to a science 5E instructional design model to guide implementation of instruction.]	Unit loosely adheres to a science 5E instructional design model to guide implementation of instruction.	Unit does not adhere to a science 5E instructional design model to guide implementation of instruction.
T/E: PIRPOSAL Model	All eight engagement phases are evident and employed as an integral component of the instructional design.	[✓ A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design.]	None or very few (4 or less) engagement phases are evident and employed as an integral component of the instructional design.

Wells, Wells & Deck, 2015



	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Lesson Plans			
8. Title	The lesson title is brief, and creatively summarizes the theme of the lesson.	The lesson title is brief, but does not capture the theme of the lesson.	The lesson title is too long or too short, and does not capture the theme of the lesson
9. Learning Objectives	Action verbs used to clearly specify observable student outcomes. Stated to measure high order thinking/learning skills.	Action verbs specify observable student outcomes, but not stated to measure high order thinking/learning skills.	Observable student outcomes not clear, and not stated to measure higher order thinking/learning skills.
Science SOLs			
Technology SOLs			
10. Instructional Design			
Science 5E Model	Thorough planning is evidenced through carefully constructed opportunities for students to engage in inquiry through active, hands-on exploration. Connection between all phases is explicit. Provides excellent opportunities for students to apply and expand their understanding, generate and explore questions, analyze data, and report findings. Appropriate assessment process measures student understanding of concepts and skills.	Provides adequate constructed opportunities for students to engage in inquiry through active, hands-on exploration. Phases are related, but connections are not explicit. Provides opportunities for students to expand their understanding, analyze data, and report findings. Adequate evidence of an appropriate assessment process to measure student understanding of concepts and skills.	Minimal and/or inappropriate opportunities for students to engage in inquiry through active, hands-on exploration. Phases have no obvious connections. Provides little opportunity for students to expand on existing knowledge. Final assessment is vague or absent.
T/E PIRPOSAL Model	Continuous, active student-centered approach that is fluid and fully integrated in the instructional design, intentionally teaches targeted science content, and promotes convergent and divergent questioning.	Active student-centered approach that is reflected but not fully integrated in the instructional design, and teaches minimal science content.	Completed, inactive teacher-centered approach.
11. Assessment: Science	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			
12. Assessment: Technology/Engineering	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			

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SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
4. Unit Summary			3	Include more phases of T/E DBL model throughout Lessons 1-4
5. Unit Timeframe			3	
6. Unit Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
7. Unit Instructional Design				
a. Science: 5E Model			3	
b. T/E: PIRPOSAL Model			2	
Total = No Revision			17	

Lesson 1	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Under 5E Model column, add Codes PR_D, PR_F - Describe how student behavior for T/E learning will be evaluated for summative assessment
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment. **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			2	
Total = No Revision			25	

Lesson 2	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Under 5E model column, add Codes I_B, I_G R_E, R_I, R_{EX} - Describe how student behavior for science learning will be evaluated for summative learning
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total = No Revision			25	

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Lesson 3	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	- Under 5E Model column, add PS_A, PS_V I_B, I_G R_E, R_I, R_{EX} - Describe how student behavior for science learning will be evaluated for formative assessment
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total = No Revision			25	

Lesson 4	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	- Under 5E Model column, add O_E, O_C SE_T, SE_A, SE_I R_E, R_I, R_{EX}
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total = No Revision			26	

Lesson 5	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	- Under 5E Model column, add A_I, A_{RD}, A_R, LO_P, LO_j PR_D, PR_F, I_B, I_G, R_E, R_I, R_{EX} PS_A, PS_V, O_E, O_C, SE_T, SE_A, SE_I Under T/E DBL phases column, add PR_D, PR_F, I_C, I_B, I_G, R_E, R_I, R_{EX}, PS_A, PS_V, PS_O O_E, O_R, O_C, SE_T, SE_A, SE_I
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			3	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total = No Revision			27	

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Lesson 9	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 10	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Rating: *Circle the letter indicating the range of scores to determine individual section ratings.*

Unit Overview

Sum from items 4 – 7 =
A. 0-15 Points (Revisions needed)
[✓ B.] 16-18 Points (Implement without revisions)

Lesson Plans

Sum from items 9 – 12 =
A. 7-24 points (Revisions needed)
[✓ B.] 25-30 points (Implement without revisions)

Overall Unit Rating

Circle one:
A. Unit must be revised (additional comments required)
[✓ B.] Unit can be implemented as written
C. Unit is an exemplar

Additional Comments

Anita Deck 4-19-16
Evaluator's Signature *Date*

Unit/Lesson –Interrater Feedback Log

Following the assessment of the unit and lessons, use this log to indicate the major strengths (provide 3) and the major suggestions (provide 3) for improvement.

Unit Overview	
Strengths 1. Concise summary 2. measurable objectives 3. Includes SOLs for other subject areas (e.g. English)	Suggestions 1. Include more phases of T/E DBL 2. model throughout Lessons 3. 1-4
Lesson 1	
Strengths 1. Use of video clips 2. Introduction of design challenge 3. Lab activity	Suggestions 1. Add 5E model codes 2. Describe how student behavior 3. for T/E learning will be evaluated for summative assessment
Lesson 2	
Strengths 1. Active research 2. Pollination demonstration 3. Photosynthesis demonstration	Suggestions 1. Add 5E model Codes 2. Describe how student behavior 3. for science learning will be evaluated for summative learning
Lesson 3	
Strengths 1. Discourse 2. Analyzing potential solutions 3. Collaboration on resources	Suggestions 1. Add 5E model Codes 2. Describe how student behavior for science learning will be 3. evaluated for formative assessment
Lesson 4	
Strengths 1. Discourse 2. Constructing and planning 3. Experimenting with design	Suggestions 1. Add 5E model codes 2. 3.
Lesson 5	
Strengths 1. Student presentations 2. Student re-evaluation of designs 3. Collecting and recording data over time	Suggestions 1. Add 5E model codes 2. Add T/E DBL Phases codes 3.

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Unit 1

T/E DBL Instructional Change Indicators (ICI)

Participant Code: C	Unit Title: Reroute the Stream							Grade Level: 5		
	Lesson 1		Lesson 2		Lesson 3		Lesson 4		Lesson 5	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Curriculum										
Objectives (action verb/measurable)	0	1		1		1		1		1
Change Assessment (0, 1, 2, 3)										
Science										
Formative	1	2		3		2		2		2
Summative	0	1		3		2		2		2
Technology/Engineering										
Formative	0	2		2		2		2		3
Summative	0	1		1		2		2		3
5E Instructional Design										
Engagement	0	1		0		0		0		0
Context/Scenario/Challenge										
Exploration	0	0		1		0		0		0
Concepts/Know/Need to Know										
Explanation	0	0		0		1		0		0
Understanding/Evidencing/Clarifying										
Elaboration	0	0		0		0		1		0
Knowledge Trans/Interpret Results/Extend Application										
Evaluation	0	0		0		0		0		1
Formative/Summative/Evidence										
Total Procedures	0	1		1		1		1		1
T/E DBL Phase Integrations										
Problem Identification	0	1		0		0		0		0
Need/Define/Formulation										
Ideation	0	0		1		1		0		0
Criteria/Brainstorm/Generate										
Research	0	0		1		1		1		0
Explore/Investigate/Examine										
Potential Solutions	0	0		0		1		1		0
Analyze/Visualize/Select										
Optimization	0	0		0		0		1		0
Experiment/Revisit/Construct										
Solution Evaluation	0	0		0		0		1		0
Test/Analyze/Retest										
Alterations	0	0		0		0		1		0
Identify/Redesign/Retest										
Learned Outcomes	0	0		0		0		0		1
Process/Iterations/Justify										
Total T/E DBL Phase Integration	0	1		2		3		5		1

Lesson Evaluation Key
Accomplished (3pts)
Developing (2pts)
Vague (1pt)

ICI Evaluation Key
0 = Absence of Variable
1 = Presence of Variable
2 = Assessment is linked to objectives
3 = Each objective is assessed

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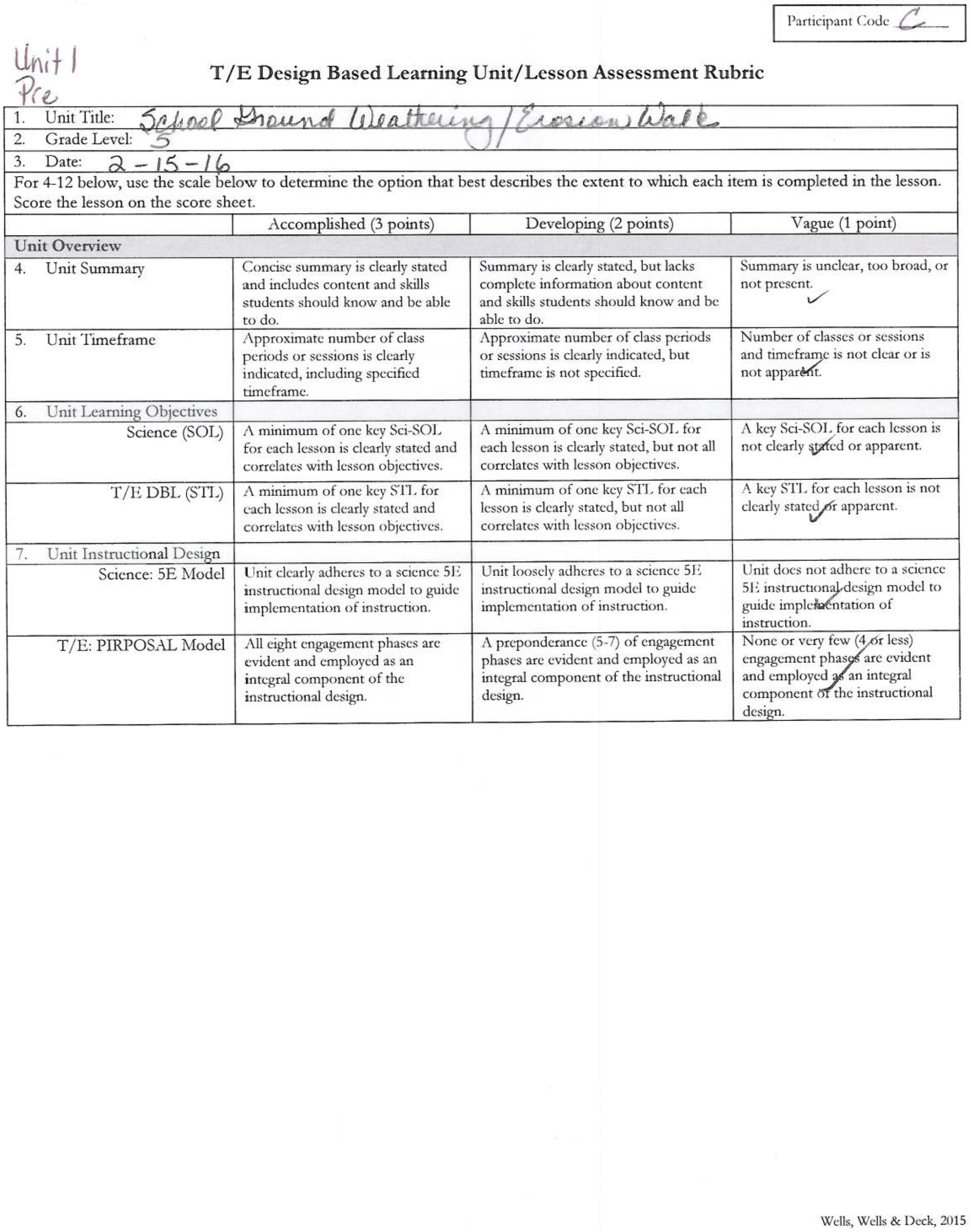

Participant Code C

Unit 1
Pre

T/E Design Based Learning Unit/Lesson Assessment Rubric

1. Unit Title: School Ground Weathering/Erosion Walk
2. Grade Level: 5
3. Date: 2-15-16

For 4-12 below, use the scale below to determine the option that best describes the extent to which each item is completed in the lesson. Score the lesson on the score sheet.

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Unit Overview			
4. Unit Summary	Concise summary is clearly stated and includes content and skills students should know and be able to do.	Summary is clearly stated, but lacks complete information about content and skills students should know and be able to do.	Summary is unclear, too broad, or not present. ✓
5. Unit Timeframe	Approximate number of class periods or sessions is clearly indicated, including specified timeframe.	Approximate number of class periods or sessions is clearly indicated, but timeframe is not specified.	Number of classes or sessions and timeframe is not clear or is not apparent. ✓
6. Unit Learning Objectives			
Science (SOL)	A minimum of one key Sci-SOL for each lesson is clearly stated and correlates with lesson objectives.	A minimum of one key Sci-SOL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key Sci-SOL for each lesson is not clearly stated or apparent. ✓
T/E DBL (STL)	A minimum of one key STL for each lesson is clearly stated and correlates with lesson objectives.	A minimum of one key STL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key STL for each lesson is not clearly stated or apparent. ✓
7. Unit Instructional Design			
Science: 5E Model	Unit clearly adheres to a science 5E instructional design model to guide implementation of instruction.	Unit loosely adheres to a science 5E instructional design model to guide implementation of instruction.	Unit does not adhere to a science 5E instructional design model to guide implementation of instruction. ✓
T/E: PIRPOSAL Model	All eight engagement phases are evident and employed as an integral component of the instructional design.	A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design.	None or very few (4 or less) engagement phases are evident and employed as an integral component of the instructional design. ✓

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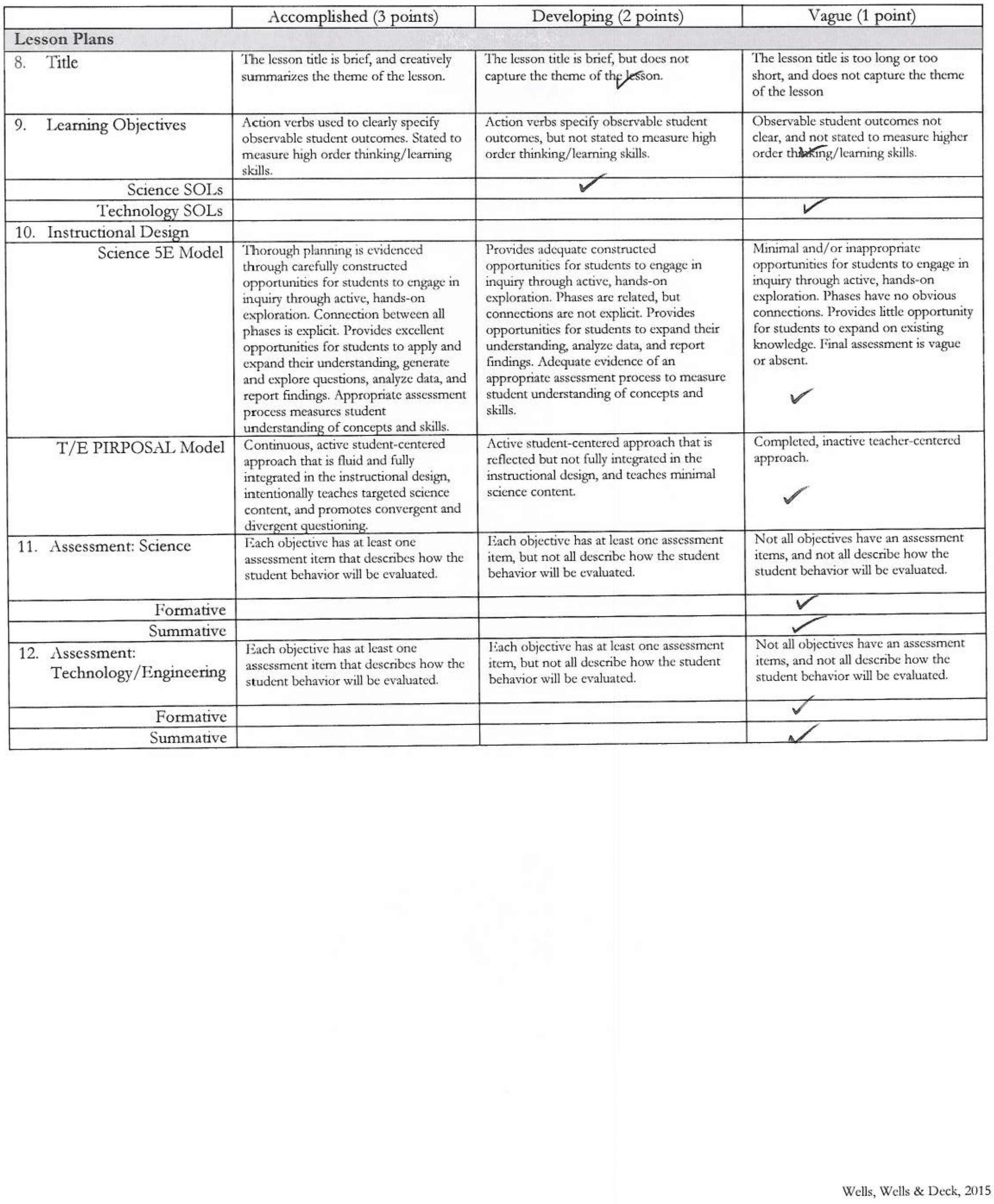

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Lesson Plans			
8. Title	The lesson title is brief, and creatively summarizes the theme of the lesson.	The lesson title is brief, but does not capture the theme of the lesson. ✓	The lesson title is too long or too short, and does not capture the theme of the lesson
9. Learning Objectives	Action verbs used to clearly specify observable student outcomes. Stated to measure high order thinking/learning skills.	Action verbs specify observable student outcomes, but not stated to measure high order thinking/learning skills.	Observable student outcomes not clear, and not stated to measure higher order thinking/learning skills. ✓
Science SOLs		✓	
Technology SOLs			✓
10. Instructional Design			
Science 5E Model	Thorough planning is evidenced through carefully constructed opportunities for students to engage in inquiry through active, hands-on exploration. Connection between all phases is explicit. Provides excellent opportunities for students to apply and expand their understanding, generate and explore questions, analyze data, and report findings. Appropriate assessment process measures student understanding of concepts and skills.	Provides adequate constructed opportunities for students to engage in inquiry through active, hands-on exploration. Phases are related, but connections are not explicit. Provides opportunities for students to expand their understanding, analyze data, and report findings. Adequate evidence of an appropriate assessment process to measure student understanding of concepts and skills.	Minimal and/or inappropriate opportunities for students to engage in inquiry through active, hands-on exploration. Phases have no obvious connections. Provides little opportunity for students to expand on existing knowledge. Final assessment is vague or absent. ✓
T/E PIRPOSAL Model	Continuous, active student-centered approach that is fluid and fully integrated in the instructional design, intentionally teaches targeted science content, and promotes convergent and divergent questioning.	Active student-centered approach that is reflected but not fully integrated in the instructional design, and teaches minimal science content.	Completed, inactive teacher-centered approach. ✓
11. Assessment: Science	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			✓
Summative			✓
12. Assessment: Technology/Engineering	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			✓
Summative			✓

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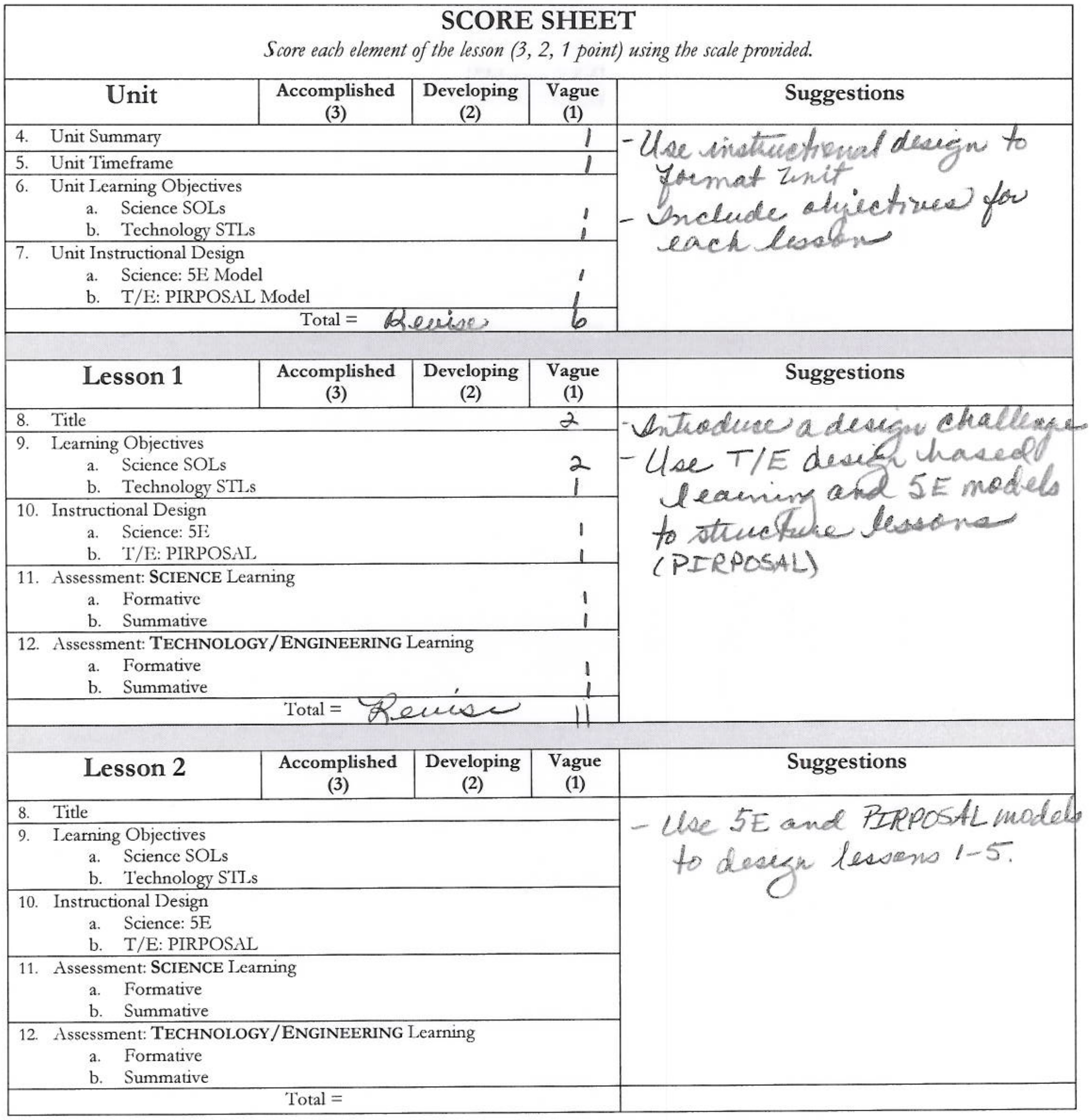

SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
4. Unit Summary			1	- Use instructional design to format unit - Include objectives for each lesson
5. Unit Timeframe			1	
6. Unit Learning Objectives				
a. Science SOLs			1	
b. Technology STLs			1	
7. Unit Instructional Design				
a. Science: 5E Model			1	
b. T/E: PIRPOSAL Model			1	
Total = Revise			6	

Lesson 1	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			2	- Introduce a design challenge - Use T/E design based learning and 5E models to structure lessons (PIRPOSAL)
9. Learning Objectives				
a. Science SOLs			2	
b. Technology STLs			1	
10. Instructional Design				
a. Science: 5E			1	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			1	
b. Summative			1	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			1	
b. Summative			1	
Total = Revise			11	

Lesson 2	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title				- Use 5E and PIRPOSAL models to design lessons 1-5.
9. Learning Objectives				
a. Science SOLs				
b. Technology STLs				
10. Instructional Design				
a. Science: 5E				
b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning				
a. Formative				
b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative				
b. Summative				
Total =				

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Lesson 3	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 4	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 5	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

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Lesson 9	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 10	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Rating: *Circle the letter indicating the range of scores to determine individual section ratings.*

Unit Overview

Sum from items 4 – 7 =
A. 0-15 Points (Revisions needed)
B. 16-18 Points (Implement without revisions)

Lesson Plans

Sum from items 9 – 12 =
A. 7-24 points (Revisions needed)
B. 25-30 points (Implement without revisions)

Overall Unit Rating

Circle one:
[✓ A.] Unit must be revised (additional comments required)
B. Unit can be implemented as written
C. Unit is an exemplar

Additional Comments

Lessons need revisions to fully address instructional design and T/E learning issues. See Suggestions for details.

Anita Deck 2-15-16

Evaluator's Signature *Date*

Unit/Lesson –Interrater Feedback Log

Following the assessment of the unit and lessons, use this log to indicate the major strengths (provide 3) and the major suggestions (provide 3) for improvement.

Unit Overview

Strengths	Suggestions
1. not included	1. Include a Unit Summary
2.	2. Expand on Lessons
3.	3.

Lesson 1

Strengths	Suggestions
1. Active learning	1. Use the PIRPOSAL and 5E models to structure instructional design
2. Use of discourse	2.
3. Student observation	3.

Lesson 2

Strengths	Suggestions
1.	1.
2.	2.
3.	3.

Lesson 3

Strengths	Suggestions
1.	1.
2.	2.
3.	3.

Lesson 4

Strengths	Suggestions
1.	1.
2.	2.
3.	3.

Lesson 5

Strengths	Suggestions
1.	1.
2.	2.
3.	3.

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Participant Code C

Unit1
Post

T/E Design Based Learning Unit/Lesson Assessment Rubric

1. Unit Title: Reroute the Stream
2. Grade Level: 5
3. Date: 3-7-16

For 4-12 below, use the scale below to determine the option that best describes the extent to which each item is completed in the lesson. Score the lesson on the score sheet.

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Unit Overview			
4. Unit Summary	[✓ Concise summary is clearly stated and includes content and skills students should know and be able to do.]	Summary is clearly stated, but lacks complete information about content and skills students should know and be able to do.	Summary is unclear, too broad, or not present.
5. Unit Timeframe	[✓ Approximate number of class periods or sessions is clearly indicated, including specified timeframe.]	Approximate number of class periods or sessions is clearly indicated, but timeframe is not specified.	Number of classes or sessions and timeframe is not clear or is not apparent.
6. Unit Learning Objectives			
Science (SOL)	[✓ A minimum of one key Sci-SOL for each lesson is clearly stated and correlates with lesson objectives.]	A minimum of one key Sci-SOL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key Sci-SOL for each lesson is not clearly stated or apparent.
T/E DBL (STL)	A minimum of one key STL for each lesson is clearly stated and correlates with lesson objectives.	[✓ A minimum of one key STL for each lesson is clearly stated, but not all correlates with lesson objectives.]	A key STL for each lesson is not clearly stated or apparent.
7. Unit Instructional Design			
Science: 5E Model	[✓ Unit clearly adheres to a science 5E instructional design model to guide implementation of instruction.]	Unit loosely adheres to a science 5E instructional design model to guide implementation of instruction.	Unit does not adhere to a science 5E instructional design model to guide implementation of instruction.
T/E: PIRPOSAL Model	All eight engagement phases are evident and employed as an integral component of the instructional design.	A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design.	[✓ None or very few (4 or less) engagement phases are evident and employed as an integral component of the instructional design.]

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Lesson Plans			
8. Title	The lesson title is brief, and creatively summarizes the theme of the lesson.	The lesson title is brief, but does not capture the theme of the lesson.	The lesson title is too long or too short, and does not capture the theme of the lesson
9. Learning Objectives	Action verbs used to clearly specify observable student outcomes. Stated to measure high order thinking/learning skills.	Action verbs specify observable student outcomes, but not stated to measure high order thinking/learning skills.	Observable student outcomes not clear, and not stated to measure higher order thinking/learning skills.
Science SOLs			
Technology SOLs			
10. Instructional Design			
Science 5E Model	Thorough planning is evidenced through carefully constructed opportunities for students to engage in inquiry through active, hands-on exploration. Connection between all phases is explicit. Provides excellent opportunities for students to apply and expand their understanding, generate and explore questions, analyze data, and report findings. Appropriate assessment process measures student understanding of concepts and skills.	Provides adequate constructed opportunities for students to engage in inquiry through active, hands-on exploration. Phases are related, but connections are not explicit. Provides opportunities for students to expand their understanding, analyze data, and report findings. Adequate evidence of an appropriate assessment process to measure student understanding of concepts and skills.	Minimal and/or inappropriate opportunities for students to engage in inquiry through active, hands-on exploration. Phases have no obvious connections. Provides little opportunity for students to expand on existing knowledge. Final assessment is vague or absent.
T/E PIRPOSAL Model	Continuous, active student-centered approach that is fluid and fully integrated in the instructional design, intentionally teaches targeted science content, and promotes convergent and divergent questioning.	Active student-centered approach that is reflected but not fully integrated in the instructional design, and teaches minimal science content.	Completed, inactive teacher-centered approach.
11. Assessment: Science	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			
12. Assessment: Technology/Engineering	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			

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SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
4. Unit Summary			3	- Include specific additional SOLs - Include all assessments
5. Unit Timeframe			3	
6. Unit Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			2	
7. Unit Instructional Design				
a. Science: 5E Model			3	
b. T/E: PIRPOSAL Model			1	
Total = Revise			15	

Lesson 1	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	-Add pre-test - Ex. - List 3 statements about impact of stream rerouting or questions about weathering, erosion, and deposition -Add codes for 5E model (PR_D, PR_F) - Specify "review and check for understanding"
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			2	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			1	
b. Summative			1	
Total = Revise			19	

Lesson 2	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Add codes for 5E - I_B, I_G, R_e, R_I, R_x - Add codes for T/E DBL - R_I, R_x - Include checkpoint assessment for design process
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				Collapse Lesson 2 and 3
a. Formative			2	
b. Summative			1	
Total = Revise			23	

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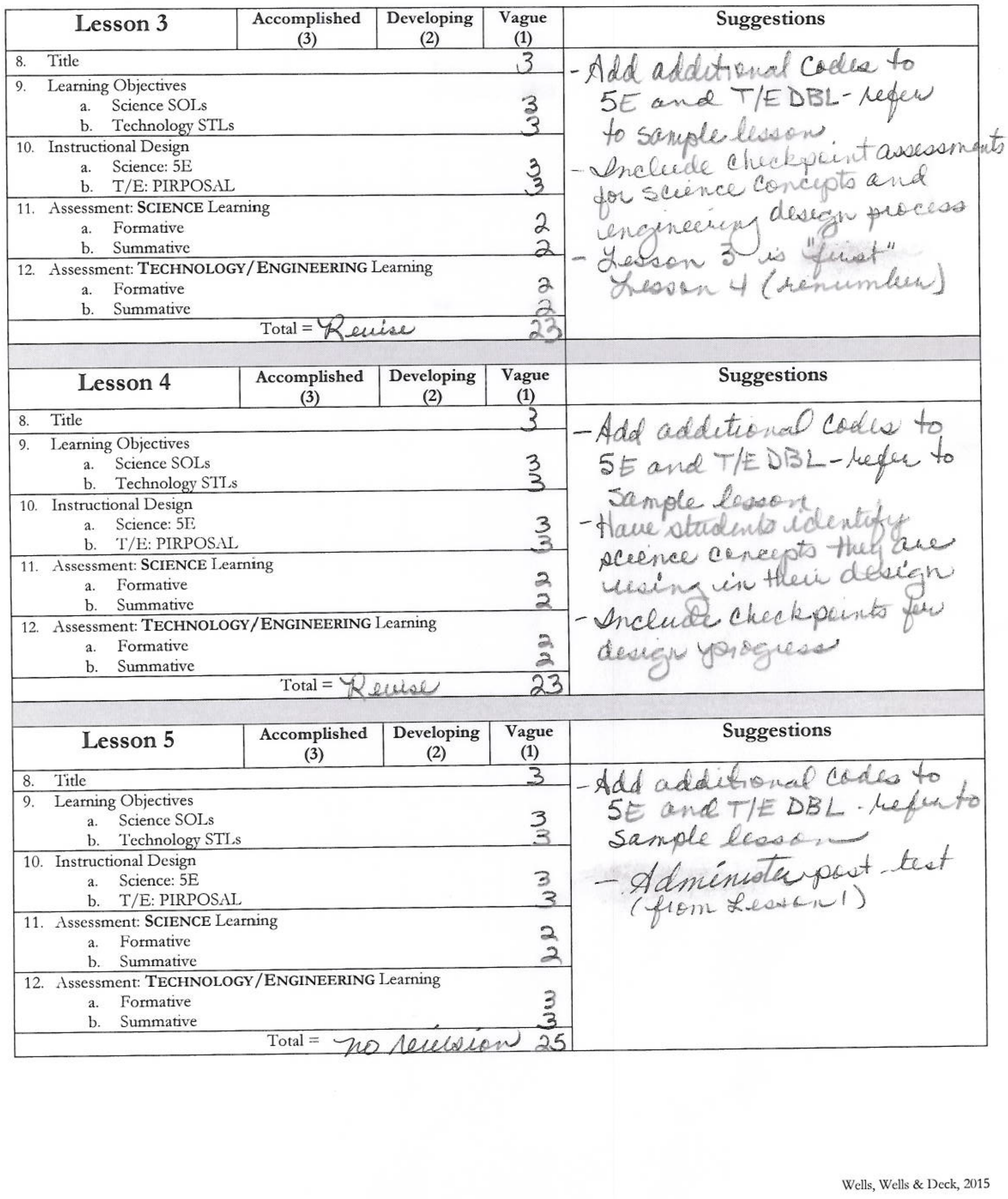

Lesson 3	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Add additional codes to 5E and T/E DBL - refer to sample lesson - Include checkpoint assessments for science concepts and engineering design process - Lesson 3 is "first" Lesson 4 (renumber)
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			3	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			2	
b. Summative			2	
Total = Revise			23	

Lesson 4	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Add additional codes to 5E and T/E DBL - refer to sample lesson - Have students identify science concepts they are using in their design - Include checkpoints for design progress
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			3	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			2	
b. Summative			2	
Total = Revise			23	

Lesson 5	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Add additional codes to 5E and T/E DBL - refer to sample lesson - Administer post-test (from Lesson 1)
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			3	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total = no revision			25	

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Anita Deck 3-7-16

Evaluator's Signature *Date*

Unit/Lesson –Interrater Feedback Log

Following the assessment of the unit and lessons, use this log to indicate the major strengths (provide 3) and the major suggestions (provide 3) for improvement.

Unit Overview

Strengths	Suggestions
1. Measurable objectives	1. Include all assessments in list
2. Timeframe	2. Specify additional SOLs
3. Detailed summary	3. Design brief - change "model" to "prototype of the stream route"

Lesson 1

Strengths	Suggestions
1. Question map activity	1. Include a pre-test of the SOL
2. Student notebooks	2. Refine language ("review and check for understanding")
3. Introduction of design challenge	3. Design brief - last sentence of Context ... to design a stream route so that erosion . . .

Lesson 2

Strengths	Suggestions
1. K-W-L chart	1. Add codes to reflect model
2. Active learning	2. Include checkpoint assessments for design process
3. Active observation	3.

Lesson 3 (Lesson 4)

Strengths	Suggestions
1. Generation of sketches, drawings	1. Include checkpoint assessments for science concepts and design process
2. Student discussion	2.
3. Generation of solutions	3.

Lesson 4 (numbered twice)

Strengths	Suggestions
1. Time allotment	1. Include checkpoint assessments for science concepts and design process
2. Recording progress	2.
3. Testing prototype	3.

Lesson 5

Strengths	Suggestions
1. Evaluation of prototype	1. Administer post-test of the targeted SOL
2. Communicating results	2.
3. Student presentation	3. Include additional codes

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Unit 2

T/E DBL Instructional Change Indicators (ICI)

Participant Code: C	Unit Title: Music Makers								Grade Level: 5	
	Lesson 1		Lesson 2		Lesson 3		Lesson 4		Lesson 5	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Curriculum										
Objectives (action verb/measurable)	1	1	1	1	1	1	1	1	1	1
Change Assessment (0, 1, 2, 3)										
Science										
Formative	3	3	3	3	3	3	3	3	3	3
Summative	1	3	3	3	2	3	2	3	3	3
Technology/Engineering										
Formative	3	3	3	3	3	3	3	3	3	3
Summative	1	3	2	3	3	3	3	3	3	3
5E Instructional Design										
Engagement	1	1	0	0	0	0	0	0	0	0
Context/Scenario/Challenge										
Exploration	0	0	1	1	0	0	0	0	0	0
Concepts/Know/Need to Know										
Explanation	0	0	0	0	1	1	0	0	0	0
Understanding/Evidencing/Clarifying										
Elaboration	0	0	0	0	0	0	1	1	0	0
Knowledge Trans/Interpret Results/Extend Application										
Evaluation	0	0	0	0	0	0	0	0	1	1
Formative/Summative/Evidence										
Total Procedures	1	1	1	1	1	1	1	1	1	1
T/E DBL Phase Integrations										
Problem Identification	1	1	0	1	0	1	0	1	1	1
Need/Define/Formulation										
Ideation	0	1	1	1	1	1	0	1	1	1
Criteria/Brainstorm/Generate										
Research	0	1	1	1	1	1	1	1	1	1
Explore/Investigate/Examine										
Potential Solutions	0	1	0	1	1	1	0	1	1	1
Analyze/Visualize/Select										
Optimization	0	0	0	1	0	1	1	1	1	1
Experiment/Revisit/Construct										
Solution Evaluation	0	0	0	0	0	0	1	1	1	1
Test/Analyze/Retest										
Alterations	0	0	0	0	0	0	1	1	1	1
Identify/Redesign/Retest										
Learned Outcomes	0	1	0	0	0	0	1	1	1	1
Process/Iterations/Justify										
Total T/E DBL Phase Integration	1	5	2	5	3	5	5	8	8	8

Lesson Evaluation Key
Accomplished (3pts)
Developing (2pts)
Vague (1pt)

ICI Evaluation Key
0 = Absence of Variable
1 = Presence of Variable
2 = Assessment is linked to objectives
3 = Each objective is assessed

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Participant Code C

Unit 2
Pre

T/E Design Based Learning Unit/Lesson Assessment Rubric

1. Unit Title:			
2. Grade Level:			
3. Date:			
For 4-12 below, use the scale below to determine the option that best describes the extent to which each item is completed in the lesson. Score the lesson on the score sheet.			
	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Unit Overview			
4. Unit Summary	[✓ Concise summary is clearly stated and includes content and skills students should know and be able to do.]	Summary is clearly stated, but lacks complete information about content and skills students should know and be able to do.	Summary is unclear, too broad, or not present.
5. Unit Timeframe	[✓ Approximate number of class periods or sessions is clearly indicated, including specified timeframe.]	Approximate number of class periods or sessions is clearly indicated, but timeframe is not specified.	Number of classes or sessions and timeframe is not clear or is not apparent.
6. Unit Learning Objectives			
Science (SOL)	[✓ A minimum of one key Sci-SOL for each lesson is clearly stated and correlates with lesson objectives.]	A minimum of one key Sci-SOL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key Sci-SOL for each lesson is not clearly stated or apparent.
T/E DBL (STL)	A minimum of one key STL for each lesson is clearly stated and correlates with lesson objectives.	[✓ A minimum of one key STL for each lesson is clearly stated, but not all correlates with lesson objectives.]	A key STL for each lesson is not clearly stated or apparent.
7. Unit Instructional Design			
Science: 5E Model	[✓ Unit clearly adheres to a science 5E instructional design model to guide implementation of instruction.]	Unit loosely adheres to a science 5E instructional design model to guide implementation of instruction.	Unit does not adhere to a science 5E instructional design model to guide implementation of instruction.
T/E: PIRPOSAL Model	All eight engagement phases are evident and employed as an integral component of the instructional design.	A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design.	[✓ None or very few (4 or less) engagement phases are evident and employed as an integral component of the instructional design.]

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	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Lesson Plans			
8. Title	The lesson title is brief, and creatively summarizes the theme of the lesson.	The lesson title is brief, but does not capture the theme of the lesson.	The lesson title is too long or too short, and does not capture the theme of the lesson
9. Learning Objectives	Action verbs used to clearly specify observable student outcomes. Stated to measure high order thinking/learning skills.	Action verbs specify observable student outcomes, but not stated to measure high order thinking/learning skills.	Observable student outcomes not clear, and not stated to measure higher order thinking/learning skills.
Science SOLs			
Technology SOLs			
10. Instructional Design			
Science 5E Model	Thorough planning is evidenced through carefully constructed opportunities for students to engage in inquiry through active, hands-on exploration. Connection between all phases is explicit. Provides excellent opportunities for students to apply and expand their understanding, generate and explore questions, analyze data, and report findings. Appropriate assessment process measures student understanding of concepts and skills.	Provides adequate constructed opportunities for students to engage in inquiry through active, hands-on exploration. Phases are related, but connections are not explicit. Provides opportunities for students to expand their understanding, analyze data, and report findings. Adequate evidence of an appropriate assessment process to measure student understanding of concepts and skills.	Minimal and/or inappropriate opportunities for students to engage in inquiry through active, hands-on exploration. Phases have no obvious connections. Provides little opportunity for students to expand on existing knowledge. Final assessment is vague or absent.
T/E PIRPOSAL Model	Continuous, active student-centered approach that is fluid and fully integrated in the instructional design, intentionally teaches targeted science content, and promotes convergent and divergent questioning.	Active student-centered approach that is reflected but not fully integrated in the instructional design, and teaches minimal science content.	Completed, inactive teacher-centered approach.
11. Assessment: Science	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			
12. Assessment: Technology/Engineering	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			

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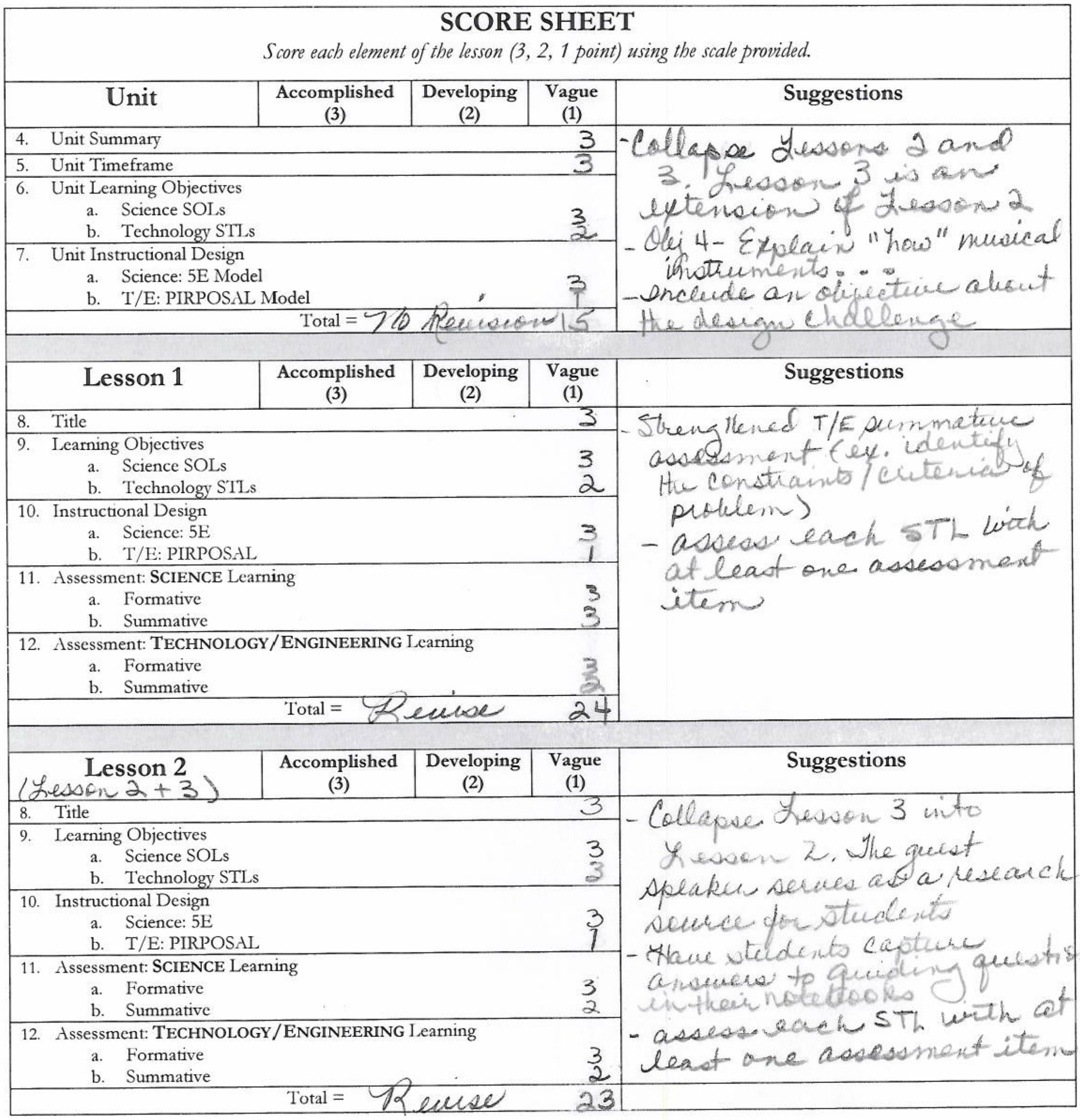

SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
4. Unit Summary			3	-Collapse Lessons 2 and 3. Lesson 3 is an extension of Lesson 2 - Obj 4- Explain "how" musical instruments... -Include an objective about the design challenge
5. Unit Timeframe			3	
6. Unit Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			2	
7. Unit Instructional Design				
a. Science: 5E Model			3	
b. T/E: PIRPOSAL Model			1	
Total = TO Revision			15	

Lesson 1	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Strengthened T/E summative assessment (eg. identify the constraints / criteria of problem) - assess each STL with at least one assessment item
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			2	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total = Revise			24	

Lesson 2 (Lesson 2 + 3)	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Collapse Lesson 3 into Lesson 2. The guest speaker serves as a research source for students - Have students capture answers to guiding questions in their notebooks - assess each STL with at least one assessment item
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			2	
Total = Revise			23	

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Lesson 3 (Lesson 4)	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	- Spot check student use of science concepts - assess each STL with at least one assessment item
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			2	
b. Summative			2	
Total = Revise			23	

Lesson 4 (Lesson 5)	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	- Assess student additional scientific investigations - assess each SOL and STL with at least one assessment item
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			2	
b. Summative			2	
Total = Revise			23	

Lesson 5 (Lesson 6)	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	Be sure exit questions assess science objectives
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			3	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total = No Revision			27	

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Lesson 9	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 10	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Rating: *Circle the letter indicating the range of scores to determine individual section ratings.*

Unit Overview

Sum from items 4 – 7 = [✓ A.] 0-15 Points (Revisions needed)
B. 16-18 Points (Implement without revisions)

Lesson Plans

Sum from items 9 – 12 = [✓ A.] 7-24 points (Revisions needed) Lesson 1-4
Lesson5 [✓ B.] 25-30 points (Implement without revisions)

Overall Unit Rating

Circle one:
[✓ A.] Unit must be revised (additional comments required)
B. Unit can be implemented as written
C. Unit is an exemplar

Additional Comments

Lessons 1-4 need revisions to fully address instructional design and T/E learning issues. See suggestions for details

Anita Deck 4-12-16
Evaluator's Signature *Date*

Unit/Lesson –Interrater Feedback Log

Following the assessment of the unit and lessons, use this log to indicate the major strengths (provide 3) and the major suggestions (provide 3) for improvement.

Unit Overview

Strengths	Suggestions
1. Objectives	1. Change "that" to "how" in Obj. 4
2. Assessment	2. Adjust timeframe when combining Lessons 2 and 3
3. Summary	3.

Lesson 1

Strengths	Suggestions
1. Use of Question Maps	1. Have students capture design process
2. Video clips	2. in their notebook
3. Introduction of design brief	3.

Lesson 2 (Lesson 2+3)

Strengths	Suggestions
1. Active learning	1. Collapse Lessons 2 and 3
2. Discourse	2.
3. Guest speaker	3.

Lesson 3 (Lesson 4)

Strengths	Suggestions
1. Application of research/info	1. Spot check student understanding of science concepts they use
2. Generation of sketches/drawings	2.
3. Use of notebook	3.

Lesson 4 (Lesson 5)

Strengths	Suggestions
1. Use of investigations	1. Assess additional science investigations
2. Construction of prototype	2.
3. student analysis	3.

Lesson 5 (Lesson 6)

Strengths	Suggestions
1. Student analysis informs redesign	1. Make sure all objectives were assessed
2. Student evaluation	2.
3. Student presentations	3.

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Participant Code C

Unit 2
Post

T/E Design Based Learning Unit/Lesson Assessment Rubric

1. Unit Title:
2. Grade Level:
3. Date:

For 4-12 below, use the scale below to determine the option that best describes the extent to which each item is completed in the lesson. Score the lesson on the score sheet.

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Unit Overview			
4. Unit Summary	[✓ Concise summary is clearly stated and includes content and skills students should know and be able to do.]	Summary is clearly stated, but lacks complete information about content and skills students should know and be able to do.	Summary is unclear, too broad, or not present.
5. Unit Timeframe	[✓ Approximate number of class periods or sessions is clearly indicated, including specified timeframe.]	Approximate number of class periods or sessions is clearly indicated, but timeframe is not specified.	Number of classes or sessions and timeframe is not clear or is not apparent.
6. Unit Learning Objectives			
Science (SOL)	[✓ A minimum of one key Sci-SOL for each lesson is clearly stated and correlates with lesson objectives.]	A minimum of one key Sci-SOL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key Sci-SOL for each lesson is not clearly stated or apparent.
T/E DBL (STL)	[✓ A minimum of one key STL for each lesson is clearly stated and correlates with lesson objectives.]	A minimum of one key STL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key STL for each lesson is not clearly stated or apparent.
7. Unit Instructional Design			
Science: 5E Model	[✓ Unit clearly adheres to a science 5E instructional design model to guide implementation of instruction.]	Unit loosely adheres to a science 5E instructional design model to guide implementation of instruction.	Unit does not adhere to a science 5E instructional design model to guide implementation of instruction.
T/E: PIRPOSAL Model	[✓ All eight engagement phases are evident and employed as an integral component of the instructional design.]	A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design.	None or very few (4 or less) engagement phases are evident and employed as an integral component of the instructional design.

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Lesson Plans			
8. Title	The lesson title is brief, and creatively summarizes the theme of the lesson.	The lesson title is brief, but does not capture the theme of the lesson.	The lesson title is too long or too short, and does not capture the theme of the lesson
9. Learning Objectives	Action verbs used to clearly specify observable student outcomes. Stated to measure high order thinking/learning skills.	Action verbs specify observable student outcomes, but not stated to measure high order thinking/learning skills.	Observable student outcomes not clear, and not stated to measure higher order thinking/learning skills.
Science SOLs			
Technology SOLs			
10. Instructional Design			
Science 5E Model	Thorough planning is evidenced through carefully constructed opportunities for students to engage in inquiry through active, hands-on exploration. Connection between all phases is explicit. Provides excellent opportunities for students to apply and expand their understanding, generate and explore questions, analyze data, and report findings. Appropriate assessment process measures student understanding of concepts and skills.	Provides adequate constructed opportunities for students to engage in inquiry through active, hands-on exploration. Phases are related, but connections are not explicit. Provides opportunities for students to expand their understanding, analyze data, and report findings. Adequate evidence of an appropriate assessment process to measure student understanding of concepts and skills.	Minimal and/or inappropriate opportunities for students to engage in inquiry through active, hands-on exploration. Phases have no obvious connections. Provides little opportunity for students to expand on existing knowledge. Final assessment is vague or absent.
T/E PIRPOSAL Model	Continuous, active student-centered approach that is fluid and fully integrated in the instructional design, intentionally teaches targeted science content, and promotes convergent and divergent questioning.	Active student-centered approach that is reflected but not fully integrated in the instructional design, and teaches minimal science content.	Completed, inactive teacher-centered approach.
11. Assessment: Science	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			
12. Assessment: Technology/Engineering	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			

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SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
4. Unit Summary			3	none
5. Unit Timeframe			3	
6. Unit Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
7. Unit Instructional Design				
a. Science: 5E Model			3	
b. T/E: PIRPOSAL Model			3	
Total =			18	

Lesson 1	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	none
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total =			26	

Lesson 2	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	none
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total =			26	

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Lesson 3	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	-none
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total =			26	

Lesson 4	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	none
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			3	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total =			27	

Lesson 5	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	none
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			3	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total =			27	

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Lesson 9	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 10	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Rating: *Circle the letter indicating the range of scores to determine individual section ratings.*

Unit Overview

Sum from items 4 – 7 = A. 0-15 Points (Revisions needed)
[✓ B.] 16-18 Points (Implement without revisions)

Lesson Plans

Sum from items 9 – 12 = A. 7-24 points (Revisions needed)
[✓ B.] 25-30 points (Implement without revisions)

Overall Unit Rating

Circle one:
A. Unit must be revised (additional comments required)
[✓ B.] Unit can be implemented as written
C. Unit is an exemplar

Additional Comments

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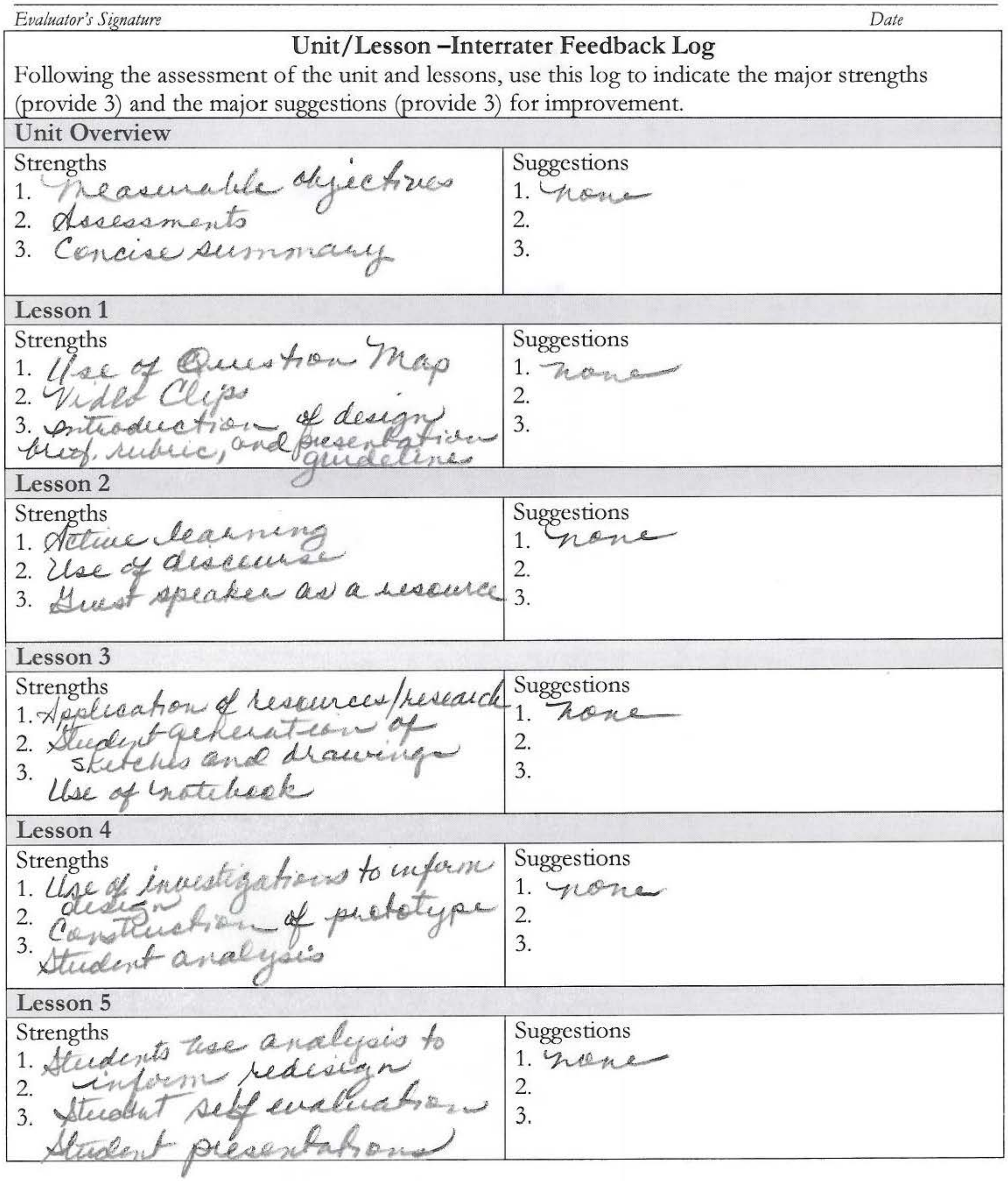

Evaluator's Signature *Date*

Unit/Lesson –Interrater Feedback Log

Following the assessment of the unit and lessons, use this log to indicate the major strengths (provide 3) and the major suggestions (provide 3) for improvement.

Unit Overview

Strengths 1. Measurable objectives 2. Assessments 3. Concise summary	Suggestions 1. none 2. 3.

Lesson 1

Strengths 1. Use of Question Map 2. Video Clips 3. introduction of design brief, rubric, and presentation guidelines	Suggestions 1. none 2. 3.

Lesson 2

Strengths 1. Active learning 2. Use of discourse 3. Guest speaker as a resource	Suggestions 1. none 2. 3.

Lesson 3

Strengths 1. Application of resources/research 2. Student generation of sketches and drawings 3. Use of notebook	Suggestions 1. none 2. 3.

Lesson 4

Strengths 1. Use of investigations to inform design 2. Construction of prototype 3. Student analysis	Suggestions 1. none 2. 3.

Lesson 5

Strengths 1. Students use analysis to inform redesign 2. Student self evaluation 3. Student presentations	Suggestions 1. none 2. 3.

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Unit1 Pre

T/E DBL Instructional Change Indicators (ICI)

Participant Code: D

Unit Title:

Grade Level:

	Lesson 1		Lesson 2		Lesson 3		Lesson 4		Lesson 5	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Curriculum										
Objectives (action verb/measurable)	1	1	1	1	1	1	1	1	1	1
Change Assessment (0, 1, 2, 3)										
Science										
Formative	1	2	1	2	1	2	1	2	1	3
Summative	0	2	0	2	0	2	0	2	0	3
Technology/Engineering										
Formative	0	3	0	2	0	2	0	3	0	3
Summative	0	2	0	2	0	2	0	2	0	3
5E Instructional Design										
Engagement	1	1	0	0	0	0	0	0	0	0
Context/Scenario/Challenge										
Exploration	0	0	0	1	1	0	1	0	0	0
Concepts/Know/Need to Know										
Explanation	0	0	0	0	0	1	0	0	0	0
Understanding/Evidencing/Clarifying										
Elaboration	0	0	0	0	0	0	0	1	0	0
Knowledge Trans/Interpret Results/Extend Application										
Evaluation	0	0	0	0	0	0	0	0	0	1
Formative/Summative/Evidence										
Total Procedures	1	1	0	1	1	1	1	1	0	1
T/E DBL Phase Integrations										
Problem Identification	0	1	0	1	0	1	0	0	0	1
Need/Define/Formulation										
Ideation	0	1	0	1	0	1	0	0	0	1
Criteria/Brainstorm/Generate										
Research	0	0	0	1	0	1	0	1	0	1
Explore/Investigate/Examine										
Potential Solutions	0	0	0	0	0	1	0	1	0	1
Analyze/Visualize/Select										
Optimization	0	0	0	0	0	0	0	1	0	1
Experiment/Revisit/Construct										
Solution Evaluation	0	0	0	0	0	0	0	1	0	1
Test/Analyze/Retest										
Alterations	0	0	0	0	0	0	0	1	0	1
Identify/Redesign/Retest										
Learned Outcomes	0	0	0	0	0	0	0	0	0	1
Process/Iterations/Justify										
Total T/E DBL Phase Integration	0	2	0	3	0	4	0	5	0	8

Lesson Evaluation Key
Accomplished (3pts)
Developing (2pts)
Vague (1pt)

ICI Evaluation Key

0 = Absence of Variable
1 = Presence of Variable
2 = Assessment is linked to objectives
3 = Each objective is assessed

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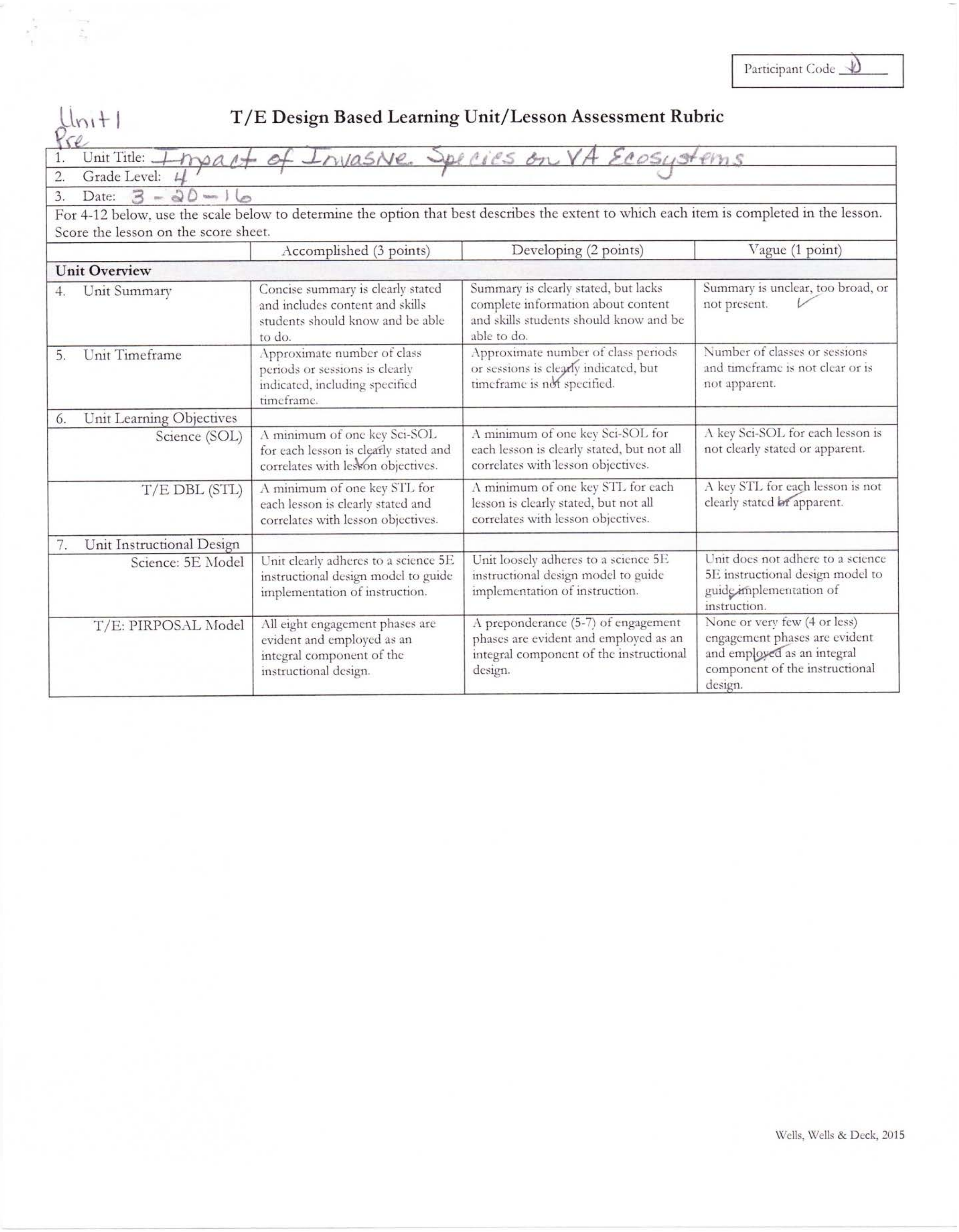

Participant Code D

Unit 1
Pre

T/E Design Based Learning Unit/Lesson Assessment Rubric

1. Unit Title: Impact of Invasive Species on VA Ecosystems			
2. Grade Level: 4			
3. Date: 3-20-16			
For 4-12 below, use the scale below to determine the option that best describes the extent to which each item is completed in the lesson. Score the lesson on the score sheet.			
	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Unit Overview			
4. Unit Summary	Concise summary is clearly stated and includes content and skills students should know and be able to do.	Summary is clearly stated, but lacks complete information about content and skills students should know and be able to do.	Summary is unclear, too broad, or not present. ✓
5. Unit Timeframe	Approximate number of class periods or sessions is clearly indicated, including specified timeframe.	Approximate number of class periods or sessions is clearly ✓ indicated, but timeframe is not ✓ specified.	Number of classes or sessions and timeframe is not clear or is not apparent.
6. Unit Learning Objectives			
Science (SOL)	A minimum of one key Sci-SOL for each lesson is clearly ✓ stated and correlates with lesson ✓ objectives.	A minimum of one key Sci-SOL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key Sci-SOL for each lesson is not clearly stated or apparent.
T/E DBL (STL)	A minimum of one key STL for each lesson is clearly stated and correlates with lesson objectives.	A minimum of one key STL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key STL for each ✓ lesson is not clearly stated or ✓ apparent.
7. Unit Instructional Design			
Science: 5E Model	Unit clearly adheres to a science 5E instructional design model to guide implementation of instruction.	Unit loosely adheres to a science 5E instructional design model to guide implementation of instruction.	Unit does not adhere to a science 5E instructional design model to guide ✓ implementation of instruction.
T/E: PIRPOSAL Model	All eight engagement phases are evident and employed as an integral component of the instructional design.	A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design.	None or very few (4 or less) engagement phases ✓ are evident and employed ✓ as an integral component of the instructional design.

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	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Lesson Plans			
8. Title	The lesson title is brief, and creatively summarizes the theme of the lesson	The lesson title is brief, but does not capture the theme of the lesson.	The lesson title is too long or too short, and does not capture the theme of the lesson
9. Learning Objectives	Action verbs used to clearly specify observable student outcomes. Stated to measure high order thinking/learning skills.	Action verbs specify observable student outcomes, but not stated to measure high order thinking/learning skills.	Observable student outcomes not clear, and not stated to measure higher order thinking/learning skills.
Science SOLs			
Technology SOLs			
10. Instructional Design			
Science 5E Model	Thorough planning is evidenced through carefully constructed opportunities for students to engage in inquiry through active, hands-on exploration. Connection between all phases is explicit. Provides excellent opportunities for students to apply and expand their understanding, generate and explore questions, analyze data, and report findings. Appropriate assessment process measures student understanding of concepts and skills.	Provides adequate constructed opportunities for students to engage in inquiry through active, hands-on exploration. Phases are related, but connections are not explicit. Provides opportunities for students to expand their understanding, analyze data, and report findings. Adequate evidence of an appropriate assessment process to measure student understanding of concepts and skills.	Minimal and/or inappropriate opportunities for students to engage in inquiry through active, hands-on exploration. Phases have no obvious connections. Provides little opportunity for students to expand on existing knowledge. Final assessment is vague or absent.
T/E PIRPOSAL Model	Continuous, active student-centered approach that is fluid and fully integrated in the instructional design, intentionally teaches targeted science content, and promotes convergent and divergent questioning. 8	Active student-centered approach that is reflected but not fully integrated in the instructional design, and teaches minimal science content. 5-7	Completed, inactive teacher-centered approach. 4 or less
11. Assessment: Science	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			
12. Assessment: Technology/Engineering	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			

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SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
4. Unit Summary			1	- need to provide unit summary - include STLs - Structure unit using 5E Model and the PIRPOSAL Model
5. Unit Timeframe			2	
6. Unit Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			1	
7. Unit Instructional Design				
a. Science: 5E Model			1	
b. T/E: PIRPOSAL Model			1	
Total = Revision			9	

Lesson 1	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			2	- Title should summarize theme of lesson - Clearly specify observable student outcomes - Structure unit using 5E and PIRPOSAL Models - Have at least one assessment item for each objective for both Science and T/E DBL for formative and summative assessments
9. Learning Objectives				
a. Science SOLs			2	
b. Technology STLs			1	
10. Instructional Design				
a. Science: 5E			1	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			1	
b. Summative			1	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			1	
b. Summative			1	
Total = Revision			11	

Lesson 2	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			2	See Lesson 1 suggestions
9. Learning Objectives				
a. Science SOLs			2	
b. Technology STLs			1	
10. Instructional Design				
a. Science: 5E			1	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			1	
b. Summative			1	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			1	
b. Summative			1	
Total = Revision			11	

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Lesson 3	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			2	See Lesson 1 suggestions
9. Learning Objectives				
a. Science SOLs			2	
b. Technology STLs			1	
10. Instructional Design				
a. Science: 5E			1	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			1	
b. Summative			1	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			1	
b. Summative			1	
Total = Revision			11	

Lesson 4	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			2	See Lesson 1 suggestions
9. Learning Objectives				
a. Science SOLs			2	
b. Technology STLs			1	
10. Instructional Design				
a. Science: 5E			1	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			1	
b. Summative			1	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			1	
b. Summative			1	
Total = Revision			11	

Lesson 5	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			2	See Lesson 1 suggestions
9. Learning Objectives				
a. Science SOLs			2	
b. Technology STLs			1	
10. Instructional Design				
a. Science: 5E			1	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			1	
b. Summative			1	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			1	
b. Summative			1	
Total = Revision			11	

Lesson 9	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 10	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Rating: *Circle the letter indicating the range of scores to determine individual section ratings.*

Unit Overview

Sum from items 4 – 7 =
[✓ A. 0-15 Points (Revisions needed)]
B. 16-18 Points (Implement without revisions)

Lesson Plans

Sum from items 9 – 12 =
[✓ A. 7-24 points (Revisions needed)]
B. 25-30 points (Implement without revisions)

Overall Unit Rating

Circle one:
[✓ A. Unit must be revised (additional comments required)]
B. Unit can be implemented as written
C. Unit is an exemplar

Additional Comments

Use rubric as a guide to help redesign Unit plan.

Anita Deck　　　　　　　　　　　　　　　　　　3-20-15

Evaluator's Signature　　　　　　　　　　　　　　*Date*

Unit/Lesson –Interrater Feedback Log

Following the assessment of the unit and lessons, use this log to indicate the major strengths (provide 3) and the major suggestions (provide 3) for improvement.

Unit Overview

Strengths 1. Unit targets SOL 4.4., 4.5, and 4.9 2. Centralized question 3. Centralized theme	Suggestions 1. Need to provide summary 2. Include STLS 3. Structure unit using 5E and PIRPOSAL models

Lesson 1

Strengths 1. Uses examples familiar to students 2. Discourse 3. Student presentations	Suggestions 1.-Clearly specify observable student outcomes 2.-Have at least one assessment 3. item for each objective Title should summarize theme of lesson

Lesson 2

Strengths 1. Discourse 2. Vocabulary development 3.	Suggestions 1. See above suggestions 2. 3.

Lesson 3

Strengths 1. Active observation 2. Recording data 3. Drawings	Suggestions 1. See above suggestions 2. 3.

Lesson 4

Strengths 1. Seed dissection 2. Use of observation 3. Recording data	Suggestions 1. See above suggestions 2. 3.

Lesson 5

Strengths 1. Measuring and recording data 2. Flower dissection 3. Drawing	Suggestions 1. See above suggestions 2. 3.

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Participant Code D

Unit 1
Post

T/E Design Based Learning Unit/Lesson Assessment Rubric

1. Unit Title: The Chesapeake
2. Grade Level:
3. Date:

For 4-12 below, use the scale below to determine the option that best describes the extent to which each item is completed in the lesson. Score the lesson on the score sheet.

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Unit Overview			
4. Unit Summary	[✓ Concise summary is clearly stated and includes content and skills students should know and be able to do.]	Summary is clearly stated, but lacks complete information about content and skills students should know and be able to do.	Summary is unclear, too broad, or not present.
5. Unit Timeframe	[✓ Approximate number of class periods or sessions is clearly indicated, including specified timeframe.]	Approximate number of class periods or sessions is clearly indicated, but timeframe is not specified.	Number of classes or sessions and timeframe is not clear or is not apparent.
6. Unit Learning Objectives			
Science (SOL)	[✓ A minimum of one key Sci-SOL for each lesson is clearly stated and correlates with lesson objectives.]	A minimum of one key Sci-SOL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key Sci-SOL for each lesson is not clearly stated or apparent.
T/E DBL (STL)	[✓ A minimum of one key STL for each lesson is clearly stated and correlates with lesson objectives.]	A minimum of one key STL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key STL for each lesson is not clearly stated or apparent.
7. Unit Instructional Design			
Science: 5E Model	[✓ Unit clearly adheres to a science 5E instructional design model to guide implementation of instruction.]	Unit loosely adheres to a science 5E instructional design model to guide implementation of instruction.	Unit does not adhere to a science 5E instructional design model to guide implementation of instruction.
T/E: PIRPOSAL Model	[✓ All eight engagement phases are evident and employed as an integral component of the instructional design.]	A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design.	None or very few (4 or less) engagement phases are evident and employed as an integral component of the instructional design.

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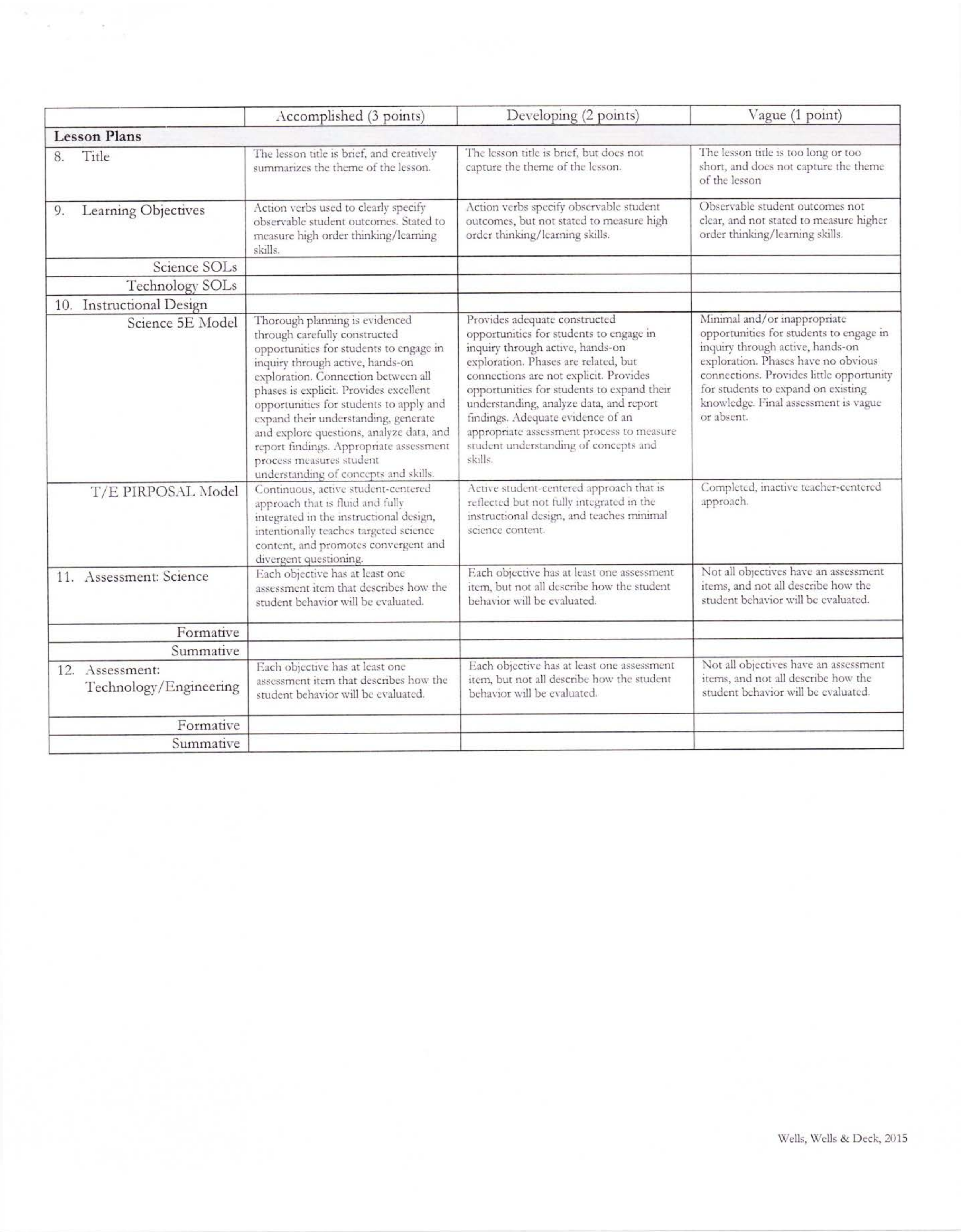

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Lesson Plans			
8. Title	The lesson title is brief, and creatively summarizes the theme of the lesson.	The lesson title is brief, but does not capture the theme of the lesson.	The lesson title is too long or too short, and does not capture the theme of the lesson
9. Learning Objectives	Action verbs used to clearly specify observable student outcomes. Stated to measure high order thinking/learning skills.	Action verbs specify observable student outcomes, but not stated to measure high order thinking/learning skills.	Observable student outcomes not clear, and not stated to measure higher order thinking/learning skills.
Science SOLs			
Technology SOLs			
10. Instructional Design			
Science 5E Model	Thorough planning is evidenced through carefully constructed opportunities for students to engage in inquiry through active, hands-on exploration. Connection between all phases is explicit. Provides excellent opportunities for students to apply and expand their understanding, generate and explore questions, analyze data, and report findings. Appropriate assessment process measures student understanding of concepts and skills.	Provides adequate constructed opportunities for students to engage in inquiry through active, hands-on exploration. Phases are related, but connections are not explicit. Provides opportunities for students to expand their understanding, analyze data, and report findings. Adequate evidence of an appropriate assessment process to measure student understanding of concepts and skills.	Minimal and/or inappropriate opportunities for students to engage in inquiry through active, hands-on exploration. Phases have no obvious connections. Provides little opportunity for students to expand on existing knowledge. Final assessment is vague or absent.
T/E PIRPOSAL Model	Continuous, active student-centered approach that is fluid and fully integrated in the instructional design, intentionally teaches targeted science content, and promotes convergent and divergent questioning.	Active student-centered approach that is reflected but not fully integrated in the instructional design, and teaches minimal science content.	Completed, inactive teacher-centered approach.
11. Assessment: Science	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			
12. Assessment: Technology/Engineering	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			

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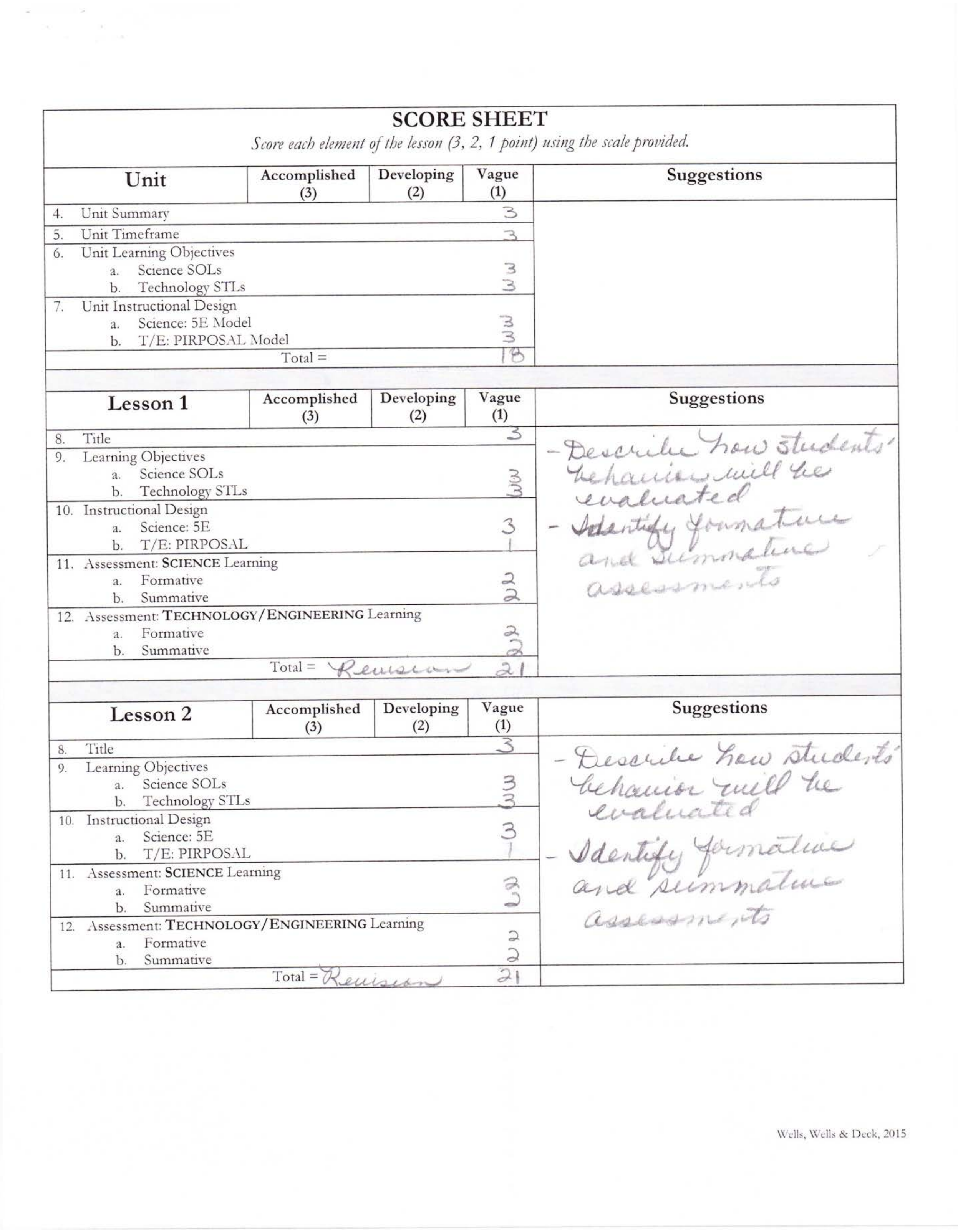

SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
4. Unit Summary			3	
5. Unit Timeframe			3	
6. Unit Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
7. Unit Instructional Design				
a. Science: 5E Model			3	
b. T/E: PIRPOSAL Model			3	
Total =			18	

Lesson 1	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Describe how students' behavior will be evaluated - Identify formative and summative assessments
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			2	
b. Summative			2	
Total = Revision			21	

Lesson 2	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Describe how students' behavior will be evaluated - Identify formative and summative assessments
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			2	
b. Summative			2	
Total = Revision			21	

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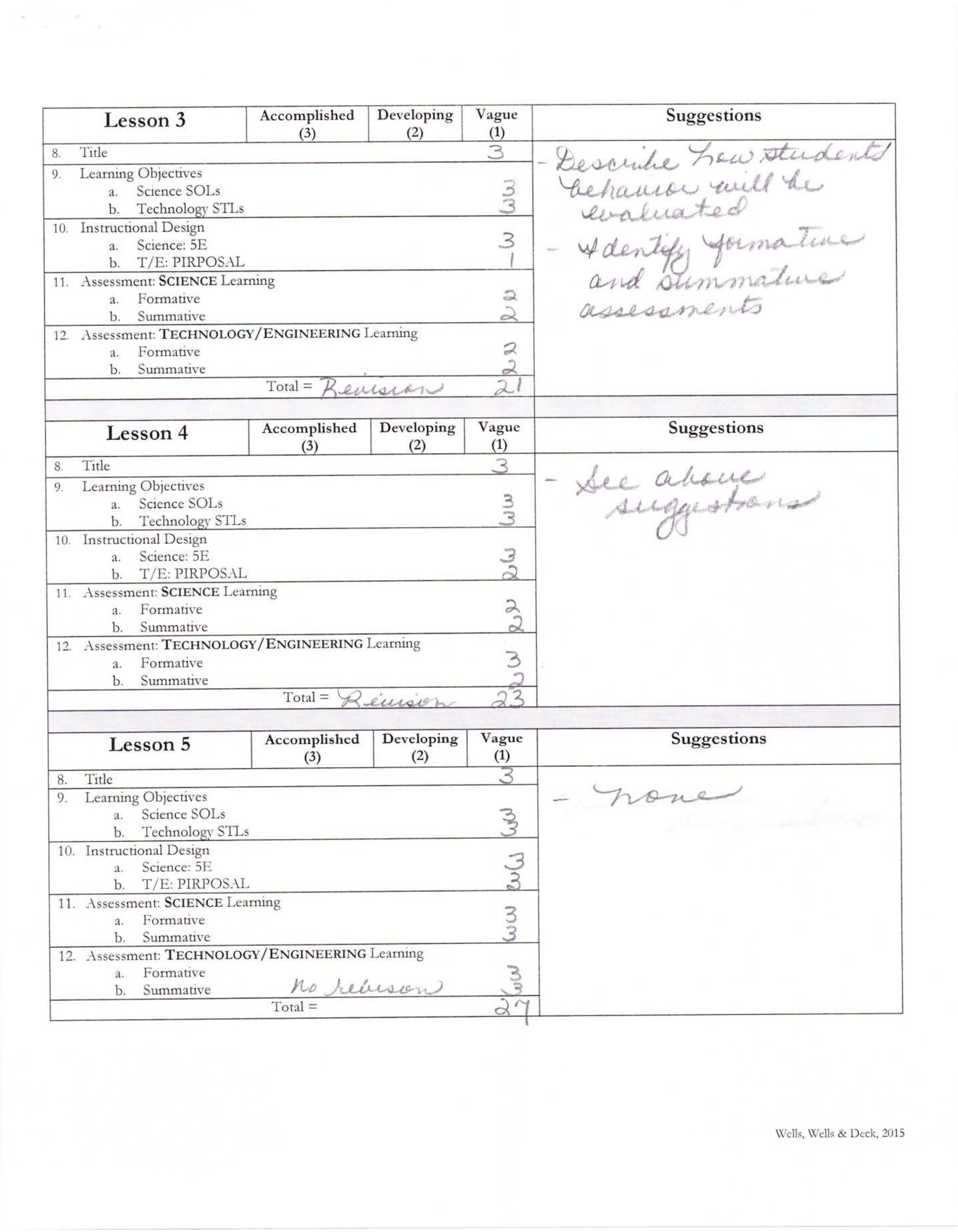

Lesson 3	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	- Describe how students behavior will be evaluated - Identify formative and summative assessments
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			1	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			2	
b. Summative			2	
Total = Revision			21	

Lesson 4	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	- See above suggestions
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			2	
b. Summative			2	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			2	
Total = Revision			23	

Lesson 5	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title			3	- none
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			3	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative	No revision		3	
Total =			27	

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Lesson 9	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 10	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Rating: *Circle the letter indicating the range of scores to determine individual section ratings.*

Unit Overview

Sum from items 4 – 7 =
A. 0-15 Points (Revisions needed)
[✓ B.] 16-18 Points (Implement without revisions)

Lesson Plans

Sum from items 9 – 12 =
A. 7-24 points (Revisions needed)
B. 25-30 points (Implement without revisions)

Overall Unit Rating

Circle one:
[✓ A.] Unit must be revised (additional comments required)
B. Unit can be implemented as written
C. Unit is an exemplar

Additional Comments

Lesson 1-4
Revisions are directed toward assessments - Describe how the students' behavior will be evaluated - Identify formative and summative assessments

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Anita Deck 4-18-16
Evaluator's Signature *Date*

Unit/Lesson –Interrater Feedback Log

Following the assessment of the unit and lessons, use this log to indicate the major strengths (provide 3) and the major suggestions (provide 3) for improvement.

Unit Overview

Strengths	Suggestions
1. Concise summary	1.- Describe how students' behavior
2. Measurable objectives	2.– will be evaluated
3. Inclusion of at least one Key SOL and STL for each lesson	– Identify formative and 3. summative assessments

Lesson 1

Strengths	Suggestions
1. Engagement with relevant activities	1. See above suggestions
2. Use of video clips.	2.
3. Introduction of design brief, rubric, and presentation guidelines	3.

Lesson 2

Strengths	Suggestions
1. Use of Watershed experiment	1. See above suggestions
2. Connection of prior and new knowledge	2.
3. Use of K-W-L chart	3.

Lesson 3

Strengths	Suggestions
1. Exploration of potential solutions	1. See above suggestions
2. Generation of notes, sketches, and drawings	2.
3. Application of gathered info	3.

Lesson 4

Strengths	Suggestions
1. Active design process	1. See above suggestions
2. Additional scientific investigations	2.
3. Analysis of findings	3.

Lesson 5

Strengths	Suggestions
1. Refining and redesigning prototype	1.
2. Self assessment	2.
3. Student presentations	3.

Unit 2

T/E DBL Instructional Change Indicators (ICI)

Participant Code: D	Unit Title: Olympic Bobsled Challenge								Grade Level: 4	
	Lesson 1		Lesson 2		Lesson 3		Lesson 4		Lesson 5	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Curriculum										
Objectives (action verb/measurable)	1	1	1	1	1	1	1	1	1	1
Change Assessment (0, 1, 2, 3)										
Science										
Formative	3	3	3	3	3	3	3	3	3	3
Summative	3	3	3	3	3	3	3	3	3	3
Technology/Engineering										
Formative	3	3	3	3	3	3	3	3	3	3
Summative	3	3	3	3	3	3	3	3	3	3
5E Instructional Design										
Engagement	1	1	0	0	0	0	0	0	0	0
Context/Scenario/Challenge										
Exploration	0	0	1	1	0	0	0	0	0	0
Concepts/Know/Need to Know										
Explanation	0	0	0	0	1	1	0	0	0	0
Understanding/Evidencing/Clarifying										
Elaboration	0	0	0	0	0	0	1	1	0	0
Knowledge Trans/Interpret Results/Extend Application										
Evaluation	0	0	0	0	0	0	0	0	1	1
Formative/Summative/Evidence										
Total Procedures	1	1	1	1	1	1	1	1	1	1
T/E DBL Phase Integrations										
Problem Identification	1	1	1	1	1	1	1	1	1	1
Need/Define/Formulation										
Ideation	1	1	1	1	1	1	1	1	1	1
Criteria/Brainstorm/Generate										
Research	1	1	1	1	1	1	1	1	1	1
Explore/Investigate/Examine										
Potential Solutions	1	1	1	1	1	1	1	1	1	1
Analyze/Visualize/Select										
Optimization	0	0	1	1	1	1	1	1	1	1
Experiment/Revisit/Construct										
Solution Evaluation	0	0	0	0	1	1	1	1	1	1
Test/Analyze/Retest										
Alterations	0	0	0	0	0	1	1	1	1	1
Identify/Redesign/Retest										
Learned Outcomes	1	1	0	0	0	1	0	1	1	1
Process/Iterations/Justify										
Total T/E DBL Phase Integration	5	5	5	5	6	8	7	8	8	8

Lesson Evaluation Key
Accomplished (3pts)
Developing (2pts)
Vague (1pt)

ICI Evaluation Key
0 = Absence of Variable
1 = Presence of Variable
2 = Assessment is linked to objectives
3 = Each objective is assessed

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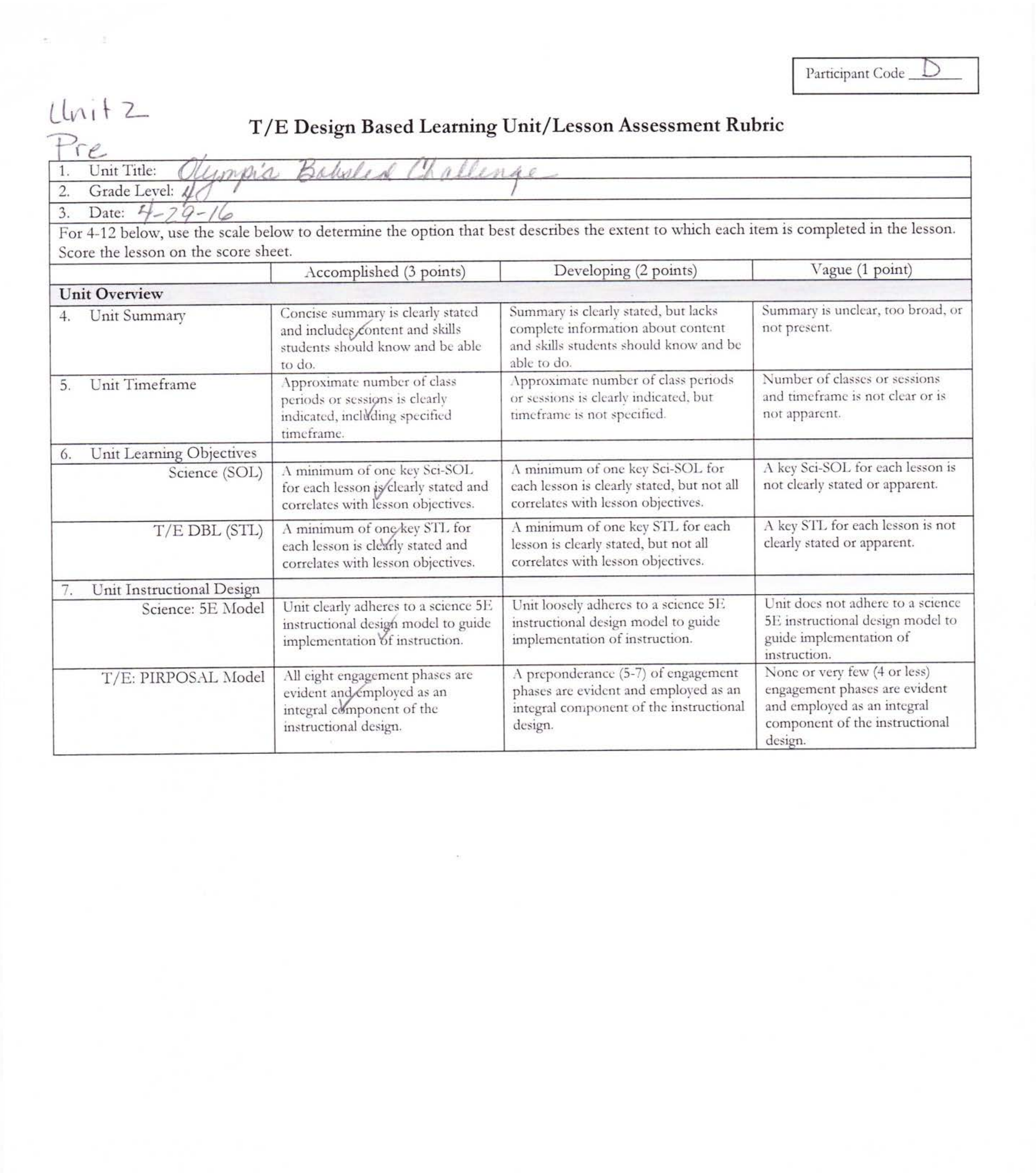

Participant Code D

Unit 2
Pre

T/E Design Based Learning Unit/Lesson Assessment Rubric

1. Unit Title: Olympia Bobsled Challenge			
2. Grade Level: 4			
3. Date: 4-29-16			
For 4-12 below, use the scale below to determine the option that best describes the extent to which each item is completed in the lesson. Score the lesson on the score sheet.			
	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Unit Overview			
4. Unit Summary	[✓ Concise summary is clearly stated and includes content and skills students should know and be able to do.]	Summary is clearly stated, but lacks complete information about content and skills students should know and be able to do.	Summary is unclear, too broad, or not present.
5. Unit Timeframe	[✓ Approximate number of class periods or sessions is clearly indicated, including specified timeframe.]	Approximate number of class periods or sessions is clearly indicated, but timeframe is not specified.	Number of classes or sessions and timeframe is not clear or is not apparent.
6. Unit Learning Objectives			
Science (SOL)	[✓ A minimum of one key Sci-SOL for each lesson is clearly stated and correlates with lesson objectives.]	A minimum of one key Sci-SOL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key Sci-SOL for each lesson is not clearly stated or apparent.
T/E DBL (STL)	[✓ A minimum of one key STL for each lesson is clearly stated and correlates with lesson objectives.]	A minimum of one key STL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key STL for each lesson is not clearly stated or apparent.
7. Unit Instructional Design			
Science: 5E Model	[✓ Unit clearly adheres to a science 5E instructional design model to guide implementation of instruction.]	Unit loosely adheres to a science 5E instructional design model to guide implementation of instruction.	Unit does not adhere to a science 5E instructional design model to guide implementation of instruction.
T/E: PIRPOSAL Model	[✓ All eight engagement phases are evident and employed as an integral component of the instructional design.]	A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design.	None or very few (4 or less) engagement phases are evident and employed as an integral component of the instructional design.

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	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Lesson Plans			
8. Title	The lesson title is brief, and creatively summarizes the theme of the lesson.	The lesson title is brief, but does not capture the theme of the lesson.	The lesson title is too long or too short, and does not capture the theme of the lesson
9. Learning Objectives	Action verbs used to clearly specify observable student outcomes. Stated to measure high order thinking/learning skills.	Action verbs specify observable student outcomes, but not stated to measure high order thinking/learning skills.	Observable student outcomes not clear, and not stated to measure higher order thinking/learning skills.
Science SOLs			
Technology SOLs			
10. Instructional Design			
Science 5E Model	Thorough planning is evidenced through carefully constructed opportunities for students to engage in inquiry through active, hands-on exploration. Connection between all phases is explicit. Provides excellent opportunities for students to apply and expand their understanding, generate and explore questions, analyze data, and report findings. Appropriate assessment process measures student understanding of concepts and skills.	Provides adequate constructed opportunities for students to engage in inquiry through active, hands-on exploration. Phases are related, but connections are not explicit. Provides opportunities for students to expand their understanding, analyze data, and report findings. Adequate evidence of an appropriate assessment process to measure student understanding of concepts and skills.	Minimal and/or inappropriate opportunities for students to engage in inquiry through active, hands-on exploration. Phases have no obvious connections. Provides little opportunity for students to expand on existing knowledge. Final assessment is vague or absent.
T/E PIRPOSAL Model	Continuous, active student-centered approach that is fluid and fully integrated in the instructional design, intentionally teaches targeted science content, and promotes convergent and divergent questioning.	Active student-centered approach that is reflected but not fully integrated in the instructional design, and teaches minimal science content.	Completed, inactive teacher-centered approach.
11. Assessment: Science	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			
12. Assessment: Technology/Engineering	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			

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SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
4. Unit Summary			3	- See suggestion for Lesson 2 and adjust time frame - Add: Working Prototype and Friction Center Lab Pack to list of Assessments
5. Unit Timeframe			3	
6. Unit Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
7. Unit Instructional Design				
a. Science: 5E Model			3	
b. T/E: PIRPOSAL Model			3	
Total = no Revision			18	

Lesson 1	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Add Codes I_C, I_B, I_G R_E, R_I, R_X PS_A to both 5E Model and T/E DBL Phases Columns
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total = no revision			26	

Lesson 2 (+ Lesson 3)	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	- Collapse Lessons 2 and 3 since both are Research and Brainstorming
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total = no revision			26	

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Lesson 3 (Lesson 4)	**Accomplished** (3)	**Developing** (2)	**Vague** (1)	**Suggestions**
8. Title			3	Renumber Lesson 4 to Lesson 3 - Add O_E, O_R, O_C codes to 5E Model and T/E DBL Phases columns
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
	Total = no revision		26	

Lesson 4 (Lesson 5)	**Accomplished** (3)	**Developing** (2)	**Vague** (1)	**Suggestions**
8. Title			3	-Renumber Lesson 5 to Lesson 4 -
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
	Total = no revision		26	

Lesson 5 (Lesson 6)	**Accomplished** (3)	**Developing** (2)	**Vague** (1)	**Suggestions**
8. Title			3	Renumber Lesson 6 to Lesson 5
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			3	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
	Total = no revision		27	

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Lesson 9	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 10	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Rating: *Circle the letter indicating the range of scores to determine individual section ratings.*

Unit Overview

Sum from items 4 – 7 =
A. 0-15 Points (Revisions needed)
[✓ B.] 16-18 Points (Implement without revisions)

Lesson Plans

Sum from items 9 – 12 =
A. 7-24 points (Revisions needed)
[✓ B.] 25-30 points (Implement without revisions)

Overall Unit Rating

Circle one:
A. Unit must be revised (additional comments required)
[✓ B.] Unit can be implemented as written
C. Unit is an exemplar

Additional Comments

Anita Deck 4-29-16

Evaluator's Signature Date

Unit/Lesson –Interrater Feedback Log

Following the assessment of the unit and lessons, use this log to indicate the major strengths (provide 3) and the major suggestions (provide 3) for improvement.

Unit Overview

Strengths	Suggestions
1. Concise summary 2. All 8 T/E DBL phases used 3. Learning objectives correlates with lesson objectives	1.- Adjust timeframe after renumbering 2. lessons 3. - Add Working Prototype and Friction Center Lab Pack to list of assessments - Provide examples of based tools in Prior Knowledge

Lesson 1

Strengths	Suggestions
1. Engagement with relevant activities 2. Use of video clips 3. Introduction of design brief, rubric, and presentation guidelines	1. Add codes - $I_C, I_B, I_G, R_E, R_I,$ 2. R_X, PS_A - to both 5E Model 3. and T/EDBL Phases columns

Lesson 2

Strengths	Suggestions
1. Brainstorming/recording responses 2. Use of K-W-L chart 3. Friction labs	1. Collapse Lessons 2 and 3 2. 3.

Lesson 3

Strengths	Suggestions
1. Application of info and research 2. Generation of sketches, notes, drawings 3. Use of computer software	1. Renumber Lesson 2. Add codes - O_E, O_R, O_C - to 5E 3. Model and T/E DBL Phases columns

Lesson 4

Strengths	Suggestions
1. Active design process 2. Scientific investigations to inform design 3. Analysis of findings	1. Renumber Lesson 2. 3.

Lesson 5

Strengths	Suggestions
1. Student presentations 2. Student self assessment 3. Student competition	1. Renumber Lesson 2. 3.

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Participant Code D

Unit 2
Post

T/E Design Based Learning Unit/Lesson Assessment Rubric

1. Unit Title: Olympic Bobsled Challenge
2. Grade Level: 4
3. Date: 3-1-16

For 4-12 below, use the scale below to determine the option that best describes the extent to which each item is completed in the lesson. Score the lesson on the score sheet.

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Unit Overview			
4. Unit Summary	[✓ Concise summary is clearly stated and includes content and skills students should know and be able to do.]	Summary is clearly stated, but lacks complete information about content and skills students should know and be able to do.	Summary is unclear, too broad, or not present.
5. Unit Timeframe	[✓ Approximate number of class periods or sessions is clearly indicated, including specified timeframe.]	Approximate number of class periods or sessions is clearly indicated, but timeframe is not specified.	Number of classes or sessions and timeframe is not clear or is not apparent.
6. Unit Learning Objectives			
Science (SOL)	[✓ A minimum of one key Sci-SOL for each lesson is clearly stated and correlates with lesson objectives.]	A minimum of one key Sci-SOL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key Sci-SOL for each lesson is not clearly stated or apparent.
T/E DBL (STL)	[✓ A minimum of one key STL for each lesson is clearly stated and correlates with lesson objectives.]	A minimum of one key STL for each lesson is clearly stated, but not all correlates with lesson objectives.	A key STL for each lesson is not clearly stated or apparent.
7. Unit Instructional Design			
Science: 5E Model	[✓ Unit clearly adheres to a science 5E instructional design model to guide implementation of instruction.]	Unit loosely adheres to a science 5E instructional design model to guide implementation of instruction.	Unit does not adhere to a science 5E instructional design model to guide implementation of instruction.
T/E: PIRPOSAL Model	[✓ All eight engagement phases are evident and employed as an integral component of the instructional design.]	A preponderance (5-7) of engagement phases are evident and employed as an integral component of the instructional design.	None or very few (4 or less) engagement phases are evident and employed as an integral component of the instructional design.

	Accomplished (3 points)	Developing (2 points)	Vague (1 point)
Lesson Plans			
8. Title	The lesson title is brief, and creatively summarizes the theme of the lesson.	The lesson title is brief, but does not capture the theme of the lesson.	The lesson title is too long or too short, and does not capture the theme of the lesson
9. Learning Objectives	Action verbs used to clearly specify observable student outcomes. Stated to measure high order thinking/learning skills.	Action verbs specify observable student outcomes, but not stated to measure high order thinking/learning skills.	Observable student outcomes not clear, and not stated to measure higher order thinking/learning skills.
Science SOLs			
Technology SOLs			
10. Instructional Design			
Science 5E Model	Thorough planning is evidenced through carefully constructed opportunities for students to engage in inquiry through active, hands-on exploration. Connection between all phases is explicit. Provides excellent opportunities for students to apply and expand their understanding, generate and explore questions, analyze data, and report findings. Appropriate assessment process measures student understanding of concepts and skills.	Provides adequate constructed opportunities for students to engage in inquiry through active, hands-on exploration. Phases are related, but connections are not explicit. Provides opportunities for students to expand their understanding, analyze data, and report findings. Adequate evidence of an appropriate assessment process to measure student understanding of concepts and skills.	Minimal and/or inappropriate opportunities for students to engage in inquiry through active, hands-on exploration. Phases have no obvious connections. Provides little opportunity for students to expand on existing knowledge. Final assessment is vague or absent.
T/E PIRPOSAL Model	Continuous, active student-centered approach that is fluid and fully integrated in the instructional design, intentionally teaches targeted science content, and promotes convergent and divergent questioning.	Active student-centered approach that is reflected but not fully integrated in the instructional design, and teaches minimal science content.	Completed, inactive teacher-centered approach.
11. Assessment: Science	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			
12. Assessment: Technology/Engineering	Each objective has at least one assessment item that describes how the student behavior will be evaluated.	Each objective has at least one assessment item, but not all describe how the student behavior will be evaluated.	Not all objectives have an assessment items, and not all describe how the student behavior will be evaluated.
Formative			
Summative			

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SCORE SHEET

Score each element of the lesson (3, 2, 1 point) using the scale provided.

Unit	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
4. Unit Summary			3	none
5. Unit Timeframe			3	
6. Unit Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
7. Unit Instructional Design				
a. Science: 5E Model			3	
b. T/E: PIRPOSAL Model			3	
Total = no revision			18	

Lesson 1	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	none
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total = no revision			26	

Lesson 2	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	none
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			2	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total = no revision			26	

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Lesson 3	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	none
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			3	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total = no revision			27	

Lesson 4	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	none
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			3	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total = no revision			27	

Lesson 5	Accomplished (3)	Developing (2)	Vague (1)	Suggestions
8. Title			3	none
9. Learning Objectives				
a. Science SOLs			3	
b. Technology STLs			3	
10. Instructional Design				
a. Science: 5E			3	
b. T/E: PIRPOSAL			3	
11. Assessment: **SCIENCE** Learning				
a. Formative			3	
b. Summative			3	
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning				
a. Formative			3	
b. Summative			3	
Total = no revision			27	

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Lesson 9	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Lesson 10	**Accomplished (3)**	**Developing (2)**	**Vague (1)**	**Suggestions**
8. Title				
9. Learning Objectives a. Science SOLs b. Technology STLs				
10. Instructional Design a. Science: 5E b. T/E: PIRPOSAL				
11. Assessment: **SCIENCE** Learning a. Formative b. Summative				
12. Assessment: **TECHNOLOGY/ENGINEERING** Learning a. Formative b. Summative				
Total =				

Rating: *Circle the letter indicating the range of scores to determine individual section ratings.*

Unit Overview

Sum from items 4 – 7 =
A. 0-15 Points (Revisions needed)
[✓ B.] 16-18 Points (Implement without revisions)

Lesson Plans

Sum from items 9 – 12 =
A. 7-24 points (Revisions needed)
[✓ B.] 25-30 points (Implement without revisions)

Overall Unit Rating

Circle one:
A. Unit must be revised (additional comments required)
[✓ B.] Unit can be implemented as written
C. Unit is an exemplar

Additional Comments

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Anita Deck
Evaluator's Signature

5-1-16
Date

Unit/Lesson –Interrater Feedback Log

Following the assessment of the unit and lessons, use this log to indicate the major strengths (provide 3) and the major suggestions (provide 3) for improvement.

Unit Overview

Strengths	Suggestions
1. Concise summary 2. All 8 T/E DBL Engagement phases used 3. All learning objectives assessed	1. none 2. 3.

Lesson 1

Strengths	Suggestions
1. Engagement with relevant activities 2. Use of video clips 3. Introduction of design brief, rubric, and presentation guidelines	1. none 2. 3.

Lesson 2

Strengths	Suggestions
1. Brainstorming/recording ideas 2. Use of K-W-L Chart 3. Use of Friction Lab Pack	1. none 2. 3.

Lesson 3

Strengths	Suggestions
1. Information and research application 2. Generation of sketches, notes, and drawings 3. Use of computer software for designing	1. none 2. 3.

Lesson 4

Strengths	Suggestions
1. Continued active design process 2. Use of scientific investigations to inform design 3. Analysis of findings	1. none 2. 3.

Lesson 5

Strengths	Suggestions
1. Student presentations 2. Student self-assessment 3. Student competition	1. none 2. 3.

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Appendix M

Understanding of a VA Science Standard of Learning Survey Results

Pre

A

UNDERSTANDING OF A VIRGINIA SCIENCE STANDARD OF LEARNING

The following science concept has been identified as a weakness for fourth and fifth grade students. The science concept is *identify possible impacts of human activity on the ecosystem.*

This concept was assessed using the following test item on the Grade 5 Science Standards of Learning test:

Which of these is an impact made by humans?

A. Marble being dug from a rock quarry

B. Marble forming from sedimentary rock

C. Oceans drying and exposing limestone

D. Limestone forming from shells of ocean animals

After reviewing the above science concept, please rate your understanding of the following.

1. How well do you understand the SOL stated above?

1	2	3	[✓ 4]	5	6	7
I do not understand this SOL		I somewhat understand this SOL.			I completely understand this SOL.	

2. How well do you understand the instructional requirements for teaching the science content in this SOL?

1	2	3	[✓ 4]	5	6	7
I do not understand the instructional requirements.		I somewhat understand the instructional requirements.			I completely understand the instructional requirements.	

3. How well do you understand the science concept in this SOL that students are expected to demonstrate?

1	2	3	[✓ 4]	5	6	7
I do not understand the science concept.		I somewhat understand the science concept.			I completely understand the science concept.	

Post A

UNDERSTANDING OF A VIRGINIA SCIENCE STANDARD OF LEARNING

The following science concept has been identified as a weakness for fourth and fifth grade students. The science concept is *identify possible impacts of human activity on the ecosystem*.

This concept was assessed using the following test item on the Grade 5 Science Standards of Learning test:

> Which of these is an impact made by humans?
>
> A. Marble being dug from a rock quarry
>
> B. Marble forming from sedimentary rock
>
> C. Oceans drying and exposing limestone
>
> D. Limestone forming from shells of ocean animals

After reviewing the above science concept, please rate your understanding of the following.

1. How well do you understand the SOL stated above?

1	2	3	4	5	[✓ 6]	7
I do not understand this SOL		I somewhat understand this SOL.			I completely understand this SOL.	

2. How well do you understand the instructional requirements for teaching the science content in this SOL?

1	2	3	4	5	[✓ 6]	7
I do not understand the instructional requirements.		I somewhat understand the instructional requirements.			I completely understand the instructional requirements.	

3. How well do you understand the science concept in this SOL that students are expected to demonstrate?

This one !

1	2	3	~~4~~	5	[✓ 6]	7
I do not understand the science concept.		I somewhat understand the science concept.			I completely understand the science concept.	

Pre B

UNDERSTANDING OF A VIRGINIA SCIENCE STANDARD OF LEARNING

The following science concept has been identified as a weakness for fourth and fifth grade students. The science concept is *identify possible impacts of human activity on the ecosystem.*

This concept was assessed using the following test item on the Grade 5 Science Standards of Learning test:

Which of these is an impact made by humans?

A. Marble being dug from a rock quarry

B. Marble forming from sedimentary rock

C. Oceans drying and exposing limestone

D. Limestone forming from shells of ocean animals

After reviewing the above science concept, please rate your understanding of the following.

1. How well do you understand the SOL stated above?

1	2	3	4	5	[✓ 6]	7
I do not understand this SOL			I somewhat understand this SOL.		I completely understand this SOL.	

2. How well do you understand the instructional requirements for teaching the science content in this SOL?

1	2	[✓ 3]	4	5	6	7
I do not understand the instructional requirements.			I somewhat understand the instructional requirements.		I completely understand the instructional requirements.	

3. How well do you understand the science concept in this SOL that students are expected to demonstrate?

1	2	3	4	[✓ 5]	6	7
I do not understand the science concept.			I somewhat understand the science concept.		I completely understand the science concept.	

Post B

UNDERSTANDING OF A VIRGINIA SCIENCE STANDARD OF LEARNING

The following science concept has been identified as a weakness for fourth and fifth grade students. The science concept is *identify possible impacts of human activity on the ecosystem.*

This concept was assessed using the following test item on the Grade 5 Science Standards of Learning test:

Which of these is an impact made by humans?

A. Marble being dug from a rock quarry

B. Marble forming from sedimentary rock

C. Oceans drying and exposing limestone

D. Limestone forming from shells of ocean animals

After reviewing the above science concept, please rate your understanding of the following.

1. How well do you understand the SOL stated above?

1	2	3	4	5	[✓ 6]	7
I do not understand this SOL		I somewhat understand this SOL.			I completely understand this SOL.	

2. How well do you understand the instructional requirements for teaching the science content in this SOL?

1	2	3	4	[✓ 5]	6	7
I do not understand the instructional requirements.		I somewhat understand the instructional requirements.			I completely understand the instructional requirements.	

3. How well do you understand the science concept in this SOL that students are expected to demonstrate?

1	2	3	4	5	[✓ 6]	7
I do not understand the science concept.		I somewhat understand the science concept.			I completely understand the science concept.	

Pre C

UNDERSTANDING OF A VIRGINIA SCIENCE STANDARD OF LEARNING

The following science concept has been identified as a weakness for fourth and fifth grade students. The science concept is *identify possible impacts of human activity on the ecosystem.*

This concept was assessed using the following test item on the Grade 5 Science Standards of Learning test:

Which of these is an impact made by humans?

A. Marble being dug from a rock quarry

B. Marble forming from sedimentary rock

C. Oceans drying and exposing limestone

D. Limestone forming from shells of ocean animals

After reviewing the above science concept, please rate your understanding of the following.

1. How well do you understand the SOL stated above?

1	2	3	4	5	6	[✓ 7]
I do not understand this SOL		I somewhat understand this SOL.			I completely understand this SOL.	

2. How well do you understand the instructional requirements for teaching the science content in this SOL?

1	2	3	4	[✓ 5]	6	7
I do not understand the instructional requirements.		I somewhat understand the instructional requirements.			I completely understand the instructional requirements.	

3. How well do you understand the science concept in this SOL that students are expected to demonstrate?

1	2	3	4	[✓ 5]	6	7
I do not understand the science concept.		I somewhat understand the science concept.			I completely understand the science concept.	

Post C

UNDERSTANDING OF A VIRGINIA SCIENCE STANDARD OF LEARNING

The following science concept has been identified as a weakness for fourth and fifth grade students. The science concept is *identify possible impacts of human activity on the ecosystem.*

This concept was assessed using the following test item on the Grade 5 Science Standards of Learning test:

Which of these is an impact made by humans?

A. Marble being dug from a rock quarry

B. Marble forming from sedimentary rock

C. Oceans drying and exposing limestone

D. Limestone forming from shells of ocean animals

After reviewing the above science concept, please rate your understanding of the following.

1. How well do you understand the SOL stated above?

1	2	3	4	5	6	[✓ 7]
I do not understand this SOL		I somewhat understand this SOL.			I completely understand this SOL.	

2. How well do you understand the instructional requirements for teaching the science content in this SOL?

1	2	3	4	5	[✓ 6]	7
I do not understand the instructional requirements.		I somewhat understand the instructional requirements.			I completely understand the instructional requirements.	

3. How well do you understand the science concept in this SOL that students are expected to demonstrate?

1	2	3	4	5	[✓ 6]	7
I do not understand the science concept.		I somewhat understand the science concept.			I completely understand the science concept.	

D

Pre

UNDERSTANDING OF A VIRGINIA SCIENCE STANDARD OF LEARNING

The following science concept has been identified as a weakness for fourth and fifth grade students. The science concept is *identify possible impacts of human activity on the ecosystem.*

This concept was assessed using the following test item on the Grade 5 Science Standards of Learning test:

Which of these is an impact made by humans?

[✓ A.] Marble being dug from a rock quarry

B. Marble forming from sedimentary rock

C. Oceans drying and exposing limestone

D. Limestone forming from shells of ocean animals

After reviewing the above science concept, please rate your understanding of the following.

1. How well do you understand the SOL stated above?

1	2	3	4	[✓ 5]	6	7
I do not understand this SOL		I somewhat understand this SOL.			I completely understand this SOL.	

2. How well do you understand the instructional requirements for teaching the science content in this SOL?

1	2	3	[✓ 4]	5	6	7
I do not understand the instructional requirements.		I somewhat understand the instructional requirements.			I completely understand the instructional requirements.	

3. How well do you understand the science concept in this SOL that students are expected to demonstrate?

1	2	[✓ 3]	4	5	6	7
I do not understand the science concept.		I somewhat understand the science concept.			I completely understand the science concept.	

Post D

UNDERSTANDING OF A VIRGINIA SCIENCE STANDARD OF LEARNING

The following science concept has been identified as a weakness for fourth and fifth grade students. The science concept is *identify possible impacts of human activity on the ecosystem.*

This concept was assessed using the following test item on the Grade 5 Science Standards of Learning test:

Which of these is an impact made by humans?

[✓ A.] Marble being dug from a rock quarry

~~B.~~ Marble forming from sedimentary rock

~~C.~~ Oceans drying and exposing limestone

~~D.~~ Limestone forming from shells of ocean animals

After reviewing the above science concept, please rate your understanding of the following.

1. How well do you understand the SOL stated above?

1	2	3	4	5	[✓ 6]	7
I do not understand this SOL		I somewhat understand this SOL.			I completely understand this SOL.	

2. How well do you understand the instructional requirements for teaching the science content in this SOL?

1	2	3	4	5	[✓ 6]	7
I do not understand the instructional requirements.		I somewhat understand the instructional requirements.			I completely understand the instructional requirements.	

3. How well do you understand the science concept in this SOL that students are expected to demonstrate?

1	2	3	4	5	[✓ 6]	7
I do not understand the science concept.		I somewhat understand the science concept.			I completely understand the science concept.	

Appendix N

Participant Post-Interview Transcripts

Participant A Post-Interview Transcript

Researcher (R): Before we get started, would you please tell me your Participant Code?

Participant A (PA): My letter is A.

R: Thanks.

The main focus of our interview is to understand your choice of ratings on the Understandings of a Virginia Science Standard of Learning Questionnaire. You were asked to rate your understanding of the science concept: *identify possible impacts of human activity on the ecosystem*.

This concept was assessed using the following test item on the Grade 5 Science Standards of Learning test:

> Which of these is an impact made by humans?
>
> A. Marble being dug from a rock quarry
> B. Marble forming from sedimentary rock
> C. Oceans drying and exposing limestone
> D. Limestone forming from shells of ocean animals

While you answer the questions, please focus on the details of your reasoning for your rating choices. Any questions before we begin?

PA: No, I'm ready. Do you want me to explain those or just explain my choice?

R: I'd like you to just explain why you chose that particular number rating for the SOL for each of the questions.

PA: Ok, I think I have it now.

R: Great! Let's begin…Question 1

Why did you chose to rate yourself at (6) for your understanding of this SOL?

PA: Ok, I'm thinking. I don't know which one you're asking me to explain A, B, C, or D.

R: Oh, neither one of those. The question about human impact and the four choices A, B, C, or D is just the test item that appeared on the SOL test which assessed the SOL. Keep in mind the SOL that I'm referring to is *identify possible impacts of human activity on the ecosystem.* What Question 1 is asking is why did you choose to rate yourself at (6) for your understanding of this SOL. Does that clarify it for you?

PA: Ok, yes, that helps me understand what you are asking. I…have the background as a master naturalist and I understand that SOL very well. There's different types human impact. There is global warming, erosion, affecting the wetlands. There is affecting ocean life, the ocean, affecting native plants, native animals, and insects, native flora.

There's different types of impacts...so I feel very confident about how I understand that SOL and what types of human impacts there are. In the first questionnaire I rated myself a four, but I was nervous about the training and just a little unsure how all of this was going to work for me and my students.

R: Ok, thank you. Next question…Why did you chose to rate yourself at (6) for your understanding of the instructional requirements for teaching the science content in this SOL?

PA: Umm… (*pause*)…thinking about this one…(*pause*)…what do I need in order to teach that? Providing a problem that has the science content in there. Ah, the PD helped me see that DBL is much better suited for doing this than a PBL. Having a challenge and what are students doing to solve that challenge and need…(*pauses*)…and what knowledge…(*pause*)…science content…(*pause*)… do they need to know so they can solve that challenge. That involves lots of things…(*pause*)…science concepts, inquiry, experiments, and having them teach each other. I understand what's needed to teach the science better.

Design based learning helped me design this unit better because it gave me a structure to follow where I can know where to use certain strategies, where to introduce the challenge, and connect everything together. It helped me provide the students with a beginning, middle, and end that connected everything together. I liked being able to teach the science within a more meaningful perspective.

R: Ok, thank you. The last question is, why did you chose to rate yourself at (6) for your understanding of the science concept in this SOL that students are expected to demonstrate?

PA: Ok…(*pause*)…ah, I would think they all go together. If I teach it, I want to be able to assess it and DBL allows me to do this in such a way that really means something to the students. When I redesigned my first unit, I was able to write it so that students actually had to produce a product and tell about it. They could even self-assess and see how they were doing. The science concept was rolled into the challenge so that they had more of a framework for the concept rather than something that was just out there…nothing to attach it to.

I was able to bring out more than just thinking about erosion, which is what most people think of when you talk about human impact. The SOLs aren't that refined so you have to choose *what* impacts you're going to have the students explore, understand, and demonstrate. The students were more in charge of their learning rather than me just trying to get them to learn the science concept. That's what thinking is all about. It helped them learned this way of thinking about how science can be used and learned.

R: Thank you for participating in this interview.

Participant B Post-Interview Transcript

Researcher (R): Ok, would you please tell me your Participant Code?

Participant B (PB): If I remember correctly, it's B.

R: Yes it is, great. Ok let's begin with the interview.
The main focus of our interview is to understand your choice of ratings on the Understandings of a Virginia Science Standard of Learning Questionnaire. You were asked to rate your understanding of the science concept: *identify possible impacts of human activity on the ecosystem*.

This concept was assessed using the following test item on the Grade 5 Science Standards of Learning test:

> Which of these is an impact made by humans?
>
> A. Marble being dug from a rock quarry
> B. Marble forming from sedimentary rock
> C. Oceans drying and exposing limestone
> D. Limestone forming from shells of ocean animals

While you answer the questions, please focus on the details of your reasoning for your rating choices. Any questions before we begin?

PB: Nope, I'm good to go.

R: Alright, question 1…Why did you chose to rate yourself at (6) for your understanding of this SOL?

PB: Oh well, I feel like I'm pretty clear on the differences between the human impact and a natural impact. Um, I saw the test question and the distractors, I knew it was really focused on knowing the difference between these, so that's what I had been teaching my students...(*pause*) …to recognize those differences, what a human might do and what might be caused by nature. So, I pretty much felt I knew this coming into the PD sessions and that the lessons I used already were getting at this.

R: Thank you. Next question…Why did you chose to rate yourself at (5) for your understanding of the instructional requirements for teaching the science content in this SOL?

PB: Alright…I think that because it connects with 4th grade with the living systems and in the 5th grade it's connected to the geology and the rocks, and rock cycle. I think it's hard to connect it to how I want to teach it, but after the sessions I can see how it will fits into how I wanted to teach it…at least in my mind and, obviously, in my, uh, the unit and lessons that I taught. It's hard to move away from a way of teaching that I've had to do. Maybe that's the problem. How I have to teach and how I want to teach. This strategy is a way to do both. I just found out that I might be losing my job because of SOL test results. That's really something after 14 years of teaching.

They just don't get it…(*pause*)…not all kids learn the same and you have reach all of them. Not a one size fits all kind of classroom, just like there's a one size fits all kind of teacher. I've had to fight against that my entire career. There are such better ways to teach kids, just like this way, but your hands are tied in everything you do. I really liked doing science this way, making it meaningful to learn. I'm glad I was a part of this study because I felt I was doing something for just me and my teaching. Oh gosh, I'd like to do more PD sessions and learn more about the nuts and bolts of all of this over a much longer time.

I would really like to work more with the template and make more of my units and lessons into this format. It's so easy to use the 5E model to make 5 lessons and then to put the design challenge in there, the science content in there, and the assessments. Um..ha!.. I probably would have done a better job at writing that second unit if I'd actually read the suggestions that you provided. I don't know why I just skipped them. My fault.

R: Thanks you. So third and final question… (*pause*)…why did you chose to rate yourself at (6) for your understanding of the science concept in this SOL that students are expected to demonstrate?

PB: Right, I think basically that the same thing. Now I'm getting a clearer understanding that it's not necessarily the difference between a positive and a negative more of a difference between humans have on the environment versus the natural effects have on the environment. So, by giving the students a design challenge to address, they are able to put a positive spin on something that otherwise may appear to be negative. Not only that, they have to talk about it and share what their thoughts are about it. I definitely have a much better idea of how I want my students to demonstrate the science and how to make that meaningful. The design challenge provides the perfect platform for doing just that. I can put everything in there that makes my students be in charge of their own learning and I know what that should look like when I evaluate it. (*Laughs*) they better watch out next year because I'll have them doing such great stuff.

R: Thank you for participating in this interview.

Participant C Post-Interview Transcript

Researcher (R): Before we get started, can you please tell me your Participant Code?

Participant C (PC): My participant code is C.

R: Thank you. Let's get started.

The main focus of our interview is to understand your choice of ratings on the Understandings of a Virginia Science Standard of Learning Questionnaire. You were asked to rate your understanding of the science concept: *identify possible impacts of human activity on the ecosystem*.

This concept was assessed using the following test item on the Grade 5 Science Standards of Learning test:

> Which of these is an impact made by humans?
>
> A. Marble being dug from a rock quarry
> B. Marble forming from sedimentary rock
> C. Oceans drying and exposing limestone
> D. Limestone forming from shells of ocean animals

While you answer the questions, please focus on the details of your reasoning for your rating choices. Any questions before we begin?

PC: No, I understand.

R: Great. Let's get started…question 1…(*pause*)…Why did you chose to rate yourself at (7) for your understanding of this SOL?

PC: Because I taught this particular test item, I felt like I understood this concept pretty well or at least I thought I did. After the PD session, I looked at this in a whole new light…a new way of teaching this SOL to my students. I probably ended up scoring them the same because of this. I actually understand that this SOL can mean more than just what I was thinking of as impact of humans on the ecosystem. In fact, I threw away that first unit that I submitted. Actually it wasn't much (*laughs*) and will use the new one that I redesigned. It makes so much more sense to teach it that way.

R: Great, thank you. Next question…Why did you chose to rate yourself at (6) for your understanding of the instructional requirements for teaching the science content in this SOL?

PC: (*pause*)…I'm just thinking…I guess that I understand there's all different kinds of things that affect the ecosystem that has to do with human impact. Not only could it be rock quarries, it could be us drinking a bottle of water and throwing the bottle away, the trash that we throw out, it can be all kinds of things and I need to incorporate these into my lessons. I haven't been including enough science in teaching this. It’s been more from a “just let’s get this done” type of thought. I don’t have a lot of experience teaching science and I try to hurry through it, but now I really like how these units are structured. You know, with the design challenge.

The template helped me put the science in there with a design challenge that is really meaningful for my students. I see this as a really great way to pull in all kinds of subject areas and SOLs. Students aren’t having to learn a lot of disjointed things with me trying to connect them together for them. They’re able to do that for themselves. I had to think about what I wanted them to get out of that design challenge and what I wanted them to understand about that science concept…what they needed to know in order to do the design challenge.

I really like the exploration of trying to find a solution to the design challenge and the structure of putting together a unit and lessons…and it doesn’t take that much time…5 lessons and you’ve covered everything that you need to…teachers can do that. I was able to cram in a lot of science, not just that SOL but several others and also a great deal of math.

R: Ok, thanks. So last question…why did you chose to rate yourself at (6) for your understanding of the science concept in this SOL that students are expected to demonstrate?

PC: I see a difference in the rating I gave before and the rating that I just gave for this one. Now I see that by using a unit that is designed with a challenge gives a real purpose to learning the science where before the purpose was to cover the material and move on. You’re not giving them worksheets; you’re not giving them things just to copy down…a real purpose for learning. I really understand what I want students to do now as opposed to before the PD sessions. I want them to be able to come up with a solution to a design challenge, use science to help them, and talk about what they have done.

When I redesigned that first unit to have students design a solution to moving the stream, they could actually see the impact of erosion and try to purpose a solution to that. They were in charge of that idea. They had to determine what effects moving the stream was going to have in the immediate area and what was going to happen downstream. By having the students see and think about this was a lot better than me telling them about it. And when they did testing on their prototypes, they had to look for additional impacts…is it eroding more than it should? By learning the science in this way, they knew what to look for when they were testing their prototypes.

R: Thank you for participating in this interview.

Participant D Post-Interview Transcript

R: Before we get started, can you please tell me your Participant Code?

Participant D (PD): It's D.

R: Great. So let's begin…

The main focus of our interview is to understand your choice of ratings on the Understandings of a Virginia Science Standard of Learning Questionnaire. You were asked to rate your understanding of the science concept: *identify possible impacts of human activity on the ecosystem*.

This concept was assessed using the following test item on the Grade 5 Science Standards of Learning test:

> Which of these is an impact made by humans?
>
> A. Marble being dug from a rock quarry
> B. Marble forming from sedimentary rock
> C. Oceans drying and exposing limestone
> D. Limestone forming from shells of ocean animals

While you answer the questions, please focus on the details of your reasoning for your rating choices. Any questions before we begin?

PD: Ok, so when I answer these questions, I'm supposed to think in terms of the SOL, identify possible impacts of human activity on the ecosystem, right?

R: Yes, that's correct. These three questions are in reference to that particular SOL.

PD: Ok, I'm ready.

R: Ok, question 1…(*pause*)…Why did you chose to rate yourself at (6) for your understanding of this SOL?

PD: Ok, uh, well, what I first started with this science concept, I really didn't understand human impact. Uh, I kind of struggled with that, but through all the activities that we did…the design challenge, the experimentation, the research, I started to understand exactly what impact was and I felt like at the end of the PD I understood that. When I started to design my own unit, uh, lessons for that first lesson, I understood what human impact was so much better. Uh, and that's basically it. Working with DBL learning, I understood the SOL more.

R: Ok, ok, thank you. Alright second question. Why did you chose to rate yourself at (6) for your understanding of the instructional requirements for teaching the science content in this SOL?

PD: Hmm… (*pause*)…ok I'm going to have to think about that one a minute…(*pause*). Ok, well if you as a teacher don't understand the content you can't teach it. Uh, instructionally I really didn't have a way to teach that specific SOL and I felt like, um, after the PD I could. Going back to that first question and thinking about this question, I really didn't understand it at all, but rated myself higher than I should have in the beginning.

And so, you know the structure gave me concrete steps to follow to be able to address the science content and give it to the kids. I just needed a way to deliver the content to the kids and with this model; it works so much better than what I was doing before. I actually understand how it should be taught and in what way it should be taught. It just worked so much better for me.

This is a really good model, getting away from drilling and workbooks. I really like the model. It really did take me a while to get my thinking on this, but I think that's good. I think this is a model that I really will use to get my kids involved in their learning. The codes were a little confusing to me at first, but then they helped me make sure that I got all those phases in. My principal has asked me to start a STEM lab and instruct the other teachers at my school on STEM lessons. I can now plan to introduce them to T/E DBL and work on sharing this strategy with other teachers. Hopefully, we can have a lot more teachers using this with our students.

R: Ok, thanks. Ok, last question…why did you chose to rate yourself at (6) for your understanding of the science concept in this SOL that students are expected to demonstrate?

PD: Well, I mean before basically human impact was handled by just reading it in a book and um, you know they just don't learn that way anymore. So this hands-on way lets them think it through, to use critical thinking skills, and uh, my instruction was just lacking in that. I didn't have it before. I just tried to talk about it a little and just left it like that and thought that I had covered it unfortunately.

I feel that this way I can cover the science and they can understand it and apply it to something in real life. They were able to actually show me that they understood the science concept, apply it, and talk about it. I liked opening with a design so the kids know right up front what is expected of them and it builds the science into the whole thing.

R: Thank you for participating in this interview.