Comparing the Effectiveness of Three Instructional Approaches in a Problem-Centered, Multimedia-Based Learning Environment

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Dedication

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Abstract

Throughout the history of the American public education system, many people have predicted that technology would significantly improve the way students learn and the way teachers provide instruction. Unfortunately, each technological innovation has failed on its promise to dramatically improve education. This has led some researchers to suggest that more research is needed to examine the influence that teacher's pedagogy has on technology integration.

This study examines three different instructional approaches used within a multimedia-based learning environment and the impact they have on student knowledge. A total of 225 students of varied academic achievement levels and three middle school geography teachers participated in the study. An online multimedia-based learning environment, GeoThentic, required students to use data and information provided in the learning environment to identify the best location in which to build a hospital in San Francisco. Each teacher used a different instructional approach for each of the three classes he or she taught. These instructional approaches were defined by and based on the literature on directed instruction, structured problem solving, and minimally guided instruction.

A written response exam and selected response exam measured the ability of a group of students to process information and analyze data provided in the GeoThentic environment. When comparing the results of these two different tests, the analyses found that students receiving minimally guided instruction performed significantly different than those students receiving directed instruction or structured problem solving

instruction. Taken together, these results suggest that minimally guided instructional approaches are less effective than directed or structured problem solving instructional approaches for this particular type of learning environment. This study also suggests that teachers must provide a certain amount of guidance to students, however, more research is needed to identify the appropriate amount of guidance needed and when less direction can be provided to students.

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Chapter 1

Introduction

“The computer is going to be a catalyst of very deep and radical change in the educational system” (Papert,1984).

A classroom projector illuminates the faces of the twenty-seven students sitting in Mr. Johnson’s eighth-grade geography classroom. Mr. Johnson focuses on the projector screen and announces to the class, “Today we are going to learn about earthquakes and their importance to geography. Please be sure you take notes on what is written on the PowerPoint presentation.” A student bursts out with a question: “Mr. Johnson, are we going to be graded on the notes we take?” Mr. Johnson replies, “Yes, I’ll be collecting your notebooks at the end of class. If I see that you have taken good notes, I’ll give you five points for today. Besides, it’s to your advantage to take good notes today, as you will need these notes to study for the test scheduled on Friday.” At the announcement of Friday’s test, the students let out a collective moan of dread.

Scenarios similar to the one described above are being played out in classrooms all across the country. Even with the introduction of technology in today’s classrooms, the ways teachers deliver instruction and the ways students are assessed have remained relatively unchanged since public schools began (Cuban, 1986; Jackson, 1990). Formalized schooling continues to perpetuate a system in which teachers ask students to acquire a series of isolated facts that they are required to recall on a future exam. Nearly 90 years ago, Whitehead (1929) advised that students should not be asked to learn such information or "inert knowledge" in isolation from the real world, because this type of knowledge does not require students to apply what they have learned to a practical setting. Whitehead's recommendation remains relevant today. Bransford, Brown, and Cocking (2000) encourage today's teachers to design instruction that asks students to complete authentic tasks that situate learning within real-world problems. Developing these types of learning experiences for students requires teachers to identify what content should be taught, examine their beliefs about how students learn, and become familiar with strategies for delivering effective instruction.

While some teachers take care to use authentic tasks and encourage students to solve real-world problems, other teachers continue to assess students in ways that are unlike anything they would encounter outside of the classroom (Rule, 2006). Consequently, a growing number of students are simply going through the motions, "doing school," rather than connecting what is learned in the classroom to a real-world context (Pope, 2001). Pope argues that schools have become more concerned with assigning points to students for completing an assignment than ensuring that students are participating in meaningful learning experiences. As school districts and states continue to labor over an appropriate set of learning objectives that all students should achieve, students have become increasingly concerned with the grades that teachers assign. Fried (2005) suggests that such an environment forces students to play the "game of school" in which the goal is for students to earn good grades. However, the grades that students receive have become more of an indication of how well students behave in class or how well they follow a teacher's directions rather than a measure of how well they perform academically. Rather than continuing to play the game, experts agree, schools need to discover ways of delivering instruction that will provide students with meaningful learning experiences. Many teachers hold the misguided belief that to provide students with these rich learning experiences, they need access to the newest technology in their classrooms. What historical analysis has shown, however, is that access to technology alone has done little to improve classroom instruction or student learning (Cuban, 1986).

Throughout the history of the American public education system, many people have predicted that technology would significantly improve the way students learn and the way teachers provide instruction. Unfortunately, each technological innovation has failed on its promise to dramatically improve education. For instance, in 1922 the famous inventor Thomas Edison predicted that the motion picture would replace the need for textbooks in schools and reshape the public education system (cited in Cuban, 1986, p. 9). In the 1940s, during World War II, the United States military used motion pictures extensively to provide a large number of soldiers with training information in an efficient and inexpensive manner (Saettler, 1990), leading some educational researchers to predict that the motion picture could be used in schools to replace traditional classroom instruction. Despite these predictions, Cuban (1986) found that the motion picture had a limited impact on schools. Teachers' use of motion pictures for instruction was infrequent, and student learning had not improved due to its use.

The motion picture is not the only technology that has failed on its promise to change education. By the late 1980s, the use of the microcomputer was another technological innovation expected to radically change education (Papert, 1984). Today, some 30 years after computers were introduced within schools, computers still have not changed education to the extent predicted. Today, the Internet is the latest technology predicted to improve public education (Department of Education, 2010). Although the Internet has allowed us to be far more connected to one another, it is uncertain that learning will be improved by having access to the Internet. Thus far, each technology has been unsuccessful on its promise to dramatically improve the way students learn or change the way teachers deliver instruction.

Current Approaches in Teaching with Technology

It is unclear why schools have remained relatively unchanged by technology when it has improved so many other facets of our society. To explain this phenomenon, some researchers have compared the adoption of technology in schools with the diffusion of an innovation in society. For instance, the diffusion of innovation theory (Rogers, 1995) is often used to describe a process by which an innovation is adopted by individuals. Figure 1 shows the curve of innovation, which illustrates how quickly an innovation is generally adopted by different segments of a population. The curve of innovation is often used to illustrate technology diffusion in schools.

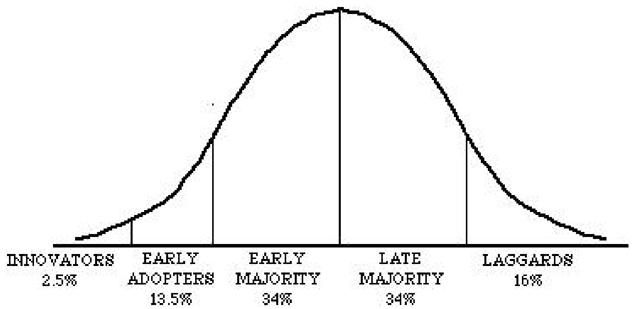

Figure 1. Curve of innovation (Rogers, 1995).

Rogers argues that individuals along the curve of innovation progress through a five-stage decision-making process when they encounter an innovation. First, the individual becomes aware of an innovation (knowledge). Next, the individual develops a positive or negative attitude toward the innovation (persuasion). Then the individual decides to adopt or reject the innovation (decision). If the innovation is adopted, the individual next employs the innovation (implementation). Finally, the individual evaluates the use of an innovation (confirmation). Whereas the general stages regarding the adoption of technology use in schools have been studied like other innovations in society, other researchers argue that these broad classifications do not identify the complex relationship between the actual factors that affect the use of technology in schools. Consequently, research on technology use in schools has tried to identify the factors that are unique to schools.

To examine technology use in schools beyond these general terms requires us to examine all the related issues that exist within our educational system. For instance, Zhao and Frank's (2003) examination of 19 different schools districts describes schools as an ecosystem whose species are invaded by innovation. In this ecosystem, teachers and technologies are species that are influenced by aspects of the environment such as national policies, state standards, and local school district decisions. Davis (2008) extends this ecosystem metaphor to the entire global community. In this global ecosystem, teachers are positioned as leaders influencing technology use in a renewed educational system.

A larger body of research has examined the individual barriers that schools face when trying to integrate technology. Much of this research on the use of technology in schools has centered on the individual teacher's attitude or perceptions of technology. For instance, teachers who are excited by the arrival of technology may see a relative advantage in using technology as a way to deliver their instruction more efficiently and effectively (Hughes, 2005). It has been found, however, that many teachers abandon the use of technology shortly after it has been introduced or revert to using technology in a way that will support their traditional approach to teaching (Cuban, 2001). Ertmer (2006) finds that many teachers' excitement about using technology fades when a particular technology challenges their current pedagogy. This has led some researchers to suggest that more research is needed to examine the influence that teacher's pedagogy has on technology integration (Doering, 1999; Ertmer & Ottenbreit-Leftwich, 2010; Hew & Brush, 2007).

Learning Theories and Applied Pedagogies

The ways in which a teacher delivers instruction with technology can usually be attributed to one of two major underlying assumptions about the way students learn. These assumptions are rooted in either objectivist or constructivist learning theory. Objectivists believe that “leaning happens when knowledge is transmitted to people and they store it in their minds,” whereas constructivists believe that “learning occurs when one constructs both mechanisms for learning and one’s own unique version of the knowledge, colored by background, experiences, and aptitudes” (Roblyer & Doering, 2009, p. 35). These two views lead to different ways of using technology to promote learning. Subscribing to an objectivist view has led to directed approaches to using technology, whereas approaches using the constructivist view have led to minimally guided uses of technology that promote inquiry.

Objectivist thinkers, such as behaviorists, argue that students can acquire basic skills and demonstrate appropriate behaviors by providing them with prompt feedback and reinforcement during learning tasks (Skinner, 1968). Applying this learning theory to instruction has promoted using technology as an instructional tutor. For example, software programs have been developed to repeatedly prompt students with basic math problems and reward them for each problem answered correctly. Cognitive behaviorists have expanded on these ideas to develop a systemic approach to structuring instruction for different levels of learning (Gagné, 1985). Applying this theory to technology may include using simulation software to direct students step by step in the knowledge needed to perform a particular task. By performing each step of a simulation, this theory holds, students should know how to accomplish these same steps again when they are prompted to do so later. Using technology in ways that align with an objectivist learning theory include other directed approaches to instruction.

Constructivist theories, in contrast, argue that students learn through experiences, typically those that represent the complex real world in which students live (Dewey, 1938). Proponents of these theories hold that providing students with appropriate scaffolds in a minimally guided learning environment allows them to develop knowledge as they discover and confront new information (Vygotsky, 1978). An inquiry-based learning environment might, for instance, ask students to imagine themselves as the mayor of a town in a river valley that traditionally floods each spring and provide the city council with a recommendation on how the town might reduce the damage caused by future floods. By providing periodic scaffolds like video clips, audio clips, and text-based guides, teachers could provide information about what causes floods and information about the surrounding geographic area that will allow students to develop an informed solution to this problem.

Each approach, objectivist and constructivist, has a considerably different perspective about the way students learn, instruction should be delivered, learning can be assessed, and technology can be used to assist in these processes. While objectivist approaches suggest that technology can be used to help learners grasp skills more efficiently, constructivist approaches suggest that technology can be used to help learners improve their problem-solving skills and transfer what they know into a new context.

Rationale for the Study

When using technology, classroom teachers employ a variety of approaches in their instruction that are often based on an underlying assumption about the way students learn. Although researchers have discussed the differences between these approaches at length, there should be more attention given on how to design quality and effective instruction. The extent and expense of incorporating technology makes it particularly important to determine what instructional methods are most effective. The purpose of this study is to compare the effectiveness of three different instructional methods used within a middle school geography classroom, each centered on a problem that students are asked to solve.

Statement of the Research Questions

This study examines three different instructional approaches used within a multimedia-based learning environment and the impact they have on student knowledge. This study will answer the following questions:

1. To what extent is student performance on a selected-response test measuring declarative knowledge affected by each of three instructional approaches: directed, structured problem solving, and minimally guided?
2. To what extent is student performance on a written-response test measuring declarative knowledge affected by each of three instructional approaches: directed, structured problem solving, and minimally guided?
3. Why do different instructional approaches influence student declarative knowledge?

Chapter 2

Review of the Literature

"Questions about the role of media should focus on the effects of learners' cognitions *with* technology as opposed to the effects *of* technology" (Jonassen et al., 1994, p. 35).

This study examines the effectiveness of three different instructional approaches on student learning. This chapter reviews the literature related to learning theory, instructional strategies, and multimedia-based learning environments. The first section examines research on human cognition from a cognitive psychology perspective. The second section examines research on three types of instructional strategies that promote learning. The third section provides a review of research on multimedia learning environments that integrate elements of those learning theories and instructional strategies.

Theoretical Perspectives on Human Cognition

Human learning can be viewed from two very different theoretical perspectives, each perspective guided by its own philosophy and addressing learning from a different point of view. The first perspective includes a group of theories known as behaviorism, which describe learning as a change in behavior based on experience (Ormrod, 2004). Behaviorists suggest that because the internal process of the mind cannot be seen, learning can only be measured by examining observable human responses to a situation. For instance, students can demonstrate that they have learned how to get to school if they are observed taking an appropriate route from their home to their school. The second perspective includes a group of theories known as cognitivism, which describe learning not as behavior but as a change in mental representations based on experience (Ormrod, 2004). Cognitivists suggest that the mental events or associations in the mind represent learning. For instance, from a cognitivist perspective, learning is evident when the student venturing home develops multiple routes to take from home to school and evaluates the best path to take based on distance and traffic patterns. Both the behaviorist and cognitive perspectives provide evidence that can help us better understand learning. These perspectives establish two very different definitions of what learning is, however, and therefore it is important that the literature reviewed adheres to just one of these perspectives. In this study, learning will be described from the cognitive perspective and contends that learning is a change in mental representations. The rest of this section will examine the literature on three major types of cognitive theories: information processing theory, parallel distributed processing theory, and situated cognition theory.

Information processing theory. Information processing theory (IPT) describes how people receive information, how this information is processed, and how individuals retrieve this information when they need to use it (Miller, 1956). Information processing theory compares human learning to the way a computer works. Just as computers input, store, and retrieve information, humans receive information, store this information in memory, and retrieve this information for later use.

This theory, often described as the store model, views learning as beginning when information is received through the sensory register. When the sensory register receives stimuli, that information is moved into short-term memory, where it will be processed or ignored. The amount of information that can be processed in short-term memory is relatively small because of its limited capacity. Miller (1956) suggests that only seven (plus or minus two) items of information can be stored in short-term memory at one time, and that this number is reduced to four items when the learner actually begins to process the information stored in short-term memory. If information in short-term memory is not discarded, researchers have found, it can begin to decay in less than 30 seconds (Atkinson & Shiffin, 1971). In order to store information permanently in memory, information must move from short-term memory into long-term memory, where it can be retrieved at a later time. Therefore, according to this theory, human knowledge can be represented as the accumulation of information stored in a person's long-term memory.

Although information processing theory depicts learning as a relatively straightforward, unambiguous process, it offers a rather incomplete model for explaining the complexity involved with human cognition. For instance, this theory does not explain how new information relates to previously stored information, nor does it address the ways in which information is arranged within long-term memory. A more complete description would include how the information stored in long-term memory is connected to other information and how it is recalled when needed.

Parallel distributed processing theory. Parallel processing theory builds upon information processing theory to provide a more complete explanation of human cognition. This theory, also known as connectionism, argues that knowledge is more than a series of compartmentalized pieces of information (Feldman & Ballard, 1982; McClelland, 1981; Rumelhart, Hinton, & McClelland, 1986). When information is processed, according to this school of thought, it is organized into knowledge structures that connect those bits of information and stored in long-term memory. As explained by Dabbagh (2005), "Information processing is understood as a process of activating these patterns, in parallel, to accommodate new information by strengthening the most relevant pattern in the knowledge structure based on the goals of the learner at the time of learning" (p. 27). According to information processing theory, the capacity of working memory is limited and unable to process large bodies of information, but parallel distributed processing argues that these large bodies of information can be moved from working memory to long-term memory when the relevant information is sequenced and connected appropriately.

Consider a learner who is trying to understand the causes and effects of earthquakes who watches a news report about an earthquake that originated along the San Andreas Fault near San Francisco, California. During the video, the learner observes the ground shaking violently, which causes a tremendous amount of property damage. According to this theory, the learner processes information from this video and stores it in long-term memory as an interrelated schema of information. The next time the learner is confronted with information about an earthquake, the network of information connecting ground shaking, property damage, and faults along the earth's surface is activated in parallel and recalled from long-term memory.

Without describing his theory as parallel distributed processing, Piaget (1952) also suggests that information can be organized into cognitive structures or schemes. As individuals encounter information within their environment, he holds, they continually construct and reexamine their existing schemes of knowledge. Individuals experience cognitive dissonance when they are presented with information that challenges their existing cognitive schemes. Piaget describes the process by which an individual handles these challenges as either assimilation or accommodation. When individuals interact with something in their environment and it is consistent with an existing scheme, they will assimilate or incorporate this information. When individuals interact with something in their environment that is inconsistent with an existing scheme, however, they may modify or accommodate this information.

To address how information is stored in long-term memory, connectionism suggests that an individual's knowledge is represented through a series of complex schematic relationships mapped within long-term memory. Because individuals maintain their own unique series of information relationships, information will not be processed or stored in a consistent manner among all individuals. According to Novak (1990), these schematic relationships can be represented by concept maps. Concept mapping is a process by which individuals document their understanding by constructing a map that links pieces of information to each other. When a teacher identifies the structures of information constructed by an individual, that teacher can design instruction to reinforce these existing schemes or provide examples that develop new connections.

Situated cognition theory. The above theories have described learning as a cognitive process that takes place within the individual. Nonetheless, according to situated cognition theory, the influence of the environment and the social interactions within our environment should not be ignored. Knowledge is bound to the social, cultural, and physical context in which it happens (Brown, Collins, & Duguid, 1989). Situated cognition suggests that knowing and doing are married to each other, and therefore leaning cannot be divorced from the context in which it exists.

Vygotsky (1978) also describes learning as a social process that is influenced by interacting with others. When individuals encounter information in an area that is beyond their own cognitive development, a more experienced person can provide an appropriate amount of guidance to extend their knowledge beyond their "zone of proximal development." Consequently, cognitive growth occurs when a more experienced individual, like a teacher, helps an individual to carry out a more challenging task.

Instructional Approaches

Underlying the instructional approach selected by a teacher are implied assumptions about the way students learn. Sometimes instruction is designed to align with a particular learning theory (Conole, Dyke, Oliver, & Seale, 2004), and at other times, teachers use instructional approaches that are mismatched with a particular learning theory (Hannafin, Hannafin, Land, & Oliver, 1997). For example, teachers might want students to think critically to solve real-world problems but instead employ a conflicting instructional approach that promotes the memorization of discrete facts on a selected response test. That said, it would be inappropriate to argue that there is just one way for all instruction to be delivered at all times. No one instructional approach is inherently better than another; instead particular instructional approaches are better aligned with particular learning goals. Each instructional approach has value in within a teacher's instructional repertoire.

Table 1 provides an overview of a particular learning theory and its implications for instruction (Dabbagh, 2005) that illustrates how learning theory and instruction inform each other. Each instructional approach reflects a fundamental difference in learning theory or philosophy.

Table 1

Learning Theories and Their Implications for Instruction

Views on Cognition and Knowledge	**Information Processing**	**Parallel Distribution Processing**	**Situated Cognition**
How is learning defined as a process?	Encoding information into long-term memory and retrieving information in response to external cues	Activating and reconstructing relevant schema for understanding new knowledge based on perception of context	Constructing meaning from activity and experience
What is the role of the instructor?	Supporting learners' use of learning strategies	Identifying misconceptions in learners' schema, providing opportunities for	Facilitating, guiding, coaching, mentoring; creating scaffolds for learning and a

		restructuring	resource-rich learning environment
What are the implications for instruction?	Providing organized instruction; arranging extensive and variable practice; enhancing learner's control of information processing	Identifying existing mental models; tracking development of learner's mental models; providing conceptual models that make instructional materials meaningful	Creating open-ended learning environments that support multiple perspectives, discovery, inquiry-based, and experimental learning (e.g., social interactions, role-playing, debates, and authentic contexts)
Instructional Approach	Directed Instruction	Structured Problem Solving	Minimally Guided Instruction

Note. Adapted from Dabbagh, 2005.

By mapping learning theories to an appropriate instructional approach, the features of each instructional approach can be described from a corresponding philosophical perspective. This section examines the three instructional approaches selected for this study: directed instruction, structured problem solving, and minimally guided instruction. Each of these approaches embodies a set of instructional models from the literature that are representative of common instructional approaches taken by classroom teachers. Few teachers will adhere explicitly to the steps of the each of the instructional approaches described below, but many will follow the general principles of these particular instructional approaches.

Directed instruction. This study defines directed instruction as a collection of pedagogical approaches in which a teacher methodically prepares instruction that is explicit and sequential. In this approach, the teacher has complete control over what information is provided to students in the classroom, and thus students must rely heavily on the teacher to give them the information needed to learn a particular concept. As Schwartz and Bransford (1998) have found, particular forms of direct instruction, such as lecturing or explaining, are extremely helpful when students do not have the prior knowledge they need. Despite this evidence, many teachers regard direct instruction as ineffective and elect instead to use a more student-centered instructional approach (Magliaro, Locklee, & Burton, 2008). Although directed instruction is generally considered teacher-centered, Magliaro et al. point out that its elements are nonetheless centered on student learning. Directed instruction breaks down complex problems into smaller manageable tasks in which a teacher models a principle, reinforces the principle, and provides feedback. When using this approach, a teacher will typically provide several examples that allow students to check their understanding. From these examples, students can practice a concept to ensure that they have processed the information and stored it in long-term memory. Finally, a teacher asks students to demonstrate that they have mastered the information through performance on an assessment.

Researchers have offered several models for designing directed instruction. One of the earliest of these models is Gagné's (1965) nine events of instruction, which offers a step-by-step approach for different learning domains. Gagné argues that the cognitive, affective, and psychomotor domains of learning require different types of instruction. To influence learning within the cognitive domain, the concern of this study, he recommends that instruction should be organized as a series of steps followed explicitly by a teacher. Figure 2 aligns each of the nine events of instruction with cognitive domain processes.

Event	Instructional Events	Cognitive Processes
1	gaining attention	reception
2	informing learners of the objective	expectancy
3	stimulating recall of prior learning	retrieval
4	presenting the stimulus	selective perception
5	providing learning guidance	semantic encoding
6	eliciting performance	responding
7	providing feedback	reinforcement
8	assessing performance	retrieval
9	enhancing retention and transfer	generalization

Figure 2. Gagné's nine instructional events (Gagné, 1965).

Whereas Gagné developed a theory for delivering instruction, other research on directed instructional approaches has examined ways of making instruction more effective and efficient so as to allow student to learn more quickly. To help students master a body of knowledge efficiently, according to Rosenshine (1987), instruction must follow specific procedures. A teacher should first demonstrate and explain a concept, then direct students to practice the concept, provide feedback to the student, and, finally, summarize the entire process for the students. Kinder and Carnine (1991) expand the definition of directed instruction to include a formalized instructional system of carefully ordered steps. To ensure that instruction is delivered in a clear and unambiguous manner to all students, Kinder and Carmine developed scripted lessons for teachers to follow as they delivered instruction. A teacher starts by using a concrete example to demonstrate a skill or rule to students. The teacher, then, provides a new example and asks students to apply the skill or rule independently.

For many teaching situations, directed instructional approaches offer a very efficient way of providing students with the information they need to achieve a particular learning objective, but this approach is not always the most effective way to help students learn. In terms of time, it is often far more efficient for a teacher to show students the steps they need to take rather than having students discover those steps on their own. Rather than having students evaluate what they already know and what they need to know, directed instructional approaches rely heavily on a teacher to convey the most appropriate information to students. In these approaches, teachers define specific learning objectives in their lessons and design instruction to intentionally promote the mastery of those objectives. Teachers are responsible for organizing information into patterns for students, rather than asking students to develop those strategies themselves.

Thus, although directed instruction is often criticized for not making learning more meaningful to students, it is a very efficient way of transmitting information to students. Learning theories that support the idea of students making meaning of the world around them tend to view directed instructional approaches as traditional and outdated, yet directed instruction continues to dominate classroom instruction, and many students continue to learn the objectives that teachers have defined.

Structured problem solving instruction. Structured problem solving is the term used in this study to describe instruction provided through several problem-centered instructional models, including anchor-based instruction (CTGV, 1990), inquiry learning (Hmelo-Silver, Duncan, & Chinn, 2007), and problem-based learning (Ertmer, Newby, & MacDougall, 1996). In these approaches, students are presented with a problem and a teacher provides a considerable amount of direction to help students solve that problem. Jonassen (1997) identifies two types of problems used in structured problem solving: those that are well-structured and "require the application of a finite number of concepts, rules, and principles being studied to a constrained problem situation" (p. 68), and those that are ill-structured and in which "one or more aspects of the problem situation is not well specified, the problem descriptions are not clear or well defined, or the information needed to solve them is not contained in the problem statement" (p. 69). Whether well-structured or ill-structured, the problems provided within structured problem solving instruction are intended to be complex enough to require students to investigate multiple knowledge structures stored in long-term memory to solve the problem. In this approach, it is the responsibility of the teacher to help students recognize the concepts embedded in the problem. When a teacher introduces information to a student, he or she examines the existing mental schema in long-term memory and decides how to accommodated or assimilated this information.

With directed instruction approaches, as noted above, the responsibility of analyzing and organizing information falls on the teacher. In structured problem solving, however, the responsibility for these tasks is shifted to the student (Means, 1994). A teacher asks students to define the problem, to evaluate their prior knowledge, to clarify any misunderstandings, and to generate solutions for the problem. Students are provided with all the resources and information they need to solve the problem, but rather than having a teacher lead students through this information and telling them how to solve the problem, students are responsible for directing their own learning. Students utilize learner control (Lawless & Brown, 1997), managing and sequencing the information they need to solve the problem. Learning happens as students explore and interact with information, evaluating their current knowledge and constructing new knowledge. Therefore, the specific learning outcomes and objectives of structured problem solving are not as clearly defined as in directed instructional approaches.

The common belief that this instructional approach forces students to learn completely on their own is incorrect. Actually, as researchers have pointed out, this approach requires a considerable amount of guidance by a teacher to help students solve the problem (Kirshner, Sweller, & Clark, 2007). The type of guidance in this approach, however, is different from the explicit steps delivered with directed instruction. According to Kester, Kirschner, van Merrienboer, and Baumer (2001), for a student to solve a problem, a teacher must supply instruction that provides both abstract "supportive" information and prerequisite information. The first of these, supportive information, is information provided to students before they are asked to attempt a complex problem. This support is similar to an advanced organizer that a teacher might provide to students as a trigger to activate a student's existing cognitive structure (Ausubel, 1960). An advanced organizer allows a teacher to provide students with information that will help them determine what they need to know before they begin trying to solve the problem. But instruction should also be provided on an "as needed" basis when students are confused, frustrated, or need help processing the information. This "as needed" instruction provides students with prerequisite information at the time they need it to help them learn specific facts or concepts.

Guided instruction, in other words, provides the scaffolding students need to solve the problem without explicitly giving students the final answer. Jackson, Krajcik, and Soloway (1998) describe supportive scaffolding as a way of helping students know what to do next. Such scaffolding is also described by researchers as guiding, coaching, or modeling. In structured problem solving, these scaffolds are removed only when learners have enough knowledge to move on and direct their own learning. Thus support gradually fades in relation to a learner's level of ability to perform a particular skill or concept (Kalyuga, Ayres, Chandler, & Sweller, 2003; Merrill, 2002).

Critics of structured problem solving argue, this instructional approach will leave students confused if teachers to do not provide student with proper direction. Kirshner, Sweller, and Clark (2007) claim that structured problem solving is not efficient because it presents students with excessive amounts of information without directing them as to how to use this information, arguing that students should not have to wade through obscure information unsure as to whether they are learning something that will prove valuable for solving the problem. Because most students have participated in classrooms that use directed instructional approaches, such critics hold, many are ill-prepared to use the strategies needed to direct their own learning in classrooms that use different instructional approaches.

Minimally guided instruction. The final instructional approach examined in this study is minimally guided instruction, which includes approaches such as discovery learning (Bruner, 1961), self-directed learning (Knowles, 1975), and open-ended learning (Land & Hannafin, 1996). In each of these approaches, a teacher provides little to no instruction to students as they attempt to solve a problem. Student instruction is self-regulated, and student progress is not monitored by a teacher. Therefore, students are responsible for determining which concepts are important to a problem. This approach assumes that, given appropriate resources, students will learn on their own while interacting with a learning environment.

Minimally guided instruction presumes that students have access to an information-rich learning environment that contains all the resources that they need to solve a problem. Because teacher instruction is mostly absent in this approach, much of the research on minimally guided learning environments has focused on the design of the learning environment. It is the support provided within the learning environment that promotes student learning.

In the real world, students often are not provided with guidance or instruction on how to solve a problem. To prepare students for this world, some researchers argue that teachers should use minimally guided instruction more often in schools. Using minimally guided instruction, teachers create an environment in which students are asked to take ownership of their own learning and develop particular strategies for solving a problem. These researchers suggest that learning in a minimally guided environment provides students with a more meaningful learning experience that leads to long-term retention and better transfer than the methods described above. As minimally guided instruction is applied, according to generative theory (Mayer, Steinhoff, Bower, & Mars, 1995), students will choose applicable information from what is available to them, organize the information into an appropriate mental representation, and integrate this representation with their existing mental schemes.

Some empirical research studies have suggested that compared to directed instructional approaches, minimally guided instruction is ineffective (Klahr & Nigam, 2004; Kirshner, Sweller, & Clark, 2007), resulting in student learning that is incidental and unpredictable. According to Mayer (2004), students are more likely to be confused and frustrated when a teacher does not provide help or encouragement. Other researchers argue that when provided with minimally guided instruction, students are often unsure of how to navigate their way through the learning environment, uncertain as to which information is relevant to help construct knowledge (de Jong & van Joolingen, 1998). Without proper assistance, such researchers claim, students continue to use inappropriate strategies that do not help provide a solution to the problem. As a result, students will often give up or pursue something completely unrelated within the learning environment (Clark & Feldon, 2005).

Multimedia-Based Learning Environments

A learning environment can be either a physical classroom space or a virtual multimedia-based arena that includes audio, video, and text. These environments are where learning theory, instructional approaches, and specific content items intersect. Early multimedia-based learning environments were influenced largely by behaviorist views of learning and thus centered on drill and practice procedures in which students built proficiency by rehearsing skills repeatedly. In this stimulus-response manner, students practiced their understanding of facts by repeating material and getting feedback along the way. Rather than examining environments that take a behaviorist approach, however, this study examines multimedia-based learning environments that are influenced by cognitive learning theory and thus designed to "supply the framework around a task in which learners develop and test their own understanding" (Deubel, 2003, p. 72).

Few current multimedia learning environments explicitly adhere to a cognitive learning theory perspective. In one exception, Doering (2004) developed a simple multimedia-based learning environment where learners were asked to perform basic tasks using a geographic information system. This study attempted to identify effective instructional approaches that teachers could use within the geography classroom. Data from this study led to the design and development of the Multi-Scaffolding Environment: Geographic Information Systems (MSE: GIS) (Doering & Veletsianos, 2007). The MSE: GIS was modeled on the Adventures of Jasper Woodbury Series (CTGV, 1992). Within the Adventures of Jasper Woodbury, students were asked to solve math problems that were embedded in real-world scenarios. Each scenario was presented through laser disc videos. These videos provided an anchor for teachers to deliver instruction. As included in the Adventures of Jasper Woodbury, the MSE: GIS also provided learners with an opportunity to solve an authentic complex problem situated in a multimedia-based learning environment. Similar to the anchored videos provided in the Jasper Woodbury series, the MSE: GIS presented students with problems through "situated" videos. These situated videos introduced students to geography concepts from the scenario and prompted to perform specific tasks that were embedded within the problem. Extending the idea to the supports provided within the Jasper Woodbury Series, the MSE: GIS provided four different types of scaffolds to students. The scaffolds explicitly provided students with assistance they needed to solve the problem. Students could elect to use whichever scaffolds they believed were needed to solve the problem. The data showed a positive relationship between the use of the scaffolds and the students' ability to solve the problem.

Using a design-based research method, Doering, Scharber, Miller, and Veletsianos (2009) made changes to refine the MSE: GIS and developed a revised multimedia environment called GeoThentic. GeoThentic preserved the elements of problem-based learning but also incorporated the technological pedagogical content knowledge (TPACK) framework to assess how teacher knowledge affected instruction and student learning (Mishra & Koehler, 2006). Multiple tools were embedded within the software as scaffolds to provide guidance to students as needed. Google Earth was also used as a stand-alone application in conjunction with the GeoThentic learning environment. Students used Google Earth to load and display data on a virtual globe that used satellite imagery. Access to Google Earth allowed students to manipulate different data layers to solve the problems with which they were presented.

The San Francisco module of the GeoThentic environment used for this study required students to use data and information provided in the learning environment to identify the best location in which to build a hospital in San Francisco. Students used Google Earth as a geospatial learning tool and the information provided in the learning environment to solve the problem. Figure 3 provides an overview of the elements within the San Francisco module that align with the characteristics of a well-defined problem as described by Jonassen (1997).

Characteristics of Well-Defined Problems	Well-Defined Characteristics in GeoThentic
All elements of the problem are presented to students	Students are provided with all the necessary Google Earth data layers needed to solve the problem.
A possible solution is specified in the problem	The mission video tells student to identify a location with low seismic activity, moderate population density, and low ground shaking
A limited number of rules and principles are organized with constrained parameters	An appropriate location would have low seismic activity, moderate population density, and low ground

	shaking

Figure 3. Elements of the San Francisco module that align with a well-defined problem.

Summary of Literature Review

This chapter has examined the research related to learning theory, instructional strategies, and multimedia-based learning environments. As discussed in later chapters, each of these areas has important implications for the design of this study and the evaluation of different instructional approaches used with the GeoThentic learning environment.

The three major types of cognitive theories—information processing theory, parallel distributed processing theory, and situated cognition theory—provide the most complete description of how a person receives information and moves this information from short-term memory into long-term memory, which represents that person's knowledge. Despite the body of research examining the differences among instructional approaches, there is little evidence as to which of these instructional approaches is most effective in multimedia-based learning environments. Consequently, there is a clear need for research to examine how different instructional strategies contribute to learning in multimedia-based learning environments.

Chapter 3

Methods

This chapter presents the methods selected to answer the research questions addressed by this study. The following sections include a description of the participants, materials, instructional approaches, research design, setting, procedures, data scoring, and analyses.

Participants

The participants of this study were selected from the membership list of the Minnesota Alliance for Geography Education, an organization of over 200 geography teachers in the state of Minnesota. Using the criterion that potential participants were teaching three separate sections of students enrolled in the same geography course, three teachers were identified and invited to participate in the study, all of whom agreed. A total of 225 students of varied academic achievement levels participated in the study. Of these students, 66% were enrolled in the eighth grade, and the remaining 34% students were enrolled in ninth grade. Each of the three teachers reported that their students had little experience using Google Earth in previous geography courses.

Materials

During the study, teachers taught their geography courses using the GeoThentic online multimedia-based learning environment. Each class used the San Francisco module, which is one of the five modules available on GeoThentic. Figure 4 displays the home page of the San Francisco module in the Select a Module section of the GeoThentic learning environment.

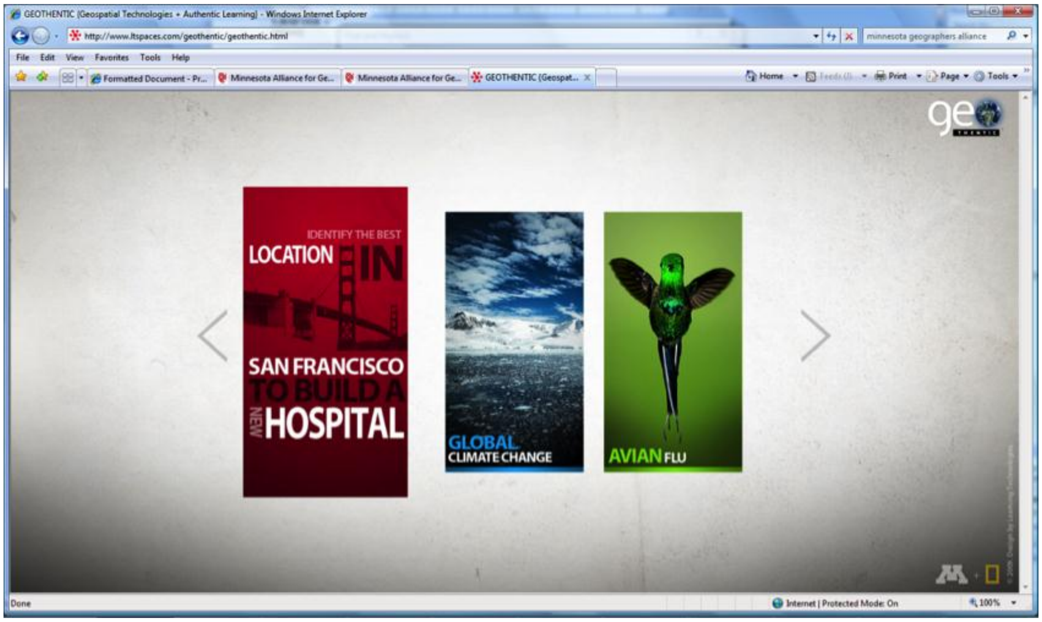

Figure 4. Three of the five modules displayed on the Select a Module page of GeoThentic.

A secondary application, Google Earth, was used as a geospatial technology in conjunction with GeoThentic. Each teacher taught the San Francisco module, using a different instructional approach for each class, including directed instruction, structured problem solving, and minimally guided instruction.

After the students completed the module, each teacher administered two tests to assess student performance. The first test was a short selected response exam used to measure student knowledge of geography concepts. The second test was a written response exam measuring the level of student declarative knowledge. After students completed the two exams, the researcher conducted several focus groups with a small sample of students from each class. At the conclusion of the module, the researcher also conducted semi-structured interviews with each teacher.

An introductory video called "Your Mission," modeled after the Adventures of Jasper Woodbury Series (CTGV, 1992), provided students with the instructions they needed to solve the problem. Similar to the anchored videos provided in the Adventures of Jasper Woodbury, the "Your Mission" video situated students within a problem that needed to be solved (Doering et al., 2009). Figure 5 displays a scene from this video, in which a fictitious news reporter presents students with the problem and asks for their help in providing a solution. The video provides additional context for the problem and identifies specific geographic concepts particular to the area of San Francisco that students should address in their solution, including population density, transportation routes, ground shaking amplification, and seismic activity. The purpose of the module is to have students use geography concepts to provide a strong justification for the best location for building a hospital in the San Francisco area.

Figure 5. Visual of "Your Mission" video in GeoThentic.

The module includes different types of scaffolds that students can use to solve the problem (Doering et al., 2009). These scaffolds serve as the assistance that Vygotsky (1978) argues teachers should provide to learners as they move from their current level of understanding to a higher level of understanding. The scaffolds available in the San Francisco module include screen-capture movies and content-specific resources.

The screen-capture movies are video recordings of a geography expert performing specific tasks using the Google Earth software (see Figure 6). The tasks performed in the movies are the same types of tasks students need to perform to solve the problem. Each video is delivered in the Adobe Flash video format, which allows students to play, pause, rewind, and fast-forward to specific parts of the video that they find unclear or confusing.

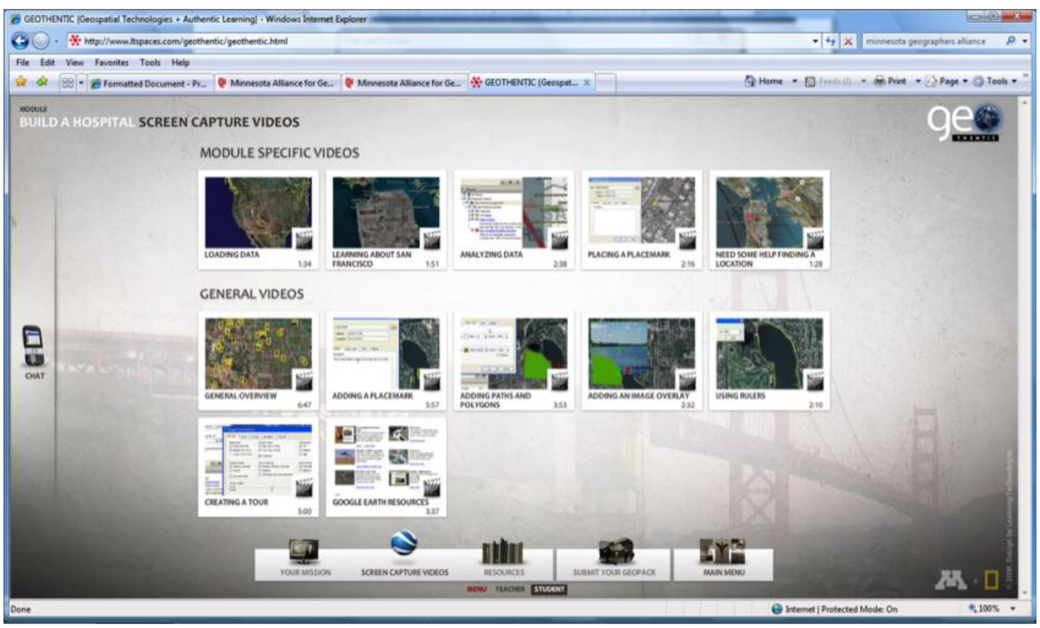

Figure 6. Menu of screen-capture videos in Geothentic.

In addition to the screen-capture videos, the module also includes content-specific resources for students. Figure 7 displays the three different types of resources included in the San Francisco module: hyperlinks, video clips, and data layers.

Figure 7. Module-specific resources available in Geothentic.

Among these resources, the hyperlinks direct students to websites with information on the causes and effects of earthquakes and pertinent information about the San Francisco area. The video clips provide students with visual examples of the effects that earthquakes have on transportation, human population, and land near an earthquake zone. The last element is layers of data about the San Francisco area that students can load into Google Earth and manipulate. These layers include data about population density, ground shaking amplification, and seismic activity in the San Francisco area, all of which are needed to solve the problem. Figure 8 shows a Google Earth image with a layer of population density data laid over the San Francisco area.

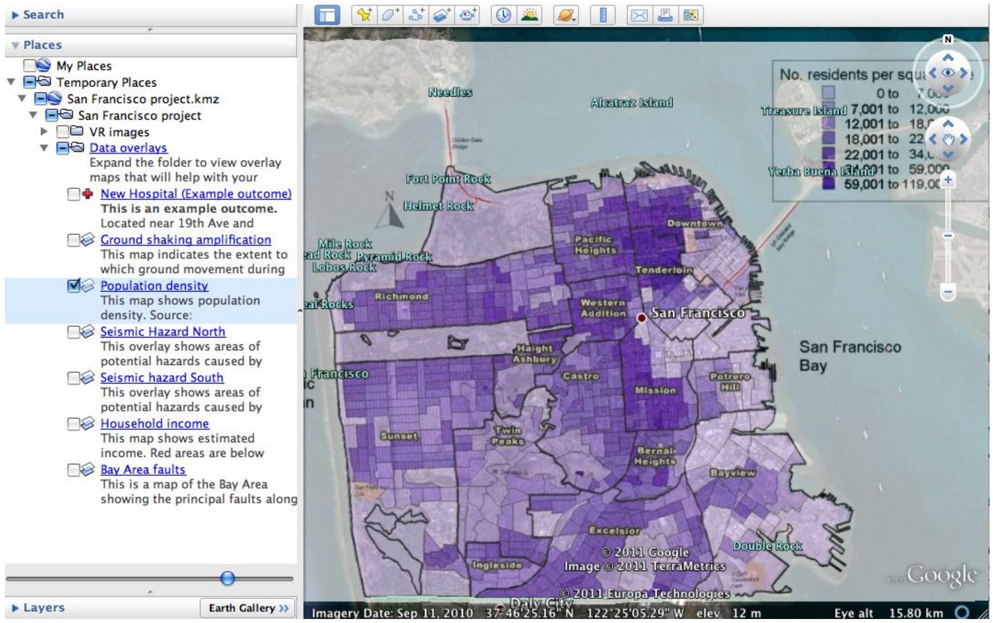

Figure 8. Population density data layer displayed in Google Earth.

Procedures for Each Instructional Approach

As noted, each teacher used a different instructional approach for each of the three classes he or she taught. These instructional approaches were defined by and based on the literature on directed instruction (Rosenshine, 1987; Schwartz & Bransford, 1998), structured problem solving (Ertmer et al., 1996; Hmelo-Silver et al., 2007), and minimally guided instruction (Land & Hannafin, 1996). To provide consistency within each of the instructional approaches used by the teachers, the researcher provided each teacher with a guide for each of the three instructional approaches used: directed instruction (see Appendix A), structured problem solving (see Appendix B), and minimally guided instruction (see Appendix C). Below is a description of the three instructional approaches used in this study.

Directed instruction. The directed instruction approach used in this study started with each teacher playing the “Your Mission” video to students.

The teacher then distributes a worksheet to students that directs students to answer questions about geography concepts included in the module (see Appendix D). Table 2 presents the major themes and concepts included on this worksheet. In accord with information processing theory (Miller, 1956), the questions are sequenced in order and chunked into major themes to build knowledge from basic levels of understanding to more advanced levels of understanding.

Table 2

Major Themes and Concepts from the San Francisco Module Included in the Worksheet

Theme	Concept
Identify the factors that cause earthquakes	a) Earthquakes happen near faults, where plates within the earth suddenly break or shift under stress, sending shock waves rippling. b) Different fault types include divergent, transform, dip-slip, and convergent faults. c) The San Andreas Fault is a transform fault that divides the Pacific and North American plates. d) The San Andreas Fault is located in San Francisco, California.
Identify the impact that earthquakes have on the landscape and environment	a) The origination of an earthquake can be measured from the epicenter. b) A seismograph measures the energy released from an earthquake. c) Earth’s plates are constantly moving, causing the ground to move very short distances over time without being apparent. d) Earthquakes that occur near faults are likely to cause more damage. e) Earthquakes that occur near areas of landfill can cause ground liquefaction.
Identify the impact earthquakes have on humans	a) Seismic activity measures earthquake activity in a particular geographic area. b) Shaking intensity measures the perceived level of shaking in a particular geographic area. c) Violent earthquakes in highly populated areas can cause a lot of damage to property, transportation, and human life.

The teacher used a classroom projector to display the GeoThentic environment to students while they were guided through the worksheet. The teacher explained each concept from the worksheet using examples from the GeoThentic environment and Google Earth software. After each question, the teacher directed students to record their answers on the worksheet. The teacher did not move to the next question until all students had answered the question correctly and had no other follow-up questions. After the students completed the worksheet, the teacher guided them to the content-specific resources and directed them to import the San Francisco data layers into Google Earth. The teacher directed students to then solve the problem presented in the video and to submit the location they selected for their hospital as a Geopack. A Geopack included a student's response to the problem defined in the module. With this instructional approach, a teacher's responsibility is to explicitly connect the themes and concepts related to the problem for students.

Structured problem solving. The structured problem solving instruction approach began with the teacher playing the same "Your Mission" video to students. A different worksheet (see Appendix E) was distributed to students and served as an advanced organizer that the teacher can use to guide student learning (Ausubel, 1960) by organizing the information from the "Your Mission" video into major themes and categories. Following the video, the instructor prompted students with questions related to the information provided on the worksheet. Unlike the directed instruction approach, with structured problem solving, the teacher asked students general questions to assess their understanding. If the teacher concluded that the majority of the students did not understand the major concepts from the problem, he or she provided students with more instruction. When the teacher concluded that the majority of students were familiar with the concepts critical to the problem, the teacher guided students to the content-specific resources and directed them to import the San Francisco data layers into Google Earth and solve the problem presented in the video and to submit the location they identified as a Geopack.

As the students explored the GeoThentic and Google Earth software, the teacher visited with individual students to ensure that students were making connections between the major concepts and themes from the module. If the teacher determined that a student lacked essential understanding or needed additional assistance, the teacher directed the student to specific scaffolds in the GeoThentic environment. If a teacher found that a considerable number of students were struggling with the same concept or task from the module, the teacher stopped the entire class, gathered the students' attention, and clarified the confusion by explicitly providing students with the information needed. Using this instructional approach, the teacher is responsible for helping students connect major themes and concepts from the problem for themselves as well as for helping students process their own understanding.

Minimally guided instruction. In the minimally guided instruction approach, the teacher introduced students to the GeoThentic environment and Google Earth application by telling them what they could find in each of the different areas of the San Francisco module, including the “Your Mission” video, the screen-capture videos, and the content-specific resources. After providing this overview, the teacher guided students to the content-specific resources and directed them to import the San Francisco data layers into Google Earth. The teacher then directed students to solve the problem presented in the video and to submit the selected location of their hospital as a Geopack.

In this approach, the teacher told students that all the information they needed to solve the problem was provided in the module, but they did not give students any direct assistance or instruction as they work. If students had questions, the assistance the teacher provided was to tell students to use the resources available in the module. Students were responsible for navigating the learning environment and finding the relevant information needed to solve the problem. Using this instructional approach, the teacher shifts the responsibility for identifying major themes and concepts from the module to the students.

Measurement of Student Learning

As described earlier, learning can be defined as a change in behavior or a change in the mind. According to Bloom (1956), learning objectives for each level of understanding can be categorized into three domains: cognitive, psychomotor, and affective. For example, within the cognitive domain, lower levels of learning are represented by knowledge—comprehension and application of basic facts and information—whereas higher levels of learning are classified as analysis, synthesis, and evaluation of a problem. Because this study takes the position that learning is a cognitive process, it measures student knowledge in a way consistent with the approaches used in cognitive psychology. Cognitive research studies the presence of declarative knowledge (Anderson, 1982). Declarative knowledge means that a learner can recall and describe particular facts and information. This type of knowledge is different than procedural knowledge, meaning that a learner can apply the facts and information within a particular context. To measure student declarative knowledge, this study employed two tests, a selected response test and a written response test, which are described below.

Selected response test. A selected response test was administered after students had completed the San Francisco module. On this test, students were asked to correctly identify specific geography concepts and facts discussed within the module (see Appendix F). While completing the test, students were not allowed to refer back to the module or the Google Earth application. The researcher scored this test by identifying how many questions the students answered correctly. The reliability and validity of questions were not established for this test because the study was the first time it had been used with the module.

Written response test. After completing the San Francisco module, students provided a written response by using Google Earth to record the latitude and longitude they identified as the best location to build a hospital in the San Francisco area. Students recorded the latitude and longitude of their location and submitted these coordinates to their teacher as a Geopack and provided a written justification for why they had chosen that location (see Figure 9).

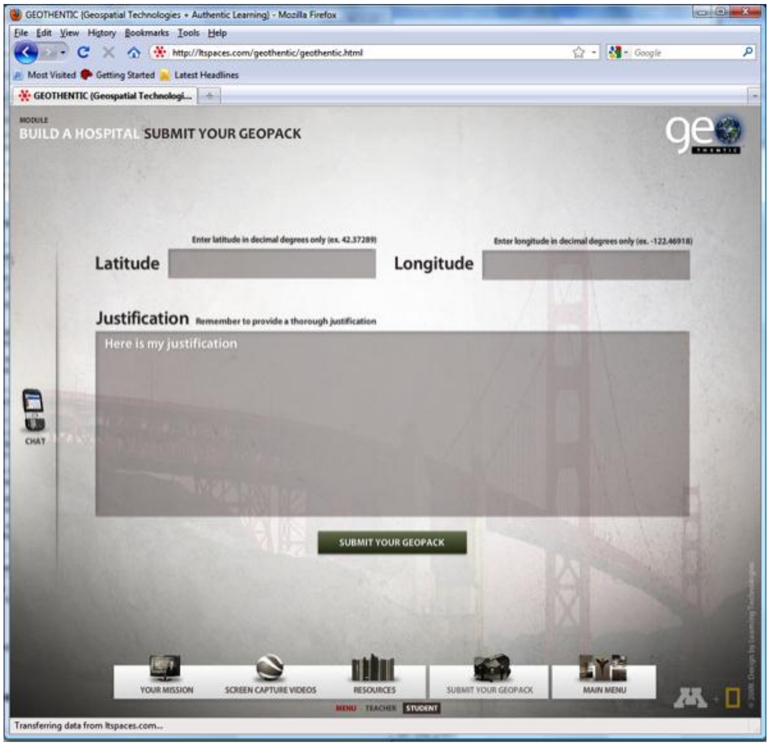

Figure 9. GeoThentic Geopack used as the study's written response test.

Research Design

The design of this study was quasi-experimental. The study was intended to discover which instructional strategy was most successful and why. Table 3 identifies the dependent and independent variables used in the study.

Table 3

Quasi-Experimental Group Assignment

	Student Learning (Dependent Variables)	
Instructional Methods (Independent Variable)	Declarative Knowledge Selected Response Exam	Declarative Knowledge Written Response Exam
Directed Instruction		
Structured Problem Solving		
Minimally Guided Instruction		

The dependent variables included the scores students earned on the selected response test and the Geopack written response test, which both measure student declarative knowledge. The study examined one independent variable with three different levels. Each level was a different instructional approach: directed instruction, structured problem solving instruction, or minimal guided instruction. In addition to the data collected by the exams, data were collected from student focus groups and instructor interviews.

Setting

This study was conducted at three different public middle schools within a large metropolitan area in the Midwest during the spring of 2010. The instruction for all the participating geography classes took place in a computer lab that met the minimum requirements needed to run the GeoThentic environment and the Google Earth software. Each student had access to his or her own computer with personal headphones to listen to audio included on the videos within the GeoThentic environment. Each instructor delivered instruction using a computer connected to a classroom projector. The projector image was clearly visible to all students on a large screen at the front of the room.

Procedures

The length of each class session varied by teacher, but the total amount of time each class was given to complete the module and assessment was between 195 and 225 minutes spread over 3 days. Each teacher was directed to use a different pedagogical approach for each of the three classes taught.

Because the order in which a teacher delivered each type of instruction to his or her three classes might inadvertently influence the mode of instruction provided to a subsequent class, each of the three teachers delivered the types of instruction in a different order, as indicated in Table 4. This procedure minimized ordering effects and the possibility that the order in which teachers delivered instruction would affect student performance. For example, using the directed instruction first may have prepared the teacher to use structured problem solving for the next class, and consequently the measurement scores from students in the structured problem solving group could have been attributed to the order of instruction rather than the instructional approach used.

Table 4

Order of Instructional Approaches for Each Teacher

	Instructional Approach		
Teacher	*Class 1*	*Class 2*	*Class 3*
Teacher #1	Directed Instruction	Structured Problem Solving	Minimal Guidance
Teacher #2	Structured Problem Solving	Minimal Guidance	Directed Instruction
Teacher #3	Minimal Guidance	Directed Instruction	Structured Problem Solving

Of the 225 students participating in the study, 75 were in the directed instruction group, 76 were in the structured problem solving group, and 74 were in the minimally guided instruction group.

Immediately after completing the module, each student completed the selected response test. Students were given no more than 20 minutes to complete this test. After all students had completed their selected response test, the teacher randomly formed groups of two or three students and directed each group to complete and submit one Geopack as their joint written response. Each GeoPack included the location the group agreed would be the best to build a hospital and their justification for selecting that particular location.

Student Focus Groups

This study sought to understand if and why a particular pedagogical approach had the most positive effect on student performance. Students from each of the nine classes were invited to participate in separate short focus groups with the researcher. During each focus group, participants were asked to discuss their experiences as they tried to solve the problem presented in the module. Each group was also asked to discuss how they had used the assistance provided by their teacher and how they had used information from the module to solve the problem.

The student focus group sessions were conducted in a semi-structured manner in which questions were used to prompt students to recall their experiences in the classroom (see Appendix E). Each focus group consisted of six students and lasted between 20 to 30 minutes.

Semi-Structured Teacher Interviews

Each teacher received specific training in the procedures and guidelines used for each instructional approach. The researcher did not account for teacher bias toward a given instructional approach, but was present for all class sessions and recorded limited observations related to the instruction each teacher provided. These observations served as questions to stimulate teachers' recall during a semi-structured interview with each teacher at the end of the study. The semi-structured interview questions were intended to collect data on each teacher's experiences using each instructional approach (see Appendix F).

Data Scoring

The selected response and written response tests were administered after students had completed the module. No pre-tests were administered to students before beginning the module. The tests were intended to measure the amount of declarative knowledge students had gained after completing the module. In this study, declarative knowledge is defined as the acquisition of information and facts. The selected response tests were scored according to the number of questions the student answered correctly.

The written response tests were taken by small groups of two or three students and were scored by how well those students applied the concepts from the module to provide a justification for the hospital location they selected. Based on how students analyzed the provided data, students could select a variety of appropriate locations, and thus no specific location was identified as being the correct location to build a hospital. Rather, students' responses were measured by whether they were able to identify geography concepts from the module and how well they had processed information from the data sets. To measure declarative knowledge, the researcher used four competencies, including how well students (a) gathered and used the appropriate information and resources, (b) assessed and accurately used the information provided, (c) determined if information was incomplete or if more was needed, and (d) interpreted and synthesized the gathered information and resources. Table 5 presents the rubric adapted from Marzano, Pickering, and McTighe (1993) that the researcher used to score student responses.

Table 5

Rubric Used to Score Student Responses on the Written Response Test

Domains	Score	Description
Gathered and used the appropriate information and resources	1	Fails to use the most major or important information resources necessary to solve the problem.
	2	Fails to use some significant information resources necessary to complete the task
	3	Uses the important information resources necessary to complete the problem.
	4	Uses the information resources necessary to complete the problem. Identifies little-known information resources or uses unique information-gathering techniques.
Assessed and used the information provided accurately	1	Makes little or no attempt to determine whether information is credible and relevant to the problem.
	2	Makes some significant errors in determining whether information is credible and relevant to the problem.
	3	Accurately determines whether information is credible and relevant to the problem.
	4	Analyzes information in detail, accurately and insightfully determining whether it is credible and relevant to the problem.
Determined if information was incomplete or if more was needed	1	Makes little or no attempt to assess whether a problem would benefit from additional information.
	2	Does not accurately assess the information needed for the problem or fails to seek out needed information.
	3	Accurately assesses the problem to identify areas requiring additional information for clarification or support and seeks out the needed information.
	4	Insightfully determines the types of information that will benefit the problem and effectively seeks out that information.
Interpreted and synthesized the information and resources gathered	1	Grossly misinterprets the information gathered for the problem or fails to synthesize it.
	2	Makes significant errors in interpreting the information gathered for the problem or synthesizes the information imprecisely or awkwardly.

	3	Accurately interprets information gathered for the problem for a task and concisely synthesizes it.
	4	Interprets the information gathered for the problem in accurate and highly insightful ways. Provides a highly creative and unique synthesis of information.

Note: Adapted from Marzano, Pickering, and McTighe (1993, pp. 84-85).

Inter-rater reliability was established by having two different researchers score the written response tests separately. The scores from each researcher were averaged to create one score to represent each group's written response test score.

Statistical Analyses

The study's statistical analyses began by computing and recording the collected data for each of the independent variables (instructional approaches) and two dependent variables (selected response test and written response test). The selected response test was taken individually by each of the 225 participants in the study, and the written response test was completed by students in small groups of two or three. The individual scores of each student in the group on the selected response test were combined and averaged to create a single score for that measure. Consequently, each group received two scores, one for each of the two tests. Among the 142 groups so scored, 45 received directed instruction, 49 received structured problem solving instruction, and 48 received minimally guided instruction.

These data were first analyzed using multivariate analysis of variance (MANOVA) procedures to determine whether students receiving a particular instructional strategy performed differently from other instructional groups as measured on both tests. As Field (2005) notes, "the overall multivariate test protects against inflated Type I errors rates because if that initial test is nonsignificant then any subsequent tests are ignored" (p. 594). If the main and interaction effects were found to be statistically significant with the MANOVA using an alpha of 0.05, two separate univariate ANOVA were performed to determine whether students receiving a particular instructional strategy scored differently from other instructional groups when measured on a selected-response test or on a written response test. If the main and interaction effects were significant for either univariate ANOVA, the Bonferroni post-hoc test was used to identify where differences occurred for each dependent variable while controlling for Type I errors. For all quantitative analyses, alpha was set at .05 and performed using the Statistical Package for the Social Sciences (SPSS, 2010).

Qualitative Analyses

The qualitative analyses of this study are meant to inform the findings of the quantitative data analyses. Data collected from student focus groups and teacher interviews were analyzed using procedures consistent with Glaser and Strauss's (1967) grounded theory, which can be used to generate and verify theory about how students attempted to solve the problem in the module and how teacher instruction shaped student performance. The researcher reviewed the data and generated ideas and themes that emerged from the student focus groups and teacher interviews. Using analytic induction, these themes developed into assertions that offered explanations as to how different instructional strategies may have attributed to student performance (Ratcliff, 1994).

Student focus groups. Focus groups were conducted with groups of six students who received the same instructional strategy from the same teacher.

Students were asked to discuss how they had used the GeoThentic learning environment and how the instructor had assisted them in solving the problem.

To analyze their responses, the researcher first made two copies of the collected data, one of which was then divided into groups by instructor and one by instructional group. The researcher then scanned student responses within each grouping to identify possible themes within the data. As themes emerged in the teacher-specific groupings, the researcher determined if those themes were unique to a specific instructor or consistent among all instructors. Similarly, after scanning the instruction-specific groupings for themes, the researcher was attentive to whether certain themes could be attributed to a specific instructional strategy.

During each pass through the data, the researcher coded particular passages that represented possible categories or themes in the data. The reason for analyzing these two opposing representations of the data to avoid making deductions that were influenced by the structure rather than the content of the data. Themes were generated to look for relationships and links between data. The researcher also examined which categories were used most often. Using the categories generated through this analytic induction, the researcher developed a concept map to help uncover connections between themes that emerged from the data (Maxwell, 2005). Figure 10 provides the concept map developed by the researcher to find instances that validated and contradicted assertions. This map also allowed the researcher to generate assertions that were bounded by similar responses among all focus groups.

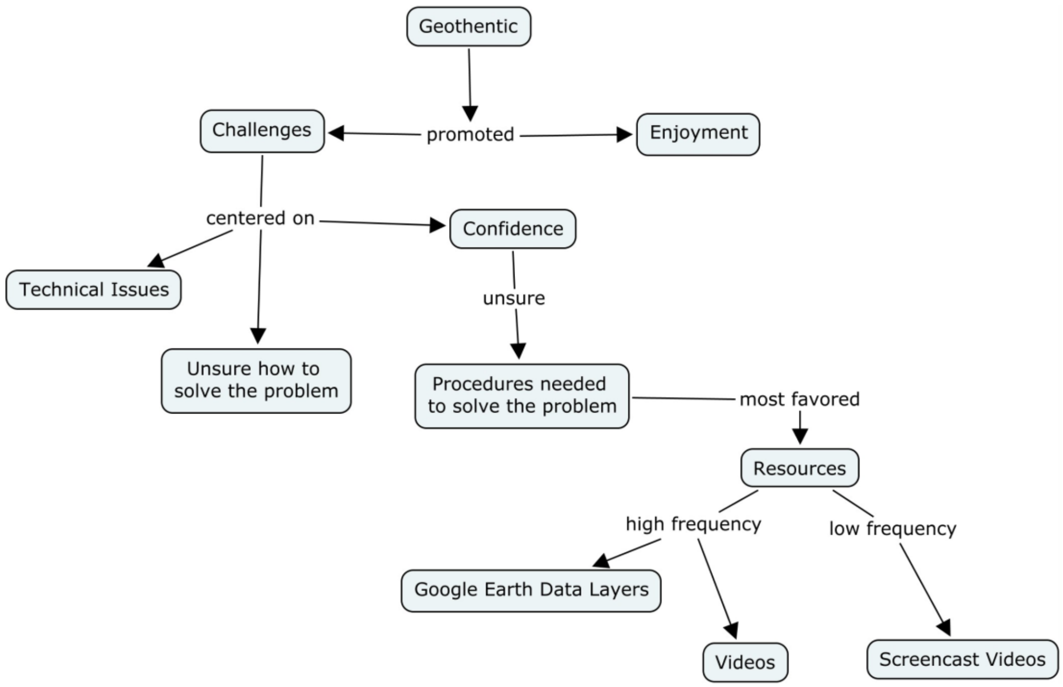

Figure 10. A concept map created after reviewing the focus group data.

Looking for consistency among the themes identified, the researcher listed the original themes in a chart and reanalyzed the focus group data again. Passing through the data another time permitted the researcher to verify that the data was coded in the same category on subsequent iterations. Passages were counted in a chart to show the frequency of data in a particular category. Displaying data in this way helped the researcher count the number of instances within each themes to see if adequate evidence was available to make reliable assertions based on category saturation. Categories that had a high number of data passages were examined closer, looking for consistency with previous identifications. The researcher also looked for examples of data that contradicted the assertions. These data could represent outlying examples that might exist. Producing frequency counts from the data allowed the researcher to generate additional assertions about the data.

Teacher interviews. The researcher also conducted interviews with each teacher, in which the teachers were asked to talk about their impressions about using GeoThentic and the instructional strategies they had been asked to use with their classes. These interviews were analyzed to determine themes that emerged in teacher perceptions about each instructional approach and their experience using each instructional approach during the project. Finally, the teacher interviews were reviewed to identify patterns and salient categories in the data.

Chapter 4

Results

This study was designed to examine the relationships among and effects of three instructional approaches used to teach geography concepts in a problem-centered multimedia learning environment. The study also attempted to determine the possible reasons for such relationships and effects. This study was designed to answer the following questions:

1. To what extent is student performance on a selected response test measuring declarative knowledge affected by each of three instructional approaches: directed, structured problem solving, and minimally guided?
2. To what extent is student performance on a written response test measuring declarative knowledge affected by each of three instructional approaches: directed, structured problem solving, and minimally guided?
3. Why do different instructional approaches influence student declarative knowledge?

This chapter presents the results of the various data analyses conducted for this study. First, the study compiled descriptive statistics for student scores on the selected response exam and the written-response exam for each of three instructional approaches: directed, structured problem solving, and minimally guided. Second, it analyzed student scores on the selected response exam and written response exam to determine possible differences among treatments. Third, it analyzed correlations between instructional strategies and scores on selected response and written exams. Fourth, it analyzed responses from the student focus groups to describe the students' experiences with each instructional strategy. Lastly, it analyzed the results of interviews conducted with each teacher to examine whether the attitudes of each teacher toward each instructional strategy may have influenced student performance.

Descriptive Strategies for Instructional Strategies

This section provides an overview of the descriptive statistics generated for student performance on the selected response exam and the written response exam. Table 6 presents student scores on each of the two assessment measurements.

Table 6

Means and Standard Deviation by treatment on performance measures

Dependent Variable	Instruction	n	Mean	SD
Selected Response	Directed	45	7.22	1.19
	Structured problem solving	49	6.68	1.31
	Minimally guided	48	6.30	1.16
	Total	142	6.72	1.27
Written Response	Directed instruction	45	9.31	2.23
	Structured problem solving	49	9.96	2.41
	Minimally guided	48	7.92	1.90
	Total	142	9.06	2.34

The data show that directed instruction group had the highest mean score on the selected response test, and structured problems solving group had the highest mean score on the written response test. As it demonstrates, the results for both tests appear consistent with earlier researchers' argument that minimal guided instruction is less effective than directed approaches to instruction

(Kirschner, Sweller, & Clark, 2006). To determine whether these results may have been caused by chance alone, further analysis using analysis of variance procedures was performed to identify the statistical variance among exam scores.

Analysis of Student Performance on Declarative Knowledge Exams

One of the main goals of this study was to determine if students receiving different instructional strategies would perform differently on two declarative knowledge exams. In this study, two measurements were used to evaluate student declarative knowledge, a selected response test and a written response test. Because the study uses two dependent variables, it is appropriate to conduct a multivariate analysis of variance (MANOVA), which allows the scores from both tests to be analyzed simultaneously. These analyses determine if students receiving a particular instructional strategy scored statistically different on the combined selected response test and written response test.

A one-way multivariate analysis of variance was conducted to determine the effect of three instructional strategies (directed instruction, structured problem solving, and minimally guided instruction) on two dependent variables (selected response tests and written response tests). The MANOVA showed a statistically significant main effect, more than chance, for the instruction students received, and the scores on the selected response and written response test at an alpha of .05, Wilks' Lambda = .80, $F(4, 276) = 7.97$, $p < .001$.

Because a significant difference was found among the three instructional strategies on both tests, individual univariate analyses of variance (ANOVAs) were conducted for each dependent variable as follow-up tests to the MANOVA.

Each ANOVA was used to identify if there was a main effect for the independent variable (instruction) on each dependent variable (selected response test and written response test).

ANOVA for selected response test. The analysis of variance on the selected-response test shows a statistically significant main effect for instruction F = (2, 139) = 6.64, p = .002. Table 7 shows a post hoc analysis for the ANOVA using the Bonferroni method. The Bonferroni method was used to control Type I error rates for multiple comparisons. The analysis indicated a significant difference (p = .001) between the mean score for direct instruction (M = 7.22, SD = 1.19) and the mean score for minimally guided instruction (M = 6.30, SD = 1.16). In other words, students who received directed instruction performed better on the selected-response test than students receiving minimally guided instruction. There was no significant difference in performance between students receiving structured problem solving instruction and either of the other instructional strategies on the selected response test.

Table 7

ANOVA (Bonferroni): Performance on Selected Response Test

Treatment Group	N	Mean Difference	Std. Error	p**
Directed Instruction	45	.5380	.25187	.103
Structured Problem Solving Instruction	49			
Directed Instruction	45	.9197	.25312	.001*
Minimally Guided Instruction	48			
Structured Problem Solving	49	.3817	.24773	.377
Minimally Guided Instruction	48			

*Mean difference significant at the .05 level

** Significant at the .05 level.

ANOVA for Written Response Test. The analysis of variance on the written response test shows a statistically significant main effect for instruction F = (2, 139) = 10.93, p < .001. Table 8 shows a post hoc analysis for the ANOVA using the Bonferroni method. The Bonferroni method was used to control Type I error rates for multiple comparisons. The analysis indicated two significant differences between two of the three groups: (a) a significant difference (p = .008) between the mean score for directed instruction (M = 9.31, SD = 2.23) and mean score for minimally guided instruction (M = 7.92, SD = 1.90), and (b) a significant difference (p < .001) between structured problem solving instruction (M = 9.96, SD = 2.41) and minimally guided instruction (M = 7.92, SD = 1.90). In other words, students receiving directed instruction or minimally guided instruction performed better on the written response test than those students receiving minimally guided instruction.

Table 8

ANOVA (Bonferroni): Performance on Written Response Test

Treatment Group	N	Mean Difference	Std. Error	p**
Directed Instruction	45	-.6481	.45530	.464
Structured Problem Solving Instruction	49			
Directed Instruction	45	1.3944	.45530	.008*
Minimally Guided Instruction	48			
Structured Problem Solving	49	2.0425	.44560	.000*

*Mean difference significant at the .05 level

** Significant at the .05 level.

As shown in Figure 11, none of the instructional strategies appeared to produce higher mean scores on both the selected response test and written response test. On the selected response test, the directed instructional approach produced the highest mean score. On the written response test, the structured problem solving approach produced the highest mean score. It is inappropriate to suggest that students receiving one particular instructional strategy perform better then other groups on both performance measures. The analyses do show for both tests, students receiving minimally guided instruction had the lowest scores among all instructional strategies.

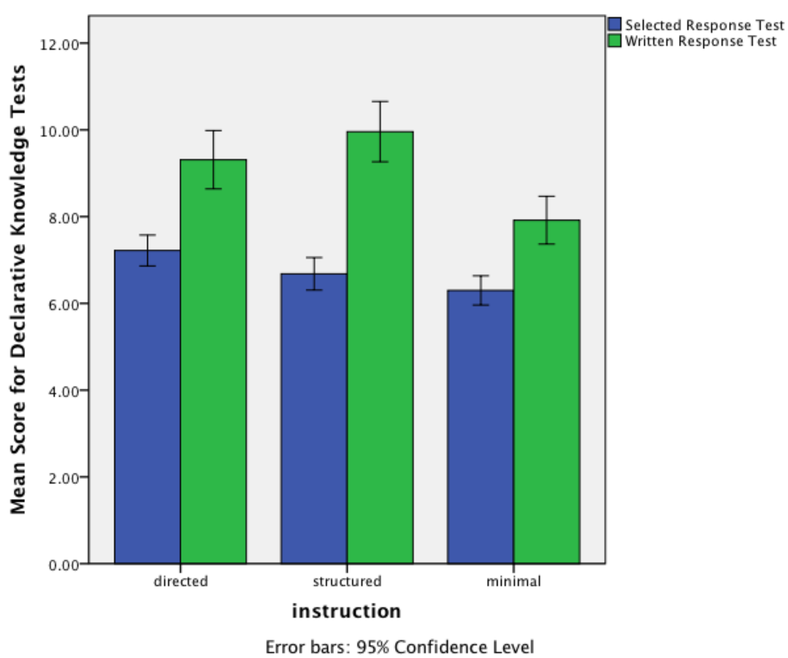

Figure 11. Declarative knowledge test means compared by instructional strategy.

Summary of Declarative Knowledge Exams

The written response exam and selected response exam measured the ability of a group of students to process information and analyze data provided in a problem-centered learning environment. When comparing the results of two different performance tests, the analyses found that students receiving minimally guided instruction performed significantly worse than those students receiving directed instruction or structured problem solving instruction.

Individual ANOVA reveal that the scores of students receiving minimally guided instruction were lower on both tests. Post hoc comparisons using the Bonferroni one-way ANOVA showed that on the selected response test, students receiving direct instruction performed significantly better than students receiving minimally guided instruction. When evaluated by the written response test, students receiving directed instruction and structured problem solving instruction performed significantly better than students receiving minimally guided instruction. Taken together, these results suggest that minimally guided instructional approaches are less effective than directed or structured problem solving instructional approaches for this particular type of learning environment.

Qualitative Data from Student Focus Groups

After examining student responses from the focus groups using the procedures outlined in the methods chapter, three assertions emerged. Table 9 presents these assertions, elaborated below with student quotes that illustrate the findings. The implications drawn from these findings are discussed in the next chapter.

Table 9

Assertions from Qualitative Data: Student Focus Groups

Assertion	Description
1	Students receiving minimally guided instruction appear to be less certain or more confused about how to solve the problem than students receiving directed or structured problem solving instruction.
2	Students preferred to learn about geography concepts by interacting with Google Earth rather than by seeking information from other resources.
3	Regardless of instructional strategy used, students enjoyed using GeoThentic to learn geography concepts and solve a problem.

These assertions generated from the data offer possible reasons as to why students in this study who received minimally guided instruction had lower test scores than students who received directed or structured problem solving instruction.

Assertion 1. *Students receiving minimally guided instruction appear to be less certain or more confused about how to solve the problem than students receiving directed or structured problem solving instruction.* The students receiving minimally guided instruction were given little to no direction from their teacher on how to solve the problem, and thus those students had to rely on the information provided on the GeoThentic website to learn the geography concepts needed to solve the problem. Students from the three focus groups who received minimally guided instruction reported feeling confused and unsure of how to solve the problem. The comments presented below represent the responses of the students receiving minimally guided instruction from all of the three teachers from this study.

> Jackie: I didn't really exactly like it all that much, because, I don't know if it was just me, but I just couldn't figure out where to go from. Like, where we could find the information. Also I feel like there wasn't enough information. I didn't know where to go.
>
> Rose: We went right into it. I didn't get how we were supposed to do half the things we were supposed to.
>
> Pat: I wish it explained more. What we were supposed to do.

In contrast, when asked to comment on their overall experience with the project, students from the directed instruction and structured problem solving focus groups made comments that reflected confidence in how to solve the problem.

> Jesse: I think it helped when Mrs. Sam [teacher], like, um, went through it, to the video, and, like, played it for us first. But then, when she started to go through all the other stuff, like, she started to go through some other things, we were all like, "Ok, we can go to the lab now. Come on." So, she could just have the whole class do the main video and then have people go find information on their own that would be more helpful.
>
> Sam: It was interesting, like, it [GeoThentic] was very easy to use and it was clearly labeled so you could pick out what you needed to do.
>
> Pam: The worksheets were really helpful. The teacher's explanations, telling us how to use it all, you know, was helpful. I wouldn't have figured it out.

Although each of the instructional groups had the same access to the GeoThentic website, responses from students who received minimally guided instruction reflected more uncertainty about how to solve the problem than those of students who received directed instruction.

Assertion 2. *Students preferred to learn about geography concepts by interacting with Google Earth rather than seeking information from other resources.* The GeoThentic website had a variety of available resources that could help students solve the problem. Some resources, like screen-capture videos, provided step-by-step instructions that showed students how to use Google Earth. Other resources included videos illustrating geography concepts and links to geographic information that could help students solve the problem.

Although all students were directed to use Google Earth to solve the problem, students less frequently reported that they had used information available on the GeoThentic website to help solve the problem. The decision by students to use Google Earth rather than the information on the GeoThentic website was not directly related to the type of instruction students received. Instead, judging from their responses, Google Earth afforded students the opportunity to interact with geography concepts rather than to simply retrieve information from the GeoThentic website about geography concepts.

> Researcher: What provided you with the most help to solve the problem or learn about geography?
>
> James: I thought Google Earth helped the most.
>
> John: Yeah, I liked using the different layers.
>
> Researcher: How did you and your group try to solve the problem?
>
> Mike: Well, first we found and looked at the ground shaking and we found an area that had the lowest possible ground shaking. Then, we had

> to look at population density and we had to move around our spot a couple of times, because once we figured out that it low shaking and low population too. So then we found one spot that had a large density and a large area, but in the middle we could put our hospital, which had low shaking and large income.
>
> Sarah: We looked at where the landfills where and made sure the spot we picked wasn't near a landfill. Then, we looked at the population and if it was, like, a big population that could be served by putting the hospital there.

When students were asked to describe the process they took to solve the problem, 12 of their 26 responses indicated that information from Google Earth was most helpful compared to any other information from the GeoThentic website. Table 10 provides a summary of these responses.

Table 10

Tools That Provided the Most Help in Solving the Problem

Frequency	Responses
12	Using Google Earth
6	Watching resource videos
2	Watching mission video
2	Visiting linked websites
1	Asking the teacher for help
1	Watching screencast videos
2	Other
26	Total

Students were able to experiment with Google Earth by turning different data layers on and off, whereas the resources on the GeoThentic website provided students with information about geography concepts explained through videos or text. According to students' responses, the experimentation possible in Google Earth provided them with contextualized information, making it less abstract than the information provided on the GeoThentic website.

Assertion 3. *Regardless of the instructional strategy used, students enjoyed using GeoThentic to learn geography concepts by solving a problem.* One theme that was notably consistent across all three instructional groups is that students enjoyed being asked to solve a problem. Several students commented on the overall activity, saying "it was fun," "it was interesting," "it was pretty cool," or "I liked it." When asked what made it fun, Jack responded, "It was more than finding my house, it was a real problem."

Qualitative Data from Teacher Interviews

The more time teachers spend in the classroom, the more opportunities they have to establish their perceptions about the value of different instructional approaches. The teachers in this study each had more than 10 years of classroom teaching experience. Therefore, it is reasonable to argue that these teachers may have had already made their own observations about each of the instructional approaches they used in the study.

During the interviews, all three teachers reported that they were most comfortable with the structured problem solving instructional approach. Furthermore, they all suggested that the elements of the structured problem solving approach aligned closest to the instructional approach they prefer to use in their classes. John, for instance, described how the instruction in his classroom is typically structured: "Ask those guided questions to keep student on track, to check for understanding. That is, basically, what I do. Asking, are you with me? Do you understand these concepts?" Similarly, Pat compared the guidance provided in her instruction with the way in which an adult bird cares for a baby bird: "Once you think they've got the wings, then you send them out there." Although Pat reported that she used structured problem solving most frequently, she did argue that "there isn't a style of teaching that fits every kid. So, you are always deciding, who is the one I'm going to lose that day?"

Another theme that emerged during the teacher interviews was an assertion that even when using directed instruction or structured problem solving, it is difficult for a teacher to accurately assess student understanding. For instance, when using directed instruction, Pat said, "I don't know if they are really getting the answer or just putting the right answer on a piece of paper and I don't really know if there is a depth of thinking when you do it that way." Although teachers using directed instruction provide students with explicit steps to follow, it is difficult for teacher to ensure that every student is actively participating in the process. This problem is also true of structured problem solving. Sam suggested that structured problem solving is sometimes challenging because "you make a lot of assumptions and so kids might look like they're getting something but they don't. Often times you think they're all on the same path and you have 10 of them that have no clue."

Chapter 5

Discussion and Recommendations

This chapter discusses and interprets the findings of the study and its implications for instruction in problem-centered, multimedia based learning environments. Also addressed in this chapter are the limitations of the study and recommendations for further research.

The results of this study found that students who received directed or structured problem solving instruction performed significantly better than student receiving minimally guided instruction on both a selected response test and a written response test, each which measured students' declarative knowledge. Findings showed that no one instructional group scored better for both the selected response test and the written response test. Instead, students in the directed groups scored highest on the selected-response test and students in the structured problem solving group scored highest on the written-response test.

Student focus groups and teacher interviews were conducted to examine aspects of each instructional strategy that could have influenced student performance on these tests. Data from these focus groups suggest that students receiving minimally guided instruction were unsure or confused as they working in the GeoThentic environment. Because of this confusion, many students in this group were unable to identify issues from the problem that were needed to make connections to geography concepts embedded in the problem. In contrast, the directed and structured problem solving groups indicated that using particular scaffolds inside GeoThentic, as well as, manipulating different data layers in

Google Earth helped students understand geography concepts. During interviews, each of the three teachers reported a preference using the structured problem solving approach compared to the other two instructional approaches used for this study. Furthermore, each of the teachers suggested that the amount of guidance provided to students during the structured problem solving approach aligned most closely with the strategies they typically use in their courses.

Implications of Findings for Instruction using Problem-Centered Multimedia-Based Learning Environments

This section will examine the relationship between different instructional strategies and student performance. Also discussed are implications this has on instruction using multimedia-based learning environments. GeoThentic is a comprehensive multimedia-based learning environment that contains all the relevant resources that students need to solve the presented problem, however, the finding suggest that simply providing access to these resources, student could not, on their own, make the connections between concepts needed to solve the problem. The data suggest that instructional strategies that provided guidance to students were more effective than those instructional strategies where teachers did not provide guidance to students. The amount of guidance a teacher needs to provide, however, seemed to vary based on the situation. Perhaps particular instructional strategies may be more effective for specific concepts, with particular students, and at particular times.

The following items include the implications for preparing instruction in a problem-centered multimedia-based learning environment:

1. Each particular scaffold used in a multimedia-based learning environment should be explicitly aligned with a concept the students need to know in order solve a problem.
2. Multimedia-based learning environments should provide suggestions for different instructional strategies with each scaffold.
3. Multimedia-based learning environments should provide opportunities for students to check their declarative knowledge.

The remainder of this section will provide ideas to align different instructional strategies that are effective for specific concepts, with particular students, at particular times.

Each particular scaffold used in a multimedia-based learning environment should be explicitly aligned with a concept the students need to know in order solve a problem. Even though scaffolds were available within GeoThentic, student receiving minimally guided instruction reported feeling lost or unsure of how to solve the problem. Students report that they used the resources within the GeoThentic environment, but many students were unable to identify how the information from these resources could helped them solve the problem. These findings are representative of the argument, made by Kirschner and Sweller (2007), that minimally guided instruction is ineffective. Without direction, students tend to navigate unconfidently through an environment unsure about the connection between concepts.

The findings from this study suggest that the environment should be organized to quickly provides students with the direction they need to navigate the environment and explicitly identify the issues embedded in a problem. Without identifying fundamental issues from the problem, students are unable to understand the relationships between corresponding concepts. This supports the assertion by Hmelo-Silver et al. (2008) that teachers need to provide students with the structure and guidance needed to solve a problem independently. This structure and guidance help students identify which concepts are important to solve the problem. Furthermore, without the understanding the concepts, it is more difficulty for students to perform the tasks they needed to solve the problem.

In GeoThentic, scaffolds were arranged by resource type. For instance, screen-capture videos were located on one page with other screen-capture videos, content-specific resources like videos, links to websites, and Google Earth data layer files were located together on a different page. Students reported that these scaffolds were helpful when they attempted to solve the problem. For instance, students reported that manipulating the data layers of Google Earth was very helpful; however, most students were unable identify how these scaffolds were aligned with particular geography concepts.

These findings imply that scaffolds should be explicitly segmented by each of the concepts that students need know in order to solve the problem. Figure 12 presents a modified diagram of a page layout for GeoThentic that organizes existing scaffolds by a particular theme—identify the factors that cause earthquakes, and its related concept—earthquakes happen near faults, where plates within the earth suddenly break or shift under stress, sending shock waves rippling.

Theme: Identify the factors that cause earthquakes

Concept: Earthquakes happen near faults, where plates within the earth suddenly break or shift under stress, sending shock waves rippling.

Resource Video	Provides an animation that shows the plates breaking and shifting under stress.
Link to Website	Provides a definition of an earthquake that includes images and diagrams
Google Earth Data Layer	Identifies the location of faults and recent earthquakes.
Screen-Capture Video	Provides specific directions on how to use the Google Earth data layer.

Figure 12. Modified page layout of GeoThentic explicitly aligning scaffolds with an appropriate theme and concept.

Next to each scaffold is a description of what information is provided when students click the scaffold. Organizing scaffolds in this manner will allow students to quickly identify how the scaffolds from the environment are related to a theme and concept. This affords teachers an opportunity to provide effective instruction for a specific geography concept. For instance, using a directed instruction approach, a teacher could better guide students through the information above that are explicitly chunked by a theme and concept. Using structured problem solving, a teacher could direct students to open a particular scaffold and help them process the provided information. For example, using the Google Earth data layer from Figure 12, a teacher could ask students to examine the relationship between faults and earthquake locations to speculate how earthquakes happen. This layout may also allow students receiving minimally guided instruction to perform better because it would help them identify the themes and concepts needed to solve the problem.

Multimedia-based learning environments should provide suggestions for different instructional strategies with each scaffold. Because it is hard for a teacher to quickly identify the specific instructional needs of an individual student, many teachers tend to use one instructional strategy to address the needs of all students in a particular class. Broadly using one instructional approach can cause a teacher to overlook the diverse needs of individual students. As described in the literature, Vygotsky (1967) argued that learners require specific assistance, in the form of scaffolds, to move beyond their current level of understanding to higher level of understanding. However, the appropriate level of assistance teachers should provide to individual students is rather ambiguous and is dependent on the current level of a student's knowledge. For instance, students in the directed instruction group reported being too closely controlled by their teacher, presumably because they already had the background knowledge being discussed; whereas, students in the structured problem solving group reported that the teacher could have done more help to explicitly identify the issues in the problem, presumably because they were unable to make the necessary connections between geography concepts. Consequently, this implies that problem-centered multimedia-based learning environments should present teachers with suggestions that provide varied instructional approaches that are effective for individual student needs.

Using particular scaffolds, a teacher can deliver the most effective instructional strategy for an individual student's needs. Figure 13 represents a potential continuum of suggestions that is displayed when a student clicks the Google Earth data layer scaffold provided in Figure 12. The suggestions include approaches that move from directed instruction to minimally guided instruction.

Theme: Identify the factors that cause earthquakes

Concept: Earthquakes happen near faults, where plates within the earth suddenly break or shift under stress, sending shock waves rippling.

Google Earth Data Layer

The majority of the most recent earthquakes occur along a particular path, this is a fault. Identify the fault that runs near San Francisco.	What can you conclude about the relationship that exists between the frequency of earthquakes and location of continental plates?	Refer to this scaffold to learn about the factors that cause earthquakes.
Directed Instruction	Structured Problem Solving	Minimally Guided
Teacher Directed		Student Directed

Figure 13. A continuum of instructional suggestions displayed when the Google Earth data layer scaffold is clicked.

This design allows a single scaffold to be represented multiple ways, providing a teacher with multiple suggestions to deliver the most effective instruction for a particular student. For example, there may be times when a teacher needs to deliver instruction that is very direct and other times when it may be more appropriate for a teacher to challenge students to make the connection between concepts themselves.

Multimedia-based learning environments should provide opportunities for students to check their declarative knowledge. Although it appears that a considerable amount of guidance should be provided to students, it is unclear as to how much teacher guidance is appropriate. As the findings of the study show, students that were unable to recognize geography concepts on the selected-response test also did poorly on the written-response test. In order for students to make the connections needed to solve the problem; they need to understand essential geography concepts from the problem. Not all students required the same amount of assistance from the teacher to learn these concepts, some were able to utilize the scaffolds on their own. To ensure that students have this knowledge, teachers need to continually assess a student's declarative knowledge. By assessing this knowledge, a teacher can identify which concepts student do not understand and provide them with the most effective instruction that can clarify existing knowledge or reinforce and extend knowledge. Figure 14 provides a modified page layout of GeoThentic that organizes the concepts from one theme in the San Francisco module. Next to each concept on this page is an icon, when clicked; prompts students with a selected response question that checks their understanding for that particular concept.

Theme: Identify the factors that cause earthquakes

?	✔	Earthquakes happen near faults, where plates within the earth suddenly break or shift under stress, sending shock waves rippling.
?	✖	Different fault types include divergent, transform, dip-slip, and convergent faults.
?	✔	The San Andreas Fault is a transform fault that divides the Pacific and North American plates.
?	✔	The San Andreas Fault is located in San Francisco, California.

Figure 14. Modified page layout of Geothentic including arranging concepts from a theme.

The results from these questions can be denoted with a checkmark for those answered correctly and a cross for those answered incorrectly, allowing a teacher to quickly distinguish the themes and concepts where student knowledge is needed. Using this information, a teacher can dynamically prepare directed instruction where students are missing information or prepare structured problem solving approaches to extend those concepts which with student already are familiar.

Limitations

There are several limitations to this study that should be considered when reviewing the results. These include the validity of the students' tests, the data collection methods, and the fixed set of procedures followed for each instructional strategy.

Student Tests. The student tests used in the study included a selected response test and a written response test. This was the first time either of the tests were used with students, consequently, neither of these measures were tested to ensure the validity of the produced results. Additional studies should conducted using these tests ensure the reliability of the select response questions asked and the rubric used for the written response test. In addition, student prior knowledge of geography concepts was not evaluated before beginning the San Francisco module.

Data collection methods. Qualitative data from the study was limited to student focus groups and teacher interviews. The finding of the study would have been more complete if the data was triangulated with additional field observations and document collection procedures.

Fixed set of procedures. Although the researcher provided each teacher with a set of directions to follow for each instructional strategy, it is uncertain as to how much one can control the dynamic nature that exists in a non-lab classroom setting. For instance, a teacher may had incidentally provided more assistance to students then specified in the directions. Additionally, although the researcher checked to make sure each of the teachers understood the differences between each instructional strategy, they may have interpreted the directions for each instructional strategy a different way. Furthermore, during interviews each teacher reported a preference for the structured problem solving approach. This preference may have encouraged the teachers to unintentionally favor this approach over another

Recommendations

In this study three different instructional strategies where used to help students solve a problem in a multimedia-based learning environment. Of these three strategies, students receiving directed instruction or structured problem solving instruction performed significantly better than those students receiving minimal guided instruction when measured on a selected response and written response exam. Certainly, this study suggests that teachers must provide a certain level of guidance to students, however, there is little evidence to suggest when student need more assistance or when less guidance can be provided to push students to explore on their own.

Additional research is needed to identify the different instances when one instructional strategy is more effective than another. Additionally, more research is needed to identify the appropriate amount of guidance needed and when less direction can be provided to students.

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Appendix A: Teacher Guide for Students Receiving Directed Instruction

Directed Instruction Approach

Lesson Objectives

- Students will identify the factors that cause earthquakes to happen?
    - Faults Types
    - Plate Tectonics Boundaries
- Students will recognize the impact that earthquakes have on the landscape/environment?
    - Liquefaction
    - Seismic Hazards
    - Epicenter
    - Ground shaking intensity
- Students will recognize the impact earthquakes have on human populations (San Francisco)?
    - Population Density
- Students will identify the factors to consider when building a hospital in San Francisco?
- Students will be able to navigate in Google Earth, turn data layers on and off, and analyze data layers.

Instruction with Guided Practice

Part 1: Students will identify the factors that cause earthquakes to happen?

Play Earthquakes (1:45) video and go to the NG Interactive guide

Have students answer the following questions correctly?

1. Have students select the proper definition what an earthquake is.
2. Match the following fault types with the appropriate definition?

Load the "Plates" data layer in Google Earth. Show students how to navigate inside of Google Earth and turn data layers on and off.

1. Identify the two tectonic plates that divide the San Andreas Fault Line.
2. Identify the type of fault that is aligned on the San Adreas Fault Line
3. Provide the lat and longitude for San Francisco, CA
4. Determine the horizontal slip during the 1906 San Francisco earthquake

Load Plates KMZ

- What are tectonic plates, what are plate boundaries (strike –slip fault)
- types of faults (normal, reverse, strike-slip, dip-slip)
    - Locate the Pacific Tectonic Plate/North American Tectonic Plate (fault line)
    - Turn on the borders and labels layer

<u>Part 2: Students will recognize the impact that earthquakes have on the landscape/environment?</u>

Play San Andres Fault (2:51),

Demonstrate section 5 (Measurement and recordings) and section 7 (triggering an earthquake)

Have student complete the following questions.

1. Define what a seismograph measures?
2. What is a creep meter?
3. What is an Epicenter?
4. True/False the higher the Richter Scale rating the more powerful the seismic waves?
5. Define liquefaction: Surface waves causes the solid ground to act like liquid. This migh cause the ground to sink around buildings. Can create sand boils, mini volcano like structures that spew sediment and water

Load the "Slips" and "Shaking" KMZ data layer in Google Earth. Show students how to navigate inside of Google Earth and turn data layers on and off.

1. Identify the horizontal slip that took place near the 1906 San Francisco earthquake.
2. What level of shaking took place in the city of San Francisco during the 1906 San Francisco area ?

<u>Part 3: Identify the impact earthquakes have on humans</u>

Play the San Francisco Video and have students access the Wikipedia article on San Francisco

1. Use the map provided and identify the geographic neighborhood locations of San Francisco that are most susceptible to earthquakes?

Play Los Angeles Earthquake (2:23) and Play Armenia Earthquake (1:03)

2. Identify some of the effects that an earthquake can have on a human population?
    - Transportation – Highways, mass transit, etc.
    - Death and Injury to human populations
    - Building damage

<u>Part 4: Students will be able to navigate in Google Earth, turn data layers on and off, and analyze data layers.</u>

Have student load the San Francisco module and use the Google Earth guide to complete the following tasks with the teacher.

1. Analyzing Data by turning on and off data layers
2. Zoom in and zoom out of an area, change the angle
3. Adjust the transparency data options.
4. Using the ruler tool to measure distance with a line or with a path.
5. Adding a polygon to evaluate areas.
6. Adding a place mark on a data set using a latitude and longitude location, changing the location, and providing a description and submitting your Geopack

Independent Practice and Assessment

Provide students with the directions to identify the best location to build a hospital in San Francisco. In their justification, students should identify the factors that should be considered when building a hospital.

Complete short multiple choice exam covering concepts addressed in this module.

Appendix B: Teacher Guide for Students Receiving Structured Problem Solving.

Structured Problem Solving Instructional Approach

Lesson Objectives

- Students will identify the factors that cause earthquakes to happen?
    - Faults Types
    - Plate Tectonics Boundaries
- Students will recognize the impact that earthquakes have on the landscape/environment?
    - Liquefaction
    - Seismic Hazards
    - Epicenter
    - Ground shaking intensity
- Students will recognize the impact earthquakes have on human populations (San Francisco)?
    - Population Density
- Students will identify the factors to consider when building a hospital in San Francisco?
- Students will be able to navigate in Google Earth, turn data layers on and off, and analyze data layers.

Structured Problem Solving Instruction

Part 1: Plan the mission video for students.

Have students generate concepts from the video they believe are important to helping solve the problem. Be sure to play the video numerous times to allow students to identify the problem and necessary information.

Be sure to guide students to pull out these issues from the mission video. Possibly create a concept map or other visual representation related to the concepts from the mission video.

1. What is an earthquake? What does it look like?
2. Why do earthquakes take place in San Francisco?
3. What make the 1906 San Francisco earthquake so devastating?
4. Determine how Earthquakes are measured in terms of intensity using the terms of magnitude, epicenter, seismic activity, and shaking.
5. What is the San Andreas fault line?
6. How do geographers assist in planning a city?
7. Why is population density important

After having students generate there understanding of the problem and the knowledge need to solve the problem provide in the "Gather and Analyze Data" worksheet.

<u>Part 2: Provide guidance and limited structure.</u>

Using the “Gather and Analyze Data” worksheet, have students drive what resources to bring up.

Ensure that student have knowledge what Earthquakes are.

- If needed, play Earthquakes (1:45) video and go to the NG Interactive guide

Load the “Plates” data layer in Google Earth. Show students how to navigate inside of Google Earth and turn data layers on and off.

- Have students identify the two tectonic plates that divide the San Andreas Fault Line.
- Identify the type of fault that is aligned on the San Adreas Fault Line
- Determine the horizontal slip during the 1906 San Francisco earlthquake

Providing Guidance

Direct students to the following resource if they need assistance with the any of the specific issues

<u>Students can’t recognize the impact that earthquakes have on the landscape/environment?</u>

- Play San Andres Fault (2:51) video.
- Demonstrate section 5 (Measurement and recordings) and section 7 (triggering an earthquake) on National Geographic
- Define liquefaction: Surface waves causes the solid ground to act like liquid. This might cause the ground to sink around buildings. Can create sand boils, mini volcano like structures that spew sediment and water
- Prompt students with the following questions.
    - How can you use a seismograph or creep meter to measure the effects of earthquakes?
    - How can you use the Richter Scale to measure the power of the seismic waves?
- Have students load the “Slips” and “Shaking” KMZ data layer in Google Earth. Show students how to navigate inside of Google Earth and turn data layers on and off.
    - Have students identify the horizontal slip that took place near the 1906 San Francisco earthquake.
    - Have students identify the level of shaking took place in the city of San Francisco during the 1906 San Francisco area ?

<u>Students can’t Identify the impact earthquakes have on humans</u>

- Play Los Angeles Earthquake (2:23) and Play Armenia Earthquake (1:03)
- Have students access the Wikipedia article on San Francisco
- Use Google Earth to identify the geographic neighborhood locations of San Francisco that are most susceptible to earthquakes?
- Ask students to identify some of the effects that an earthquake can have the following:
    - Transportation – Highways, mass transit, etc.
    - Death and Injury to human populations
    - Building damage

Students are unable to navigate in Google Earth, turn data layers on and off, and analyze data layers.
Have students load the "Plates" data layer in Google Earth. Show students how to navigate inside of Google Earth and turn data layers on and off.

- Identify the two tectonic plates that divide the San Andreas Fault Line.
- Identify the type of fault that is aligned on the San Adreas Fault Line
- Provide the lat and longitude for San Francisco, CA
- Determine the horizontal slip during the 1906 San Francisco earlthquake
- Identify the location of tectonic plates boundaries
- Identify the types of faults (normal, reverse, strike-slip, dip-slip)

Independent Practice and Assessment

Provide students with the directions to identify the best location to build a hospital in San Francisco. In their justification, students should identify the factors that should be considered when building a hospital.

Complete short multiple choice exam covering concepts addressed in this module.

Appendix C: Teacher Guide for Students Receiving Minimally Guided Instruction

Minimally Guided Instructional Approach

Lesson Objectives

- Students will identify the factors that cause earthquakes to happen?
    - Faults Types
    - Plate Tectonics Boundaries
- Students will recognize the impact that earthquakes have on the landscape/environment?
    - Liquefaction
    - Seismic Hazards
    - Epicenter
    - Ground shaking intensity
- Students will recognize the impact earthquakes have on human populations (San Francisco)?
    - Population Density
- Students will identify the factors to consider when building a hospital in San Francisco?
- Students will be able to navigate in Google Earth, turn data layers on and off, and analyze data layers.

Anchored based Instruction

Part 1: Plan the mission video for students.

Have students generate concepts from the video they believe are important to helping solve the problem. Be sure to play the video numerous times to allow students to identify the problem and necessary information.

Be sure to guide students to pull out these issues from the mission video. Possibly create a concept map or other visual representation related to the concepts from the mission video.

Part 2: Direct students to each of the scaffolds provided in the environment and encourage them to use these areas to solve the problem.

Independent Practice and Assessment

Provide students with the directions to identify the best location to build a hospital in San Francisco. In their justification, students should identify the factors that should be considered when building a hospital.

Complete short multiple choice exam covering concepts addressed in this module.

Appendix D: Student Guided Worksheet for Directed Instruction

My Name	**GeoThentic: Build a Hospital Module**

Identify the Best Location in San Francisco to Build a Hospital

Section 1a: Identify the factors that cause earthquakes

Answer the following questions after watching the short video about earthquakes and reviewing the information on the National Geographic: Forces of Nature. Do not move on until your teacher has reviewed the correct answers with you.

1. Write a definition of an earthquake?

   "Earthquakes happen when plates, or rocks, within the Earth suddenly break or shift under stress, sending shock waves rippling."

2. Match the following fault types with the appropriate definition?

	Fault Type		Definition
B	Normal/Divergent	A.	Occur where plates are colliding and one side of the fault is pushed up and over the other.
D	Strike-Slip/Transform	B.	Common throughout the world, are when plate boundaries pull apart and Earth's crust is stretched. One side of the fault slips down.
C	Dip-Slip	C.	Occurs when one plate moves sideways and one moves downward
A	Reverse/Convergent/ Thrust	D.	Plates meet evenly and slide against each other horizontally

Do not continue until you have verified that all of your answers are correct and that you have no other questions about this section.

Section 1b: Identify the factors that cause earthquakes

Load the "plates.kmz" data layer into Google Earth. Answer the following questions after your teacher shows you how to navigate inside of Google Earth and how to work with different data layers.

3. What two tectonic plates divide the San Andreas Fault Line?

   Pacific Plate and the North American Plate

4. Identify the type of fault that is aligned on the San Andreas Fault Line?

   Strike-Slip/Transform

5. Place a pin on the latitude and longitude for San Francisco, CA. Provide the correct latitude and longitude for the location.

	Degrees	Minutes	Seconds
Latitude:	37	46	29 ± 50
Longitude:	122	25	9 ± 50

Do not continue until you have verified that all of your answers are correct and that you have no other questions about this section.

Section 2a: Identify the impact that earthquakes have on the landscape and environment

Answer the following questions after watching the short video about the San Andreas Fault line and reviewing the information on the National Geographic: Forces of Nature. Do not move on until your teacher has reviewed the correct answers with you.

6. What does a seismograph measure?

   This device makes tracings on paper or film when an earthquake occurs. This reveals to experts where the quake began, how long it lasted, and how much energy was released.

7. What does a creep meter measure?

   Movement or shifting of the Earth's plates caused by earthquakes

8. What is the epicenter of an earthquake?

   The point on the earth's surface directly above where movement first occurred in the fault.

9. The higher the Richter Scale rating the (more or less) powerful the seismic waves

10. Define the term liquefaction:

    During an earthquake surface waves cause the solid ground to act like liquid. This might cause the ground to sink around buildings. Can create sand boils, mini volcano like structures that spew sediment and water

Do not continue until you have verified that all of your answers are correct and that you have no other questions about this section.

Section 2b: Identify the impact that earthquakes have on the landscape and environment

Load the "slips.kmz" and "shaking.kmz" data layer into Google Earth. Answer the following questions after your teacher shows you how to navigate inside of Google Earth and how to work with different data layers.

Load the "Slips" and "Shaking" KMZ data layer in Google Earth. Show students how to navigate inside of Google Earth and turn data layers on and off.

11. Identify the horizontal slip that took place near San Francisco in the large 1906 earthquake.

11.5 Feet

12. What level of "perceived shaking" occurred in the city of San Francisco during the 1906 earthquake?

    Violent

Do not continue until you have verified that all of your answers are correct and that you have no other questions about this section.

<u>Section 3a: Identify the impact earthquakes have on humans</u>

Answer the following questions after reviewing the information on Wikipedia and watching the short videos about the city of San Francisco, the Los Angeles earthquake, and the Armenia earthquake. Do not move on until your teacher has reviewed the correct answers with you.

13. Identify the neighborhood locations of San Francisco most susceptible to liquefaction during earthquakes?

    Marina
    Hunters Point
    Embarcadero
    Treasure Island

14. Identify some of the effects that an earthquake can have on a human population?

    Transportation (Highways, mass transit, etc)
    Death and Injury (population density)
    Building damage

Do not continue until you have verified that all of your answers are correct and that you have no other questions about this section.

<u>Section 4a: Navigate in Google Earth, working with different data layers to analyze a variety of data.</u>

Load the "sanfranciso.kmz" data layer into Google Earth. Be sure you can complete the following tasks after your teacher shows you how to navigate inside of Google Earth and how to work with different data layers.

1. Turn on/off data layers
2. Zoom in and zoom out of an area
3. Change the tilt that you are viewing data.
4. Adjust the transparency data layers.
5. Use the ruler tool to measure distance with a line or with a path.
6. Add a polygon to evaluate a particular area

7. Add a place mark to your data set and identify the latitude and longitude location in degrees, minutes, and seconds.

Do not continue until you have verified that all of your answers are correct and that you have no other questions about this section.

Independent Practice and Assessment

It is now your task to identify the best location to build a hospital in San Francisco with the information you have gathered. In your answer provide a justification on what factors you considered to decide where to build a hospital.

	Degrees	Minutes	Seconds
Latitude:			
Longitude:			

Appendix E: Student Guided Worksheet for Structured Problem Solving.

My Name

Identify the Best Location in San Francisco to Build a Hospital

Watched the video that describes your mission to "identify the best location in San Francisco to build a hospital." As the video prompted you you'll need to consider a few things as your teacher guides you through the concepts related to earthquakes and the city of San Francisco. As you are guided through this problem, you will have to analyze a variety of data to solve the mission.

As you begin working to solve your mission, consider some of the factors that will help determine where the best location is to build a new hospital. Using this list of factors, keep track of important factors to consider when choosing a location. You may add additional factors to consider.

Factors	Why is this factor important to consider when choosing a location?	Notes from Google Earth
Fault Locations		
Population Density		
Ground Shaking Intensity / Amplification		
Liquefaction		

To solve the mission you should be able to complete the following tasks with Google Earth. If you need help completing the tasks listed below, go to the Screen Captures tool inside of GeoThentic and learn how to perform these tasks.

1. Loading data into Google Earth

2. Learn about Geographic features about San Francisco by turning on/off data layers
3. Zoom in and zoom out of an area
4. Change the tilt that you are viewing data.
5. Adjust the transparency data layers.
6. Use the ruler tool to measure distance with a line or with a path.
7. Add a polygon to evaluate a particular area

Add a place mark to your data set and identify the latitude and longitude location in degrees, minutes, and second.

Appendix F: Selected-Response Test

[Note: Answers to questions provided bolded.]

Name:

San Francisco Lesson Multiple Choice Questions
Please select the best answer for the question.
Once you have selected your answer, please circle your answer.

1. Which option provides the best description of earthquakes?
    a. Earthquakes occur when geographic areas are overpopulated causing disturbances under the earth's surface.
    b. Science has been unable to explain why earthquakes happen and we are still unsure what causes them.
    c. Plates within the earth break or shift under stress, sending shock waves rippling to surface
    d. When earth's surface temperatures reach a certain temperature an earthquake occurs to cool down the earth's surface.

2. Which option best describes the areas where earthquakes are more likely to occur?
    a. Areas located near highly populated areas
    b. Areas located near lightly populated area
    c. Area located near bodies of water
    d. Areas located between tectonic plates

3. Which option best describes how frequently earthquakes occur around the world?
    a. Earthquakes happen almost every day, but many cause no noticeable disturbances to people on the surface.
    b. Earthquakes do not occur that often, only a few occur during a year
    c. Earthquakes are connected to particular seasons of the year and happen during those times
    d. Earthquakes are more likely to happen when the earth's surface reaches a certain temperature

4. The highest density of population in San Francisco is found where?
    a. Northeast
    b. Southeast
    c. Northwest
    d. Southwest

5. What is the name of the fault that lies directly to the west of San Francisco?
    a. Monte Vista Fault
    b. Calaveras Fault
    c. San Andreas Fault
    d. Greenville Fault

6. The city of San Francisco is located near a fault that separates the Pacific tectonic plate and the North American tectonic plate. This fault is an example of a strike-slip fault; also know as a transform fault. Which option best describes what happens to the two tectonic plates located at this type of fault?
    a. The plates collide and one side of the fault is pushed up and over the other
    b. The plates pull apart; one side of the fault slips down, and the earth's crust is stretched.
    c. One plate moves sideways and one plate moves downward.
    d. The plates meet evenly and slide against each other horizontally

7. Choose the option below that best describes what a seismograph measures.
    a. The amount of energy that was released during an earthquake
    b. The distance a fault moved during an earthquake
    c. The amount of human injury caused during an earthquake
    d. The thickness of the earth's crust

8. In which areas are structures less likely to be affected by seismic activity?
    a. Structures built on a landfill
    b. Structures built along the coastline
    c. Structures build on bedrock
    d. Structures build over fault zones

9. The point on the earth's surface directly above where movement first occurred during an earthquake
    a. Hypocenter
    b. Epicenter
    c. Fault
    d. Seismograph

Appendix G: Semi-Structured Focus Group Questions with Students

[Note: This discussion will be driven by students' comments, stimulated recall of the GeoThentic environment, and researchers' observations during the teaching.]

- Describe your experiences using the GeoThentic environment?
- Please describe the process you took as you tried to solve the problem? What did you think about as you tried to solve the task you were given?
- What provided you the most help learning geography and solving your task?
- What do you believe was *not helpful* in learning geography or solving your task?
- What do you think your teacher did that helped you learn geography and to solve the problem in this activity?
- If you were going to change things about this experience, what would they be and why?
    a. Identify struggles or confusing spots.
- How easy to use were the movie that presented the mission to you? Did you use it? Was it helpful in completing the task?
- How easy to use were the screen capture movies? Did you use them? Were they helpful in completing the task?

How easy to use were the resources? Did you use them? Were they helpful in completing the task?

Appendix H: Semi-Structured Teacher Interview Questions

[Note: This discussion will be driven by teachers' comments, stimulated recall of the GeoThentic environment, and researchers' observations during the teaching.]

- Describe your experiences when using the GeoThentic environment?
- What features do you believe were most helpful in teaching geographic information system and helping students learn geography?
- What aspects of your instructional approaches do you think assisted students in learning geography through a geographic information system?
- What features of GeoThentic do you believe were *helpful* in using geographic information system to learn geography?
- What features of the learning environment do you believe were *not helpful* in using geographic information system to learn geography?
- If you were going to change things about or in the environment, what would they be and why?
    a. Identify struggles, confusing spots.
    b. Identify concerns you would have as a teacher using GeoThentic in your classroom.
- What are/were your impressions of the lessons and instruction with your class?
- How do you think your students responded to the GeoThentic environment? What do you think they liked most? What were they most bored and/or confused by?