ACTIVE-CONSTRUCTIVE-INTERACTIVE: INVESTIGATING THE EFFECTIVENESS OF DIFFERING INSTRUCTIONAL STRATEGIES IN A CLASSROOM SETTING

A dissertation submitted to the Kent State University College of Education, Health and Human Services in partial fulfillment of the requirements for the degree of Doctor of Philosophy

By

Connie J. Romig

December 2016
A dissertation written by

Connie J. Romig

B.A., Miami University, 1976

M.Ed., Kent State University, 1983

Ed.S., Kent State University, 1985

J.D., The University of Toledo, College of Law, 1995

Ph.D., Kent State University, 2016

Approved by

Bradley J. Morris, Co-director, Doctoral Dissertation Committee

Chris Was, Co-director, Doctoral Dissertation Committee

John Dunlosky, Member, Doctoral Dissertation Committee

Accepted by

Mary Dellmann-Jenkins, Director, School of Lifespan Development and Educational Services

Mark A. Kretovics, Interim Dean, College of Education, Health and Human Services
The purpose of this study was to examine the instructional strategy taxonomy proposed by Chi (2009) in a natural classroom setting. Specifically, according to Chi, instructional strategies that allow students to be active in their learning are more effective than those that allow the student to be merely passive, while constructive strategies are more effective than active and interactive are more effective than constructive. Each of the instructional strategies was employed in four Introduction to Educational Psychology Classes and the learning outcomes, as determined by student performance on unit exams, were compared.

The participants were 120 undergraduate students who were enrolled in the introductory course. Each class was presented with a unit employing each instructional strategy, active, constructive and interactive, twice over the course of the semester. At the end of each unit an instructor-made exam was administered. Comparisons were conducted to determine whether any one of the instructional strategies was superior to the others in terms of student learning outcomes. According to Chi’s taxonomy, interactive instruction should yield the best learning outcomes, followed by constructive instruction and then active instruction.
Results indicated that there was no significant effect attributable to the type of instructional strategy employed. These results indicate the difficulties inherent in implementing and comparing instructional strategies as delineated within Chi’s taxonomy in a classroom environment. Further research is indicated to determine the appropriate strategies that can be implemented within a classroom setting and that will elicit each type of instruction. Another concern that should be addressed through further research is the amount of time devoted to the implementation of each instructional strategy. With further refinement of the research methodology, it is anticipated that a satisfactory answer to the question of the effectiveness of instructional strategies within a classroom setting can be fully addressed.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>LIST OF TABLES</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## CHAPTER

### I. INTRODUCTION

- Rationale for the Study .......................................................... 11
- Summary ................................................................. 13

### II. REVIEW OF THE LITERATURE

- Active Versus Passive Instruction ........................................... 15
- Constructive Instruction ...................................................... 20
- Interactive Instruction .......................................................... 30
- Instructional Strategies Studied in Laboratory Settings ................. 36
- Summary of Instructional Strategies ........................................... 38
- Conclusion ................................................................. 40

### III. METHODOLOGY

- Problem Statement .................................................................... 43
- Hypothesis ............................................................................. 43
- Operational Definitions .......................................................... 43
- Procedure ............................................................................... 46
  - Participants .......................................................................... 47
  - Materials/Instruction Content .................................................. 47
  - Design ................................................................................. 49
- Instructional Strategies ......................................................... 51
- Lecture for Chapter 1 ............................................................. 52
- Unit 1—Chapter 1 Study Guide .................................................. 58
- Assessment Method .................................................................. 61
- Statistical Analysis Procedures .................................................. 69
  - Phase One ............................................................................. 69
  - Phase Two ............................................................................. 70

### IV. RESULTS

- Descriptive Statistics ............................................................... 72
- Summary .................................................................................. 78

### V. DISCUSSION

- Summary/Overview of the Problem .............................................. 79
- Research Question ................................................................... 80
- Findings Related to the Literature ............................................... 80
- Differences Between This Study and Previous Studies .................. 82
LIST OF TABLES

Table                                                                |
Page
1. Active, Constructive, Interactive Characteristics, Overt Activities and Instructional Strategies | 11
2. Mean Exam Scores by Class and Instructional Strategy                  | 73
3. Combined Means by Class and Instructional Strategy                    | 74
4. Means and Standard Deviations by Instructional Strategy               | 75
5. Composite Z scores by Instructional Strategy                           | 76
6. T-test/ANOVA Comparisons of Instructional Strategies by Unit Exam     | 77
CHAPTER I

INTRODUCTION

In classroom environments, a critical goal of instruction is to create knowledge in long-term memory that is maximally useful and transferable to appropriate contexts (Dunlosky, Rawson, Marsh, Nathan & Willingham, 2013; Kirschner, Sweller & Clark, 2006). But the question arises: how best to achieve this goal? A great deal of research has been conducted, some in a laboratory setting (Dorestani, 2005; Chi, Roy & Hausmann, 2008; Muldner, Lam & Chi, 2014), some within the classroom (Freeman, Eddy, McDonough, Smith, Okorafor, Jordt & Wenderoth, 2014; Michel, Cater III & Varela, 2009; McConnell, Steer & Owens, 2003; Paas & Van Merrienboer, 1994), that attempts to address the question of how best to create useful and transferable knowledge in long term memory. Studies that attempt to assess the effectiveness of different instructional strategies are hampered by the application of a variety of terminologies to describe what is occurring in the classroom, making it difficult to compare results across studies. Also, studies conducted within a controlled laboratory setting may clearly indicate the instructional strategy being employed, but many are generally not clear on how these strategies can be transferred to the classroom. This study is intended as an initial foray into the field of effective instructional strategies applied within the classroom, with the hope of informing current practitioners of the most effective means of imparting useful and transferable knowledge in the classroom. Although this study is solely concerned with instructional strategies and the overtly observable learning activities they invoke, the underlying cognitive processes that may correspond to each activity will be discussed in
an effort to help in our understanding of the effectiveness of each instructional strategy and learning activity (Chi, 2009).

The acquisition of knowledge and the best way to impart knowledge from instructor to student has long been a concern for educators. In ancient Greece, for example, Socrates (c. 470-399 BCE) was concerned with how people acquire knowledge and how knowledge can best be imparted from instructor to student. This topic was important because Socrates saw knowledge as the means by which the individual and society may advance (King, Viney & Woody, 2013). During Roman times, Quintillian (35-100 AD) argued for public education to preserve democratic ideals, and advocated good teaching and attractive curriculum to keep students’ interest (Berliner, 1993). By the late fifteenth and early sixteenth centuries, Jean Luis Vivres stressed that knowledge and education were necessary to create social reforms (King et al., 2013). Yet despite the fact that education and instruction have been recognized as integral to society for more than two thousand years, there is still much discussion and disagreement about how best to achieve the education of our students. Thus it is imperative for educators to empirically study instructional strategies to insure that we are utilizing the most effective possible methods of encouraging learning.

A multitude of instructional factors contribute to learning activities. For the purposes of this discussion, we will adopt Bandura’s definition of learning as “knowledge acquisition through cognitive processing of information acquired both from being a part of society and from individual thought processes” (Young, Klemz & Murphy, 2003, p. 131, referencing Bandura, 1986). It has been demonstrated that different overt learning
activities activate different cognitive processes (Chi, 2009), and different instructional strategies can be employed to elicit these different learning activities (Dorestani, 2005) Instructional strategies describe the methods utilized by the instructor in conducting the activities within the classroom (Michel, Cater III & Varela, 2009). These strategies are employed to elicit specific overt and observable learning activities in the students (Chi, 2009). Chi (2009) has suggested that it may also be useful to consider the potential underlying cognitive processes corresponding to each observable activity to gain more understanding into their effectiveness in facilitating learning. Although several researchers have discussed the relative merits of various instructional methods with the types of learning activities involved, and the types of cognitive processes resulting from each, there is often not a sufficient amount of quantified data available to educators to allow them to make competent, informed decisions regarding the best, most effective instructional strategies. Also, the terms used to describe various instructional strategies along with their accompanying learning activities are not always clearly defined or differentiated, resulting in a great deal of confusion as to what is actually being described (Chi, 2009). In an effort to clarify the effectiveness of learning activities, Chi (2009) has suggested a taxonomy that is meant to act as a starting point for considering instructional strategies, the overt learning activities that they elicit, and their effectiveness. Chi’s taxonomy includes three types of activities: active, constructive and interactive activities, and then describes the cognitive processes that each involves. Firstly, active learning activities are defined as activities that require the student to do something, and are characterized by that overt activity (Chi, 2009). In contrast, learning activities that are
considered constructive involve a set of activities that produce additional, sometimes new, content relevant outputs (Chi, 2009). Finally, learning activities that encourage the learner to be interactive can refer to several forms of overt activities such as interacting with another person, responding to a system, or interacting in a way that involves motor movements (Chi, 2008). The taxonomy suggested by Chi to describe the relative effectiveness of these learning activities can be summarized as: passive < active < constructive < interactive (Chi, 2009). Passive instruction is characterized by the instructor lecturing to the students and the students listening (Michel, Cater III & Varela, 2009). Interestingly, although it is well established that instructional methods employing learning activities that allow the students to remain passive recipients of information are less effective than other, more active instructional strategies, these passive forms of instruction are still, all too often employed in the classroom (Harris, 2011; Williams & McClure, 2010). Perhaps this reliance on passive learning activities is due to the lack of a coherent alternative that would allow instructors to employ better instructional strategies, to introduce better learning activities and to know that these strategies are proven empirically to be more effective.

In an effort to provide evidence for more effective instructional strategies, Chi and her colleagues (Chi, DeLeeuw, Chiu & LaVancher, 1994; Chi, Roy & Hausman, 2008; Chi, 2009; Muldner, Lam & Chi, 2014) have amassed an impressive body of research demonstrating that instruction that allows a student to be active, that is, that allows the student to do something, is superior to that which allows the student to be passive, or to simply listen without doing more. This conclusion is supported by the work
of Harris (2011), who indicated that traditional lectures do not stimulate thoughts or change attitudes (citing Huxham, 2005), by Williams and McClure (2010) who found that passive instruction defined as traditional lecture only, was ineffective in knowledge gain and retention as demonstrated by class quiz scores, and by Freeman and his colleagues (2014), who conducted a meta-analysis of 225 studies that compared passive versus active instructional methods in STEM courses. In this analysis, passive instruction was defined as lecture-based which, the authors state, “has been the predominant mode of instruction since universities were founded in Western Europe over 900 years ago” (p.1), while active learning, the authors indicate, engages students in the process of learning through activities and/or discussions in class as opposed to passively listening to an expert (Freeman, Eddy, McDonough, Smith, Okorofo, Jordt & Wonderoth, 2014). Chi (2009) describes the superiority of active activities in engaging the learners in the learning activity by stating that it is likely that by doing activities students are more engaged with the learning materials than they would be by sitting passively, a position supported by Williams and McClure (2010), who state that passive learners demonstrate a lack of engagement within the classroom. In a laboratory setting, Chi and her colleagues (2008) found that active lone observers, those who observed a recorded tutoring session of another while alone, but who wrote problem solving steps down, manipulated the tutoring tape by pausing or rewinding and who posed self-querying questions, gained more in terms of their ability to solve physics problems than passive lone observers who did not engage in these active behaviors. Studies discussing the
various forms of instructional strategies, and the learning activities that result from each will be reviewed in more depth in Chapter 2.

As a general concept, there is ample evidence that instruction that provides learning activities that encourage learners to be active results in superior learning outcomes when compared to instruction that allows the learners to remain passive (Freeman et al., 2014; Dorestani, 2005). Active learning is effective because it encourages students to be actively engaged in the process of learning rather than allowing them to sit passively listening (Freeman et al., 2014). Chi (2009) defines instruction that encourages active learning as including any activity that requires the student to do something physical, such as looking at and searching for something, pointing or gesturing, underlining, copying and pasting, repeating sentences or copying problems, and so forth. In this categorization, note taking is also included as an active activity, when compared to not taking notes, which is passive (Chi, 2009). Active learning has been demonstrated to be effective in fostering knowledge that is capable of being retained for a relatively long time, when compared to passive activities (Dorestani, 2005). Thus, it is preferable to less active activities. However, although instruction that encourages active learning can take many forms, the activity it fosters may be of a somewhat limited nature, in that it does not require the learner to go beyond the information that is presented.

Recognizing the relative limitations of active learning activities, Chi (2009) has described constructive instructional strategies, which result in constructive learning activities, as those that go beyond being active to include further learner involvement. Generally, the characteristics of constructive learning activities are that they require
learners to produce overt outputs and the outputs are not contained in or presented in the instructional materials (Chi, 2009). Constructive learning activity outputs are those in which learners produce new, content relevant ideas, such as self-explaining, drawing a concept map, asking questions, posing problems, comparing and contrasting cases, integrating text with a diagram, making plans, inducing hypotheses, drawing analogies, generating predictions, reflecting and monitoring one’s understanding, and constructing timelines for historical phenomenon (Chi, 2009). Constructive activities allow learners to infer new knowledge, to integrate new information with existing knowledge, to organize and restructure their knowledge or to repair faulty knowledge (Chi, 2009). These activities involve the cognitive processes of comparing, connecting, inferring new ideas, insights, and conclusions, analogizing and generalizing, and integrating new knowledge with old knowledge (Chi, 2009). According to Chi (2009) the types of instructional strategies that may result in constructive activities include strategies such as direct prompting, providing a template to be filled out by the student, or presenting worked examples. According to Chi’s taxonomy, instruction that encourages learners to be constructive has been demonstrated to improve learning outcomes (Chi, 2008).

As an example of a constructive activity, a number of studies have demonstrated the utility of one form, worked examples, for learning and transfer for students from elementary school to university (Rittle-Johnson, 2006; Rittle-Johnson & Star, 2007; Kaminski, Sloutsky & Heckler, 2008). The basic premise of worked examples, which demonstrate an expert-like solution path, is that “a student who has seen a variety of instantiations of a concept may be more likely to recognize a novel analogous situation
and apply what was learned” (Kaminski et al., 2008, p. 454). Another activity that is described as constructive is self-explanation. Self-explanation involves having students explain how concepts are related, explain their understanding of a concept, or explain some aspect of their processing during learning (Dunlosky et al., 2013). Self-explanation encourages the integration of newly learned materials with existing prior knowledge (Chi et al., 1994), and allows the explainer to gain a deeper understanding of the material to be learned (Roscoe & Chi, 2008). Requiring the student to produce some new form of output, then, moves beyond being simply active. In this way the student is more engaged and involved in the learning activity, and the effects have been shown on a wide range of criterion measures, such as improving the acquisition of problem-solving skills, aiding the invention of new problem-solving approaches, supporting the solving of logic puzzles, and facilitating the solving of various types of math problems (Dunlosky et al., 2013; Rittle-Johnson, 2006).

In this model, interactive engagement, which involves the learner talking with another person, responding to a system, or being involved physically with another person (Chi, 2009), moves beyond constructive engagement and provides additional supports for learning (Chi et al., 1994; Jeong & Chi, 2007, Young et al., 2003; Chi, 2009; Muldner et al., 2013). Interactive learning activities may allow participants to achieve knowledge convergence, a process by which several individuals are able to establish mutual understanding of a concept or problem through their social interactions (Jeong & Chi, 2006). As individuals work together to solve a problem, they may coordinate their understandings of the situation and converge their cognitive representations of the
problem so that they are able to understand the positions of others and incorporate those positions into their own view (Jeong & Chi, 2006). In this way, each learner’s perspective is expanded to incorporate the perspective(s) of other group members. Interactive instruction goes beyond constructive instruction in that it is associated with communication skills involving other people, as well as critical thinking, a logical analytical approach to problem solving, and the evaluation of one’s own actions (Enkenberg, 2001).

Instructional strategies that result in interactive learning activities include responding to a system, interacting with another person involving motor activities, interacting with an expert in instructional dialogues, and interacting with a peer in joint dialogues in which both peers make substantive contributions to the topic or concept (Chi, 2009). The goal of these types of interactions is to produce a common mental model (Chi, 2009). There is evidence supporting the notion that students consider learning with other students as effective, as indicated by learners’ self-reports of overall knowledge gained, the skills and abilities they developed and the effort they expended in a particular class (Young et al., 2003; Dorestani, 2005). There is also evidence that cooperative groups of learners achieve at higher levels of thought, retain information learned longer than learners working alone, and perform significantly better on critical thinking tests (Gokhale, 1995; Rittle-Johnson & Star, 2007). The participation of group members among themselves results in group members jointly interpreting a situation, coordinating their understanding, sharing meaning, and coming up with a solution to the problem as a group (Jeong & Chi, 2006; Stahl, 2005).
There are various forms of interactive instruction, including problem-based learning, learning by designing, case-based teaching and cognitive apprenticeships, for example, and they all share a common theme (Enkenberg, 2001): they stress the interaction among students to construct, rather than convey, knowledge. One of the main benefits of interactive instruction is that it allows students to interact with each other in joint dialogues, in which both, or all, participants make substantive contributions to the topic or concept under discussion, thus each participant can build on the other’s contribution (Chi, 2009). Proponents of interactive instruction point to its generalizability to real world situations as supportive of its effectiveness. A drawback to interactive learning is that it can be a time-consuming process: student-centered groups may be difficult for the teacher to initiate and manage (Bruning, Schraw & Norby, 2011), and if a specific conclusion is required, the process may fail to yield that conclusion (Ormrod, 2012). The challenge for educators employing these strategies is to assess the results of the group interactive process.
Table 1

Active, Constructive and Interactive Characteristics, Overt Activities and Instructional Strategies (Adapted from Chi, 2009)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Active</th>
<th>Constructive</th>
<th>Interactive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overt activities</td>
<td>Doing something physically</td>
<td>Producing outputs that go beyond the presented information</td>
<td>Dialoguing on a topic and considering the partner’s contribution</td>
</tr>
<tr>
<td>Instructional</td>
<td>Look, gaze Underline Point, select Paraphrase</td>
<td>Explain or elaborate provide reasons construct a concept map, connect</td>
<td>Respond to scaffoldings revise errors argue, defend confront</td>
</tr>
<tr>
<td>Strategies</td>
<td>Questioning students, encouraging Note taking</td>
<td>Self-explaining, explaining to others, worked examples</td>
<td>Group problem solving</td>
</tr>
</tbody>
</table>

Rationale for the Study

Based upon the evidence, active instruction eliciting active learning activities is superior to passive instruction which elicits passive learning activities (Williams & McClure, 2010; Dorestani, 2005), while constructive instruction and constructive learning activities are superior to active instruction, and interactive instruction and learning activities are superior to constructive instruction (Chi, 2009). However, much of the research supporting these conclusions was conducted within the confines of the laboratory setting, or with small, controlled groups (Chi, 2009). Basic research on cognition, problem solving and learning often provides clear results in lab settings, however, applying these findings to the classroom often fails to produce expected effects (Mayer, 2012; Dunlosky & Rawson, 2012). Also, as Chi (2009) has indicated, there
appears to be a lack of consensus within the research community regarding the use of the terms “active”, “constructive” and “interactive”. Thus for the purposes of this study, the definitions of terms adopted in Chi’s (2009) taxonomy will be applied so that the different strategies can fully be evaluated for their effectiveness in the classroom. Since the ultimate goal of research into the effectiveness of instructional strategies must be to inform educators in the field as to what works best within the classroom, it is essential to replicate these findings in actual classrooms, and with a clear understanding of the strategies used to elicit each type of instruction. Thus it is necessary to adequately describe and adapt the various instructional strategies eliciting the accompanying learning activities to allow them to be employed in the classroom and to assess the learning outcomes within the classroom, to determine whether the results obtained in the laboratory or in a small confined group are able to be duplicated in a real classroom. This is the rationale for the present study:

1. to create classroom-based implementations of the instructional strategies and learning activities defined above as active, constructive and interactive,

2. to test whether the lab-based results of the relative effectiveness of different instructional strategies and learning activities can be obtained in a classroom setting. Specifically, that learning is greater for active compared to passive activities, greater for constructive compared to active activities, and greater for interactive compared to constructive activities.
Summary

In all instances, the effectiveness of an instructional strategy and its accompanying learning activity will be measured using the learning outcomes of the students, as measured by their performance on class exams. Thus the research question being addressed here is, does constructive instruction yield better learning outcomes than active and does interactive instruction yield better learning outcomes than either active or constructive instruction in a real classroom setting? The results of this study have real world implications because they inform classroom teachers of the efficacy of different instructional strategies that they can employ in their classrooms to improve the ultimate learning outcomes of their students.
CHAPTER II

REVIEW OF THE LITERATURE

“Tell me and I forget.

Teach me and I remember. Involve me and I learn.”

~(Benjamin Franklin, cited in Chi, 2009)

This saying illustrates three types of instruction differentiated explicitly in the theoretical framework that guides this intervention (Chi, 2009). This framework is formed by the taxonomy developed by Chi (2009) that differentiates four levels of learning activity fostered by specific types of instruction: passive instruction, active instruction (“Teach me and I remember”), constructive instruction, and interactive instruction (“Involve me and I learn”). In classroom environments, multiple instructional factors may contribute to learning, and separating out which instructional factor is associated with the greatest learning outcomes is difficult (Young, Klemz, & Murphy, 2003). Laboratory settings, of course, have the advantage of allowing for control of variables not always possible in the classroom. Research within the classroom does not always allow for complete control of all possible variables, thus implementation of research strategies within the classroom context presents unique issues of implementation. In addition, the meanings of the terms are not always clearly defined both conceptually and operationally. In psychology it is not unusual for researchers to be confounded by the jingle jangle of words, the “jingle” being the tendency to use common terms to refer to different underlying conceptions (Duckworth & Schulze, 2009, p. 3, citing Thorndike,
1904), and the “jangle” being the use of different terms to describe common underlying conceptions (Duckworth & Schulze, 2009, p. 3, citing Kelley, 1927).

The following sections will provide details on the theoretical framework to be implemented in a classroom-based research project: the taxonomy developed by Chi (2009). The first step is to provide clear conceptual and operational definitions for the main concepts. Specifically, to differentiate passive, active, constructive and interactive learning activities, the cognitive processes underlying each, the type of instruction implemented based on each, and the type of learning that should result from each. Next, we will explore the differences between research that is conducted the laboratory compared to that which has been conducted in the classroom. We will then consider how to implement each instructional strategy in a classroom setting to produce the best learning outcomes in the classroom.

**Active Versus Passive Instruction**

Passive instruction is characterized by the instructor lecturing to the students, either with or without an accompanying PowerPoint slide presentation, and is prevalent in the teaching approach of many college professors (Michel, Cater III & Varela, 2009). In this type of instruction, student activity is limited to simply listening, possibly taking some notes and asking an occasional question (Freeman et al., 2014). Students in a passive instruction type of classroom are provided a syllabus, a class schedule and are given exams, usually of a limited number (Michel, Cater III & Varela, 2009). Passive instruction may lead the student to memorize the given information, resulting in the creation of declarative knowledge, but not in the formation of deeper cognitive processes
(Michel, Cater III & Varela, 2009). Passive instruction has also been linked to a drop in student attention, a decrease in retention, and a decline in student intrinsic motivation (Cooper et al., 2010; Benware & Deci, 1984).

In contrast to passive instruction, active instruction incorporates those activities considered passive, but moves beyond them and encourages students to do something more than just listening while learning: students are engaged in activities such as reading, accompanied by discussing and writing (Chi, 2009; Michel, Cater III & Varela, 2009; Dorestani, 2005). Active learning has been defined as learning that engages students in the process of learning through activities and/or discussions in class, as opposed to passively listening to instruction (Freeman et al., 2014). The active learning that results from active focused instruction is characterized by the overt activities of the learners, such as those mentioned above, and involves the cognitive processes of attending, searching existing knowledge, and encoding new information (Chi, 2009). It activates the learner’s existing knowledge base, adding information to the existing database and expanding it. It may also involve repairing misconceptions and misunderstandings (Chi, 2009). In a study that directly compared passive instruction to active instruction, Michel and his colleagues (2009) demonstrated that both forms of instruction involve the cognitive process of creating declarative knowledge, however, active instruction was more effective at achieving this than was passive instruction. Numerous other studies have also demonstrated that active learning is more effective learning when compared to passive learning (Svinicki, 1998; Dorestani, 2005). Active learning has been demonstrated to be a more effective way to ensure thorough initial learning and long-
term retention (Svinicki, 1998; Dean, Jr., & Kuhn, 2006). Passive learning ("Tell me and I forget.") has been identified as being prevalent in the teaching approach taken by many professors, who deliver lectures for the majority of the class time, affording little opportunity for student input (Michel, Cater III & Varela, 2009).

Active learning can include such activities as looking at and searching, pointing to, gazing, underlining or copying, repeating sentences or copying problems, summarizing, and manipulating videos, among others (Chi, 2009). Active learning engages the student, and stimulates student involvement in the class (Michel et al., 2009).

In their study comparing passive instruction with active instruction in Earth Science classes, McConnell, Steer and Owens (2003) found that, in the traditional lecture class, only a handful of students participated in discussions, whereas in the active class, in which instructors built learner participation into the class through exercises that asked the students to apply newly acquired knowledge to solve problems by responding to concept test questions on an electronic personal response system, a substantial majority of students were actively engaged. These researchers found that students in the active classes slightly outperformed the lecture only classes on exams and scored higher on the Group Assessment of Logical Thinking (GALT) test (McConnell et al., 2003). In another study that examined the effectiveness of active versus passive instruction for nursing students, passive (lecture only) instruction was demonstrated to decrease student participation and to result in the retention of merely 10-20% of the information presented (Harris, 2011). In this study, the active instruction included the use of video casting-the delivery of audio and video content on demand, and Voice Thread, which allowed
students to be involved in online discussions about uploaded videos and presentations. In class activities included simulation games, concept maps and role-play. The students’ activities in the active instruction groups were clearly more active, engaging in more participatory events, when compared to lecture alone, but the study was unclear as to the amount of time the students utilized Voice Thread, an activity which potentially could move the instruction from simply being active to being interactive according to Chi’s (2009) taxonomy.

In a recent meta-analysis of active learning in STEM subjects, active learning, which was interpreted broadly to include such activities as group problem solving (which would be classified as interactive in the taxonomy; Chi, 2009), tutorials completed during class, use of personal response systems, and workshops, among others, was demonstrated to increase students’ exam performance by just under half a standard deviation when compared to passive learning, defined as lecture only, while passively listening to lectures without further activity, increased students’ failure rates by 55% (Freeman et al., 2014). As mentioned above, for the purposes of this meta-analysis, the instructional techniques defined as active varied widely in intensity and implementation and included a wide variety of activities. Although all of the included activities described as active are in fact active, according to the taxonomy described by Chi (2009), many, such as workshops, tutorials, and group problem solving may also be considered constructive or interactive, and it is difficult to parse out these different approaches in these data. However, what is apparent in this study is that the increases in achievement demonstrated in this meta-analysis held across all of the STEM disciplines and occurred in classes of all sizes,
course types and course levels. Active learning (which may have included both constructive and interactive instruction) was demonstrated to be particularly beneficial in small classes and as performance or concepts became more demanding (Freeman, et al., 2014).

In a study comparing the learning outcomes of students in business classes taught in what was described in either a passive format (lecture based) or an active format (which incorporated elements of experiential, problem-based, participative and cooperative learning), the active students scored approximately four percentage points higher than the passive students on both the mean and median of their exam scores, a difference which was significant (Michel et al., 2009). The researchers that conducted this study acknowledge the idea that active learning is a broadly used term that describes several models of instruction that hold learners responsible for their own learning. In this study, the active groups were divided into small groups and assigned business projects that were due at the end of the semester. The instructor served as a facilitator for the groups, and the groups engaged in group discussions every class. Students were quizzed at the beginning of each class on their mastery of the content covered in the class. From this description it is apparent that, although the authors (Michel et al., 2009) characterize their intervention as active, Chi’s (2009) taxonomy would classify this form of instruction interactive.

From the above described studies, we see that instruction that leads to active learning has been demonstrated to be superior to instruction that leads to passive learning: active learners activate existing knowledge, assimilate, encode or store new
information and search their existing knowledge bases in the course of their learning (Chi, 2009), all of which result in improved learning outcomes. Because passive instruction has not been demonstrated to be an effective instructional strategy, and passive learning has not been demonstrated to lead to long-term retention, passive instruction was not included in the study described here.

Further, we have seen that there appear to be conflicting definitions of active learning (Michel et al., 2009). Because of this, much research that is categorized as describing active instruction and/or learning is actually describing other forms of instruction that may provide different types of support for learning. The present framework differentiates constructive learning and interactive learning from active learning, to distinguish underlying cognitive processes, instructional strategies, and to determine which form of instruction is most beneficial to learners. Therefore, we will move on to consider constructive instruction and learning and interactive instruction and learning to better clarify the strengths and weakness of each as compared to active instruction and learning.

**Constructive Instruction**

The terms constructive instruction and learning are used to describe instructional activities in which learners are active and produce additional outputs that contain new, content relevant ideas that go beyond the information given; thus the learner is moving beyond the initial information given, assimilating it and constructing new knowledge (Chi, 2009). An activity is only considered constructive if the learner has produced something new that was not initially presented in the learning materials. Activities
considered to be constructive include drawing a concept map, generating and asking questions, posing problems, comparing and contrasting cases, integrating text with a diagram, generating predictions, reflecting and monitoring one’s understanding and more (Chi, 2009). Constructive activities allow learners to infer new knowledge, to integrate new information with existing knowledge, to organize their own knowledge so that it becomes more coherent, to repair their own faulty knowledge, and to restructure their own knowledge (Chi, 2009). The cognitive processes involved in constructive learning include comparing, connecting, inferring new ideas, new insights, new conclusions, analogizing and generalizing, and integrating new knowledge with old knowledge (Chi, 2009). Constructive learning is best supported by methods of instruction that allow learners to activate knowledge to be used to make sense of new, incoming information and to integrate the new information with the appropriate preexisting knowledge (Mayer, 2004). Strategies that are frequently used in the classroom to encourage and elicit constructive activities include worked examples, self-explaining or explaining to others, discovery learning and inquiry-based classrooms (Chi, 2009; Chi, DeLeeuw, Chiu, & LaVancher, 1994; Chi et al., 2008). Implicit in these instructional strategies are activities such as exploring, comparing, connecting, analyzing, or generalizing. Construction is involved when learners make connections and perceive separate objects as being part of a unit, when they plan and predict outcomes, or when they construct cognitive maps that describe how their environment is laid out (Ormrod, 2012; Chi, 2009). To encourage constructive learning in the classroom, we have already mentioned strategies such as worked examples, inquiry-based classrooms, discovery learning, and self-explanation
or explaining to others, all of which encourage the learner to engage in constructive actions rather than passive ones. We will consider these strategies in more detail herein.

Worked examples typically consist of a problem-statement, one or more solution steps, and the final solution to the problem (Atkinson & Renkl, 2007). The basic premise of worked examples is that a student who has seen a variety of instantiations of a concept will be more likely to recognize a new and analogous situation and to apply the concept appropriately to this new example (Kaminski, Sloutsky & Heckler, 2008). Research on learning from worked examples has shown that they are effective because learners gain a deeper understanding of the problem by decomposing the example steps and then linking them to the underlying principles to be learned (Roscoe & Chi, 2008). A large number of studies have demonstrated the utility of worked examples for learning and transfer for students from elementary school to university (Paas & VanMerrienboer, 1994; Atkinson & Rankl, 2007; Rittle-Johnson & Star, 2007; McLaren, Lim & Koedinger, 2008). Worked examples have been demonstrated to be particularly beneficial for learners with a low level of prior knowledge in the domain (Atkinson & Renkl, 2007).

Worked examples have also been particularly successful in teaching mathematics, where the presentation of numerous solved problems appears to result in the development of an abstract representation of the problem, which in turn is able to be transferred to novel problems (Rittle-Johnson & Starr, 2007; Kaminski et al., 2008). In a study that employed worked examples in the instruction of geometric principles, results indicated that training with worked examples required less time, was perceived as demanding less mental effort, and resulted in better transfer than training with conventional problems,
where only the problems were presented, without the solutions (Paas & VanMerrienboer, 1994).

A further aspect of worked examples that makes it attractive for teachers is its ease of use. The teacher need merely provide students with several examples of how a problem is to be solved, and the student constructs his or her own knowledge from there. Constructive learning from worked examples has been demonstrated to be superior to passive learning like that provided by lecture or explanation alone (Chi, 2009).

Another constructive approach to classroom learning, inquiry-based classrooms, are those that provide learning via guided, scaffolded participation in activities, which promotes constructive learning, rather than via a lecture format, (Bruning et al., 2011). This is in contrast to discovery learning, in which students are free to explore their learning environment on their own, with little or no teacher guidance (Mayer, 2004). The role of the teacher in an inquiry-based classroom is in providing guidance for participation in activities, but the instruction is learner-centered, and is not dictated by the teacher’s agenda (Bruning et al., 2011).

Teacher-provided scaffolding in inquiry-based instruction has been demonstrated to elicit meaningful and elaborate joint construction of information (Chi et al., 2008). In a study conducted by Chi and her colleagues (2008), tutors provided scaffolding to tutees, who then provided constructive responses. Learning outcomes improved both for the tutees who received the tutor provided scaffolding and also for those students who observed these interactions with another student with whom they could interact (Chi et al., 2008). In a study conducted by Reid, Zhang and Chen (2003) studying scientific
discovery learning in a computer simulation environment, several types of support were provided to the 12 and 13-year-old science students, including interpretive support, experimental support and reflective support. Interpretive support helped the learners to conduct their learning activities and to generate understanding. Experimental support helped the learners design scientific experiments, predict and observe outcomes, and draw conclusions. Reflective support helped the learners understand and integrate their discoveries (Reid, Zhang & Chen, 2003). Illustrating the difficulty in identifying the appropriate terminology in describing instructional strategies, the researchers in this study characterized the instruction as discovery-based, however it clearly fits with the above definition of inquiry based instruction, since various forms of scaffolding were incorporated into the instruction (Reid, Zhang & Chen, 2003).

In contrast to the instruction provided in inquiry-based classrooms is discovery learning, where the child has a chance to investigate objects on his or her own. Generally speaking, discovery learning is based upon the idea that, if given the chance to explore, a child will discover certain concepts independently. This is much like the process that preschoolers go through all the time in learning from their environment, and thus can be seen as a natural way in which children can learn. It also echoes Piaget’s assertion that teaching a child something prematurely keeps the child from inventing it himself, and consequently prevents complete understanding (Piaget, 1970, cited in Klahr and Nigam, 2004). Unlike inquiry-based instruction, where the teacher provides guidance for the learning activities, the effectiveness of discovery learning depends on how likely the learner is to discover the target information or novel information on his or her own. In a
study conducted by Bonawitz and her colleagues (2011), for example, preschoolers were presented with a novel toy and were either shown how the toy could be manipulated or left to discover what the toy could do on their own. The children who were presented with the demonstration played with the toy less, performed fewer actions on the toy and discovered fewer target functions than the children left to discover the actions of the toy themselves. These results led to the conclusion that one limitation of passive instruction is that children exposed to this form of instruction may infer that there is nothing more to be learned about an object after a knowledgeable teacher provides evidence of an object’s function, and will not make an effort to further explore the object (Bonawitz et al., 2011).

A possible advantage of discovery learning is that research has demonstrated that children who discover their own procedures may have better transfer and conceptual knowledge than children who were only exposed to passive instruction (Rittle-Johnson, 2006; Dean, Jr., & Kuhn, 2006). According to proponents of discovery learning, in discovery learning the learner is actively participating in the learning process and the information learned is considered to be more meaningful to the learner than information received from someone else (Svinicki, 1998). However, detractors point out that this form of learning may be inefficient and the learners may simply not learn the information that they were intended to learn (Mayer, 2004).

From the above discussion we have seen that worked examples, inquiry-based instruction and discovery learning all offer constructive learning opportunities and can be used in a classroom setting, although they vary in how much control the teacher will exert over the learning environment. Another activity that Chi has described as constructive is
self-explanation (Chi et al., 1994). In the technique of self-explanation the learner explains some aspect of his or her thought processing during learning (Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013), and generates explanations of correct material by him or herself rather than explaining the learner’s own, potentially incorrect, solutions or adopting explanations provided by others (Rittle-Johnson, 2006). Self-explanation is generally accepted as an important, effective, and domain-general means to improve learning (Rittle-Johnson, 2006). One reason that self-explanation is an effective learning strategy is that it facilitates the integration of new information into existing knowledge (Chi et al., 1994). Generally speaking, providing an explanation is helpful to the person who is doing the explaining because it helps him or her organize material so that the explanation can be formulated. It also encourages the retrieval of necessary information from long-term memory, which is then constructed into an explanation (Ormrod, 2012). Self-explanation has been demonstrated to be an effective means of improving the acquisition of problem-solving skills, aids the invention of new problem-solving approaches, supports the solving of logic puzzles, and facilitates the solving of various types of math problems (Rittle-Johnson, 2006; Dunlosky et al., 2013). To be effective, however, these self-explanations must be meaningful elaborations that go beyond the information that was initially presented (Chi, 2009); simply repeating back information in a rote manner will not elicit the benefits of self explanation.

Self-explanation is a constructive activity because it generates new declarative or procedural knowledge. Self-explanation also encourages the integration of newly learned materials with existing knowledge (Chi et al., 1994). During self-explanation
learners monitor their own comprehension and generate inferences to fill in gaps in their knowledge or to revise misunderstandings (Roscoe & Chi, 2008).

In a study reported by Chi and her colleagues (1994) involving self-explanation, students were given passages to read regarding the circulatory system, and then were presented with questions regarding the passage they had read. Results indicated that those participants who engaged in a great deal of self-explanation demonstrated higher gains in individual achievement than did those who engaged in less self-explaining. These effects were apparent regardless of whether the participants were described as having high or low ability. In another study, third to fifth graders were given prompts to self-explain mathematical equivalence problems to determine the effect of the explanation on procedural learning, procedural transfer, and conceptual understanding (Rittle-Johnson, 2006). According to the results of this study, both generating self-explanations and receiving direct instruction led to procedural learning, but prompts to self-explain led to greater learning and transfer than did direct instruction, and these benefits were maintained over time (Rittle-Johnson, 2006). Self-explanation has also been demonstrated to enhance the effectiveness of other instructional strategies such as worked examples. Atkinson and Renkl (2007) have indicated that, while worked examples are an effective source of instruction, particularly for learners with low levels of specific knowledge in the domain, their beneficial effects are more likely to be realized when the learners actively process the examples by engaging in productive self-explanation activities. Other studies that looked at the effects of worked examples paired with self-explanation found significant positive effects on far transfer, indicating that the
combination of the two constructive activities are likely to have an effect on conceptual learning rather than just on short-term learning (McLaren et al., 2008). Rittle-Johnson (2006), however, did not find that self-explanation improved conceptual knowledge, but, as indicated earlier, did find that it improved learning and transfer of the mathematical equivalence concepts being taught.

Beyond making strategies such as worked examples more effective, implementation of self-explanation, simply having students explain their processing during learning activities, has been demonstrated to be effective on a wide range of criterion measures, and facilitated an impressive range of learning outcomes across a range of tasks and content domains (Dunlosky et al., 2013). For example, Dunlosky et al. (2013) found that self-explanations support the solving of logic puzzles, the solving of various math problems, and helped younger students overcome various kinds of misconceptions, improving their understanding of false beliefs. Another benefit of self-explanations is that students can profit from this instructional technique with minimal training and the effects are consistent across age ranges and across a range of learning outcomes (Dunlosky et al., 2013).

The above discussion demonstrates that self-explanation helps learners retrieve and organize information, allows for the integration of new information into existing knowledge (Chi et al., 1994), and improves learning and transfer (Rittle-Johnson, 2006). It allows learners to monitor their own comprehension and generate inferences to fill in gaps in their knowledge or to revise misunderstandings (Roscoe & Chi, 2008). It also has the benefit of being easy to train students to use.
Having demonstrated the efficacy of self-explanation in improving learning outcomes, an open question is whether explaining to others is as effective as self-explanation. Explanations to others may provide the same learning benefits as self-explanations, because the explanations have to be constructed, requiring the same processes of organization and retrieval as self-explanations. However, in a study conducted by Roscoe and Chi (2008), students’ learning outcomes were compared between students who tutored a peer and students who self-explained the material. Contrary to expectation, the students who self-explained demonstrated superior learning outcomes to those who tutored a peer, an example of explaining to others. These results were explained by observing that, in the peer tutoring sessions most of the knowledge building was initiated by the tutees, whereas in the self-explanations students engaged in more reflective knowledge building, including self-monitoring, knowledge integration and generation of inferences (Roscoe & Chi, 2008). Thus the difference in learning outcomes may be attributable to the fact that the student tutors were attempting to meet the needs of the tutees, and were not engaged in the cognitive processes of organization and retrieval required by self-explanation, while the self-explainers were concerned solely with their own knowledge building.

From the above discussion, we see that the process of constructing an explanation of a learning event, either to oneself or to another person, results in improved understanding and learning outcomes. Explanation allows the learner to retrieve and organize relevant information, which improves retention. This leads us to explore the advantages of interactive instruction more generally.
Interactive Instruction

Some of the previously discussed instructional and learning activities are not only constructive, but may also be interactive. Interactive learning, also referred to in the literature as collaborative learning, can involve a learner talking with another person or persons, responding to a system, or in interaction that involves motor movements (Chi, 2009). It can involve collaborating with an expert in instructional dialogues or engaging with a peer or several peers in joint dialogues, where both or all of the peers make substantive contributions to the topic or concept (Chi, 2009). During interactive learning, learners jointly interpret a situation, coordinate their understanding, and come up with a solution to a problem together (Jeong & Chi, 2006). The key ingredients for interactive problem solving include providing support to help learners engage in learning activities effectively, gradual withdrawal of support and providing tools that help learners to learn (Goncu & Gauvain, 2011). The goal of this interaction is for the learners to jointly construct or produce a shared mental model through processes such as discussion, augmentation and negotiation (Chi, 2009; Goncu & Gauvain, 2011). The cognitive processes that underlie interactive learning activities are much the same as those that underlie constructive learning activities, such as comparing, connecting, inferring, generating conclusions, analogizing and generalizing, and integrating new knowledge with existing knowledge (Chi, 2009). However, in interactive activities, the learner has the benefit of the interactions with another agent, which may provide additional information, new perspectives, corrective feedback, and possibly a new line of reasoning to pursue (Goncu & Gauvain, 2011). Interactive activities also allow for the formation of
shared mental models, which allow individuals within interactive groups to organize their knowledge collaboratively so that they can recognize relationships within the environment and construct expectations (Mathieu, Heffner, Goodwin, Salas & Cannon-Bowers, 2000). In the classroom, activities that facilitate interactive learning include small group problem solving, having students write test questions and discuss them in small groups, allowing students to complete quizzes in small groups and/or having teams of students debate relevant issues.

In general, studies that have looked at the benefits of interactive instruction have demonstrated that collaborative interaction allows learners to share knowledge, which appears to increase in the learners’ common knowledge (Jeong & Chi, 2006). This increase in the knowledge of each of the learners involved in interactive instruction is described as “knowledge convergence” (Jeong & Chi, 2006, p. 287). Knowledge convergence is defined as the process by which “two or more people share mutual understanding through social interactions”, and reflects the social nature of knowledge construction (Jeong & Chi, 2006, p.287). As learners interact, so long as all participants participate in the interaction, they jointly interpret a situation, coordinate their understanding, and come up with a solution to a problem together (Jeong & Chi, 2006). The jointly constructed knowledge can come either from members of the interactive group experiencing the same environmental and cultural condition, or it may result from the actions of the members of the group in collaboratively interpreting a situation or solving a problem together (Jeong & Chi, 2006). Regardless of the source of the knowledge convergence, learning with a partner or partners increases the amount of
knowledge accumulated as well as improving the accuracy of the mental model constructed (Jeong & Chi, 2006).

Interactive learning takes place through a process of shared meaning making, where the meaning is not simply transferred from mind to mind, but it is constructed through the activities of the group members (Stahl, 2003). In a study reported by Young and his colleagues (2003), working on group projects enhanced learners’ self-reports of their performance and resulted in improved course grades. Instruction geared toward interactive learning changes the role of the instructor to a more informal coach-like role, which may facilitate student-faculty interaction by allowing for more of a collaborative relationship (Young et al., 2003). The benefits of interactive learning were also demonstrated when learners observed other students being tutored: when observers were able to interact with other observers, the learning outcomes for the interactive observers were the same as for the students being tutored (Chi et al., 2008; Muldner et al., 2014).

A potential problem with interactive instruction is that not all dialogue patterns are interactive at all: one participant may control the interaction. For an instructional strategy to be truly interactive all participants must make substantive contributions to the topic or concept under discussion (Chi, 2009); a “critical mass” of learners’ active participation is necessary (Hron & Friedrich, 2003, p. 72).

Because of the need to assure that all group members participate, small groups would appear to be more effective in encouraging all members’ interaction than larger groups (Hron & Friedrich, 2003). However, smaller groups may limit diversity and have
less varied expertise (Gokhale, 1995), so the choice of group size may require some trade-offs.

The problems associated with assuring all participants’ contributing to discussion aside, interactive instruction is supported by the tenants of the Socio-cultural Theory of development in that it recognizes the importance of group interactions in learning (Stahl, 2003; Hull & Saxon, 2009). According to this theory, knowledge is built on interactions between group members that cannot be attributed to any individual group member alone; it is the process by which two or more people share mutual understanding through social interaction, and students can perform at higher levels in interaction with one another than they can when they work individually (Gokhale, 1995; Jeong & Chi, 2007). It is this participation of the group members among themselves that results in shared meaning and understanding (Stahl, 2005). Although there are various forms of interactive instruction, including problem-based learning, learning by designing, case-based teaching and cognitive apprenticeships, for example, they all share a common theme (Enkenberg, 2001). That is, they stress the interaction among students to construct, rather than convey, knowledge, and proponents indicate that interaction promotes critical thinking, and that cooperative teams demonstrate higher achievement levels and longer retention than do students who work quietly alone (Gokhale, 1995). For interactive instruction to be effective, in working within a small group environment, students should engage in a common and authentic task where each group member depends on and is accountable to one another, leading to a deeper level of learning, shared understanding, critical thinking and long-term retention of the learned materials for all group members (Tsai, 2011). In
the classroom, when interactive instruction is initiated, it is important for the teacher to clearly specify the academic task, and then to explain how the collaborative or interactive learning structure is to be implemented (Gokhale, 1995).

In a study that looked at the effectiveness of one form of interactive instruction, problem based learning (PBL), Schmidt and colleagues (Schmidt, Loyens, van Gog & Paas, 2007) presented carefully constructed “problems” to small groups of learners. PBL attempts to create a learning environment that allows students to learn in the context of meaningful problems, to actively construct mental models to help in understanding the problems, using prior knowledge, and to learn through sharing cognitions with other group members. The activation of prior knowledge and elaboration are considered crucial processes in PBL. Like Gokhale (1995), Schmidt et al. (2007) emphasize the need to train and familiarize students with the interactive process prior to the start of instruction. Results of this study indicated that the interactive approach utilized in PBL allowed for flexible guidance from a tutor and was compatible with the activation of prior knowledge and elaboration, resulting in improved learning (Schmidt et al., 2007). In a similar study that compared learning outcomes for seventh grade math students who were either encouraged to compare their problem solutions with a partner or who solved the problems on their own, Rittle-Johnson and Star (2007) found that students in the compare group made greater gains in procedural knowledge and flexibility, again supporting the effectiveness of interactive instructional activities.

Interactive instruction has also been demonstrated to be effective in an online class environment. Hull and Saxon (2009) compared the learning outcomes for two
groups of online math students: one group that solved problems independently and one that worked in groups of 3 or 4 students. These researchers found that the differences between the treatment (group solvers) and control (independent solvers) groups were significant, with the groups that worked together to co-construct their knowledge demonstrating superior learning outcomes. In a study conducted by Benbunan-Fich and Hiltz (1999), online students were assigned to solve an ethical dilemma either alone or in a group. According to the results, the students working in groups submitted better and longer reports and were more satisfied with their solutions than were the students working alone. The groups in this study appeared to serve as a resource to reduce anxiety and uncertainty of group members and to increase their satisfaction with the outcome, as indicated by participants’ responses to a post-test questionnaire (Benbunan-Fich & Hiltz, 1999).

Proponents of interactive instruction point out that many of the ultimate goals for learning, those skills needed for success in adult life, are facilitated by this approach. For example, students will eventually need to cope with change, work in teams, and demonstrate self-directed learning as adults. These skills, it is argued, are all fostered within an interactive instructional design, that encourages learners to jointly interpret a situation, coordinate their understanding and come up with a solution to a problem together (Jeong & Chi, 2006). Interactive instruction also fosters “communication skills, critical thinking, a logical analytical approach to problem solving, and the evaluation of one’s own actions” (Enkenberg, 2001, p. 498). Thus, proponents of interactive instruction point to its generalizability to real world situations as supportive of its effectiveness.
Interactive interaction allows learners to share knowledge and is responsible “knowledge convergence” in which “two or more people share mutual understanding through social interactions” (Jeong & Chi, 2006, p.287).

A drawback of interactive learning is that it can be a time consuming process and student-centered groups may be difficult for the teacher to initiate and manage (Bruning et al., 2011). As was seen with discovery learning, since information is structured so that learners can draw conclusions for themselves, the process is unpredictable, and it may be difficult to accurately assess learning outcomes. There is also concern that the minimal guidance provided during interactive instruction may be significantly less effective and efficient than guidance specifically designed to support the cognitive processes necessary for learning (Kirschner et al., 2006). In fact, if the instruction is completely unguided, students may acquire misconceptions or incomplete or disorganized knowledge (Kirschner et al., 2006). Kirschner and colleagues (2006) have also raised the concern that this type of minimally guided instruction places a significant burden on working memory, and because working memory is burdened by the need to search for problem solutions, it is not available to use to learn. The challenge for educators employing these strategies is to assess just how much knowledge the group was able to construct themselves, and the accuracy of this knowledge, as a result of their interaction.

**Instructional Strategies Studied in Laboratory Settings**

When evaluating the effectiveness of instructional strategies, it is important to differentiate each strategy being evaluated. Active instructional strategies facilitate active learning, which engages the learners through activities such as reading, writing or
discussing (Chi, 2009; Michel, Cater III & Varela, 2009; Dorestani, 2005). The overt activities engaged in by the learners involve the cognitive processes of attending, searching for and activating existing knowledge, and encoding new information (Chi, 2009). In contrast, constructive instructional strategies encourage learners to produce additional outputs that contain new, relevant ideas that go beyond the information provided (Chi, 2009). Constructive activities allow learners to infer new knowledge, to organize their knowledge and to restructure their knowledge to repair faulty knowledge (Chi, 2009). Activities that facilitate constructive learning include worked examples, explaining to the self or others, and inquiry-based classrooms (Chi, DeLeeuw, Chiu & LaVancher, 1994; Chi et al., 2008; Chi, 2009). Interactive instruction encourages the learner to interact with another person or persons in a group, or to interact with a system (Chi, 2009). During interactive activities, learners jointly interpret a situation, coordinate their understanding and come up with a solution to a problem together (Jeong & Chi, 2006).

In some of Chi’s research regarding the effectiveness of instructional strategies, variables are controlled in a laboratory setting to assure that the type of instruction being studied falls clearly within one of the categories included in the taxonomy (Chi, Roy & Hausmann, 2008; Muldner, Lam & Chi, 2014). In several laboratory studies comparing subjects’ observations of tutoring sessions of others, Chi and her colleagues demonstrated that active observers, those who were encouraged to become active and constructive observers through interacting with peers, gained more than passive observers (Chi, Roy & Hausmann, 2008). In these studies, the observers’ access to the conversation between
the tutor and the tutee was considered essential to learning vicariously, and results indicated that there were no significant differences between the conditions of being tutored directly, observing the tutoring session with a collaborator, and working collaboratively with another student. These results demonstrate the superiority of being active in the learning environment, and the collaboration, either between two observers of a tutoring session or between two students learning material in collaboration further demonstrates the effectiveness of interaction in instruction (Chi et al., 2008; Muldner et al., 2014). Thus, the results of comparisons of instructional strategies in the laboratory, which encourage either active or interactive learning activities, support the differentiation of instructional strategies and learning activities described in Chi’s (2009) taxonomy.

**Summary of Instructional Strategies**

We have seen that interactive learning increases learners’ interest in learning activities, and there is evidence that cooperative groups of learners achieve at higher levels of achievement, retain information learned longer than learners working alone, and perform significantly better on critical thinking tests, where learners were required to transfer learned methods to novel problems (Gokhale, 1995; Rittle-Johnson & Star, 2007). The superiority of interactive or collaborative instruction is supported by Sociocultural Theorists, who point out that collaborative or joint problem solving is fundamental to learning and development (Goncu & Gauvain, 2011). According to Vygotsky, the use of language in interactions differentiates humans from other species and is essential to our development (Goncu & Gauvain, 2011). Learning thus emerges from the joint construction of understanding through these social interactions (Goncu & Gauvain, 2011).
Constructive instruction and activities involve learners producing additional outputs not contained in the information originally given. These activities allow learners to infer new knowledge, to integrate new information with existing knowledge and to organize their own knowledge (Chi, 2009). However, constructivist and interactive instruction are not without their critics. Kirschner, Sweller, and Clark (2006) have expressed their concern regarding the lack of sufficient guidance in many of the programs instituted under these instructional methods. According to Kirschner et al. (2006), minimally guided instruction places a huge burden on working memory, and because working memory is burdened by the need to search for problem solutions, it is not available to use to learn. This assertion has been contradicted by Schmidt and his colleagues (2007), who contend that the less structured approaches such as problem based learning are actually more compatible with the manner in which our cognitive structures are organized than is direct instruction, in that problem based learning allows for activation of prior knowledge through small group discussion. This knowledge activation acts to facilitate understanding and the remembering of new information.

The evidence presented above indicates that constructive and interactive instruction can improve learning outcomes over either passive or simple active instruction. It is therefore important for educators to recognize the importance of using these instructional strategies in the classroom with the ultimate goal of improving learning outcomes for the students.
Conclusion

From this review of the current evidence, we have seen that active instruction is that which elicits learning activities that actively engage the learner, including, but not limited to, reading, discussing and writing (Chi, 2009; Michel, Cater III & Varela, 2009; Dorestani, 2005). Active learning activities involve the cognitive processes of attending, searching and activating existing knowledge, encoding new information, repairing misconceptions and misunderstandings, and allowing for the restructuring of knowledge (Chi, 2009). Moving beyond active instructional strategies are those that are described as constructive instructional strategies.

Constructive instructional strategies lead to learning activities in which the learners produce additional outputs that contain new, content relevant ideas that go beyond the information presented (Chi, 2009). Constructive activities allow learners to infer new knowledge, to integrate new information with existing knowledge, to organize their own knowledge so that it becomes more coherent, to repair their faulty knowledge and to restructure their knowledge (Chi, 2009). From constructive instruction we move on to consider interactive instructional strategies. Interactive instructional strategies involve activities that result in the learner talking and collaborating with another learner or learners, with an expert, or with a system.

Interactive learning activities involve the cognitive processes of joint interpretations of a situation, coordination of understanding, achieving a problem solution together, and joint construction of a shared mental model. From our consideration of these instructional strategies, the activities they elicit and the cognitive processes that
they involve, we may reach the conclusion that active learning is superior to passive, constructive learning is superior to active and interactive is superior to constructive.

We must then consider what activities can be carried into a real classroom to instigate each of these instructional strategies and their concurrent learning activities. To elicit active learning activities in the classroom, activities such as looking at and searching, pointing to, gazing, underlining or copying, repeating sentences or copying problems, taking notes, answering questions in class, summarizing, and manipulating videos, among others can be employed. To encourage constructive learning activities in the classroom, activities such as worked examples, self-explaining or explaining to others, discovery learning and inquiry-based classrooms, have been demonstrated to be effective, and each has been discussed in detail above. Interactive learning activities occur when learners collaborate in joint dialogues with a peer or peers, or with an expert, where both or all participants make substantive contributions to the topic or concept (Chi, 2009). Thus any activity that allows groups of learners to work together toward a common goal can be characterized as an interactive activity.

However, because some of the results discussed in the current research are derived from research conducted in a laboratory setting, and others, although conducted in a classroom, varied the forms of instruction greatly, it is necessary to establish a means of scaling the instructional strategies so that they may successfully and appropriately be implemented in the classroom allowing for the effectiveness of each strategy and its concomitant learning activities to be compared to each of the other strategies and activities. Thus the current study was envisioned, describing practical implementations of
each instructional strategy within a classroom, and allowing for direct comparisons of learning outcomes. From the comparisons of learning outcomes, it may then be possible to reach practical conclusions, applicable in the classroom, as to the relative effectiveness of active instructional strategies, constructive instructional strategies and interactive instructive instructional strategies. It is important to study the effectiveness of the described instructional strategies in the classroom context to inform educators and to ensure that they are utilizing the most effective strategies in the classroom that can be predicted to elicit the best learning outcomes. Thus the present study was devised to answer this need.
CHAPTER III

METHODOLOGY

Problem Statement

As indicated in Chapter 2, the model proposed by Chi and her colleagues (2009), has not been empirically validated in an authentic classroom setting. Thus, the goal of this study is to test the model outlined above in an authentic educational context, an intact classroom. More specifically, the experiment will answer the research question of whether interactive learning activities do, in fact, result in superior learning outcomes as compared to constructive learning activities, and whether constructive learning activities result in superior learning outcomes as compared to active learning activities.

Hypothesis

Students in an introductory Educational Psychology class will demonstrate superior learning outcomes when presented constructive instructional strategies designed to elicit constructive learning activities as compared to active instructional strategies designed to elicit active learning activities, and will further demonstrate superior learning outcomes when presented with interactive instructional strategies designed to elicit interactive learning activities as compared to constructive or active activities.

Operational Definitions

The Independent Variable is the instructional strategy to be employed in four university Introductory Educational Psychology classes. The instructional strategies have been selected to elicit one of three types of learning activities described by Chi (2009) in her taxonomy of learning activities: Active, Constructive or Interactive, and each
instructional strategy will be employed twice during the course of the semester for each class.

*Active learning* is learning that engages the student in the process of learning through activities and/or discussions in class. The active learning that results from active focused instruction is characterized by the overt activities of the learners, such as reading, discussing, answering questions, writing and taking notes, and involves the cognitive processes of attending, searching existing knowledge, and encoding new information (Chi, 2009). It allows the learner to add information to the existing database and expand it, and may involve repairing misconceptions and misunderstandings (Chi, 2009). For the purposes of this study, the instructional strategy to be used to elicit active learning is lecture-based, with the instructor writing important information on the dry-erase board, to facilitate student note taking, and asking questions of the class to ensure active class participation.

Lectures are prepared by the instructor by taking notes on the chapter of the text to be presented. The instructor then presents the information from the notes orally to the class. Students are encouraged to take notes based on the information contained in the lecture. The instructor also intermittently asks questions of the class to elicit active participation in the form of students answering these questions. This strategy is consistent with Chi’s (2009) description of learning activities that are described as active.

*Constructive learning* is learning that facilitates learners’ production of outputs that are additional to the originally presented information. An activity is only considered constructive if the learner has produced something new that was not initially presented in
the learning materials. Activities that are considered to be constructive include generating and asking questions, self-explanation and explaining to others, posing problems, and reflecting and monitoring one’s understanding, among others (Chi, 2009). The instructional strategy to be utilized to elicit constructive learning includes providing the students with study guides prepared by the instructor, and based upon the information in the chapter of the text to be covered, that the students complete on their own. Students are required to move beyond the information presented in the text to construct their own responses to the study guide questions. Students then present their responses on the study guides to the class, allowing for the constructive process of explaining to others. This instructional strategy elicits the type of learning activity that Chi (2009) has identified as constructive.

*Interactive learning* moves beyond the activities described as constructive to include the learner interacting with another person or persons in the joint construction of knowledge. It can involve collaborating with a peer or several peers in joint dialogues, where both or all of the peers make substantive contributions to the topic or concept (Chi, 2009). During interactive learning, learners jointly interpret a situation, coordinate their understanding, and come up with a solution to a problem or situation together (Jeong & Chi, 2006). In the instructional activity utilized to facilitate interactive learning, students are assigned to groups and are assigned portions of the text from which the group will make a presentation to the class. This allows the group to work together to determine how best to convey the information to the class, and is an example of the type of learning activity that Chi (2009) has described as interactive.
The Dependent Variable is student achievement, which will be determined by a post-test for each unit of information presented, and which will measure the amount of knowledge regarding the content matter that the students possess at the completion of the unit. The unit post-tests are instructor made and are taken directly from the information contained in the textbook and presented in class. This method of assessment was chosen to assure that the measurement instrument accurately measured information that was made available to the participants both in the class and in the reading material. Each unit exam consists of multiple-choice, true/false and short answer questions, and each exam is worth a total of 100 points. Since the measurement instruments are compiled by the instructor, who presents the information to the class, and are drawn directly from the information presented in the text, face validity is assured, as is construct validity.

Each exam is administered in a paper/pencil format during regular class time. Participants have the entire class period, one hour and fifteen minutes, to complete the exam. Scoring is done by the instructor by hand, by comparing the responses on the test instrument to the correct answers on the scoring key. This maximizes accuracy of scoring by eliminating any opportunity for scorer bias. Each participant’s exam score is posted onto Blackboard, then moved to an Excel spreadsheet and finally to SPSS for final data assessment.

**Procedure**

This study was conducted to examine the instructional strategy taxonomy proposed by Chi (2009) in a natural classroom environment. Each of the instructional
strategies was employed in a classroom setting, and learning outcomes, as measured by student performance on unit exams, were compared.

Participants

Four sections of an introductory Educational Psychology class at a Midwestern university, over the course of two semesters, Fall of 2014 and Spring of 2015, served as subjects for the study. All students were at least sophomores at the university. The number of students in each class was as follows: Section 1, N=27; Section 2, N=35; Section 3, N=34; and Section 4, N=24, Total N=120.

Materials/Instruction Content

The content material covered in the class was based upon the class textbook, *Educational Psychology: Windows on Classrooms* (Eggan & Kauchak, 2013), and was divided into six units, most of which covered two chapters from the text. Units covered the information as follows:

**Fall, 2014**

Unit 1 – Chapters 1, Understanding Learning and Teaching & 4, Learner Diversity

Unit 2 – Chapters 2, Cognitive and Language Development & 6, Principles of Cognitive Learning Theory and the Construction of Knowledge

Unit 3 – Chapters 7, Cognitive Learning and Human Memory & 8, Complex Cognitive Processes

Unit 4 – Chapters 9, Behaviorism and Social Cognitive Theory & 12, Classroom Management: Developing Self-regulated Learners
Unit 5 – Chapters 10, Motivation and Learning & 11, A Classroom Model for Promoting Student Motivation

Unit 6 – Chapters 14, Increasing Learning Through Assessment & 15, Standardized Testing and Learning

**Spring, 2015**

Unit 1 – Chapters 1, Understanding Learning and Teaching & 4, Learner Diversity

Unit 2 – Chapters 2, Cognitive and Language Development & 6, Principles of Cognitive Learning Theory and the Construction of Knowledge

Unit 3 – Chapters 7, Cognitive Learning and Human Memory & 8, Complex Cognitive Processes

Unit 4 – Chapter 9, Behaviorism and Social Cognitive Theory

Unit 5 – Chapters 10, Motivation and Learning & 11, A Classroom Model for Promoting Student Motivation

Unit 6 – Chapters 14, Increasing Learning Through Assessment & 15, Standardized Testing and Learning

The setting for each class was a regular classroom on campus. Each classroom provided adequate seating for the participants, and a sightline to the front of the classroom where a dry-erase board was located for the purpose of writing important information, facilitating participant note taking.
Design

The purpose of this research study is to attempt to establish a cause/effect relationship between the Independent Variable, the instructional strategy employed, and the Dependent Variable, the learning outcome achieved by the participants. Assignment of participants into groups was non-random in that intact, natural groups were used comprised of four individual university classes. One variable was manipulated: the instructional strategy used to convey the content information to the class. Each class had access to the same reading materials, the same instructor taught every class and used the same lecture notes to present lectures to the class, assuring reliability of the delivery of instructional strategies and fidelity of information presented across groups. The same instructor who presented the information to the groups constructed the exams and scored the exams to assure reliability of assessment across groups. The instructor was a third year doctoral student with previous teaching experience in the subject matter.

Each unit was presented using one of the instructional strategies designed to elicit the learning activities described by Chi (2009): active, constructive or interactive. Thus each instructional strategy was used twice for each class over the course of the semester. Prior to the beginning of the semester, the instructional strategy assigned for each unit was randomized so that the classes generally did not receive the same instructional strategy at the same time. The schedule of instructional strategies was as follows:

Fall, 2104

Group 1

Unit 1 – Constructive
Unit 2 – Active
Unit 3 – Interactive
Unit 4 – Constructive
Unit 5 – Active
Unit 6 – Interactive

**Group 2**

Unit 1 – Active
Unit 2 – Interactive
Unit 3 – Constructive
Unit 4 – Active
Unit 5 – Interactive
Unit 6 – Constructive

**Spring, 2015**

**Group 3**

Unit 1 – Active
Unit 2 – Interactive
Unit 3 – Constructive
Unit 4 – Interactive
Unit 5 – Active
Unit 6 – Constructive

**Group 4**

Unit 1 – Active
Unit 2 – Constructive

Unit 3 – Interactive

Unit 4 – Constructive

Unit 5 – Interactive

Unit 6 – Active

**Instructional Strategies**

Because passive instruction has been well documented to result in inferior learning outcomes when compared to the other instructional strategies, it was determined not to include passive instruction in the present study (Harris, 2011; Freeman et al., 2014). It was hypothesized that students in an introductory Educational Psychology class would demonstrate superior learning outcomes when presented with constructive instructional strategies eliciting constructive learning activities when compared to active instructional strategies, and will further demonstrate superior learning outcomes when presented with interactive instructional strategies that elicit interactive learning activities as compared to constructive or active. To assure that each class had sufficient opportunity to experience each instructional strategy, each type of instructional strategy was employed twice over the course of the semester for each class. The instructional strategy employed for the active instructional units was a combination of instructor lecture, and instructor-led question and answer activities. The instructor also used the dry erase board to write out important concepts, which the students were encouraged to include in their note taking. This method was chosen to elicit active student participation due to the frequent student questioning and assisted note taking, both of which Chi has indicated elicit active
participation in students (Chi, 2009). Although it is impossible, within a classroom setting, to be 100% sure that all students were in fact actively involved in the class activities, the instructor made every effort to assure that they were actively participating by looking at the students, observing them writing in their notebooks or typing on their computers, and asking them questions. These are the procedures that any good instructor would employ within a classroom setting, and are therefore appropriate for the purposes of this study. Lectures were prepared by the instructor by taking notes on the chapter of the text to be presented. The instructor then presented the information from the notes orally to the class. This assured that all lectures covered the same information from the text. The instructor also intermittently asked questions of the class to elicit active participation of the class in the form of responses to the instructor-initiated questions. An example of the lecture notes used to present information from Chapter 1 to the class follows.

**Lecture for Chapter 1**

Which of the following factors contributes most to children’s learning and development? Curriculum and materials available to them; Facilities and extra curricular activities; Class size; Leadership; You. The answer is you. The quality of a school is determined by the quality of its teachers. One study found that students who had effective teachers in the 3rd, 4th and 5th grades scored more than 50 percentile points higher on standardized math tests than those with ineffective teachers. Other research findings: 5 years in a row of expert teaching can almost close the gap between disadvantaged and advantaged students.
Americans believe that improving the quality of teachers will improve education. Experts are people who are highly knowledgeable and skilled in a particular domain, such as teaching. Effective teachers produce more learning in their students than would be expected from the students’ background and ability. Effective teachers are experts. They possess knowledge and skills that their less effective colleagues do not.

Educational psychology studies human teaching and learning. It focuses on the professional knowledge and skills essential for teaching effectively. Professional knowledge = the body of information and skills unique to an area of study, eg. Law, medicine, teaching, etc. (Discuss the learning and teaching inventory on pages 6 & 7.)

Points made: Even older students have difficulty thinking abstractly;

Learners often do not know what they know; IQ tests include knowledge of facts;

Simply explaining information to students is not enough to get them to learn; Knowledge of subject matter does not guarantee that the person can teach it; Overuse of praise can make it ineffective;

The most effective classroom management strategy is to prevent problems before they occur;

Pre-service teachers are often overly optimistic about their teaching ability;

Teaching alone does not lead to being a good teacher – have to have knowledge of learners and learning;

Frequent, thorough assessment is one of the most powerful and positive influences on learning.
Pedagogical knowledge = an understanding of how to represent topics in ways that make the content understandable to learners. Knowledge of content and pedagogical knowledge are related but not the same. Expert teachers possess both.

Ways to present content area:

Examples – useful when teaching a well-defined topic (density – cotton in a glass)

Demonstrations (Cooking class) Case studies

Simulations (A mock trial)

Metaphors (school pride/nationalism) Models (atom, solar system etc.)

The ability to represent topics in ways that are understandable to students requires pedagogical content knowledge plus understanding of the content. General pedagogical knowledge = understanding of instructional strategies and classroom management that apply to all subject matters and topics. Instructional strategies = planning effective lessons, involving students in learning and checking for understanding. Classroom management = creating classrooms that are safe, orderly and focused. To be effective, you must understand learners and learning. You will learn this in this class!

When you teach, you are constantly making decisions. Use reflective practice = the process of conduction a critical self-examination of one’s teaching. It helps you become aware of student differences and to evaluate the impact of your instruction on learning. Children of different ages and abilities have different developmental levels. Developmentally appropriate practice is important – instruction matched to learners’ capabilities and needs.

Acquiring professional knowledge
Experience

Research – the process of systematically gathering information in an attempt to answer professional questions.

Types of research in education: Descriptive
Correlational Experimental Qualitative Action

Descriptive research = uses tests, surveys, and observations to describe a situation or phenomenon. Does not predict future events or describe relationships.

Correlational research = the process of looking into relationships between variables that enables researchers to predict changes in one variable on the basis of changes in another variable *without implying causation*. Correlation = a relationship, positive or negative between 2 or more variables. Much of what we know about the relationships between teaching and learning is based on correlational research.

Experimental research = systematically manipulates variables in attempts to determine cause and effect.

Qualitative research = attempts to describe a complex educational phenomenon using data such as words and pictures. Relies on interviews, field notes and other descriptive methods.

Action research = applied research designed to answer specific school or classroom related questions.

*Theories* are developed from results of research; sets of related patterns to explain and predict events. Help organize research findings and provide guidance for teaching.

Theories are useful because:
They allow us to explain events
They allow us to predict behavior and events.
We will get into a number of theories in this class that will be useful to you in your classrooms.

The Principles of Learning and Teaching tests are part of Praxis II. The information that you learn in this class will be covered!

So we will be studying:
Student learning and development
Self-regulation
Delay of gratification

Technology is important in education, but we will not spend a lot of time on it.

Think ahead to your first teaching job – what do you think your primary role will be?

Imparting content knowledge is only part of the picture
Help students learn to accept responsibility for their own actions
Develop socially and morally
Respect and embrace peers from different backgrounds
Persevere in the face of frustration
Value the acquisition of knowledge and skills that may not be intrinsically interesting to students.

**Self-regulation** = the ability to direct and control one’s own actions and emotions.

You want your students to become self-regulated learners. Delay of gratification = example Mischel’s marshmallow studies in the 1960’s. Results – 4 year olds who could
delay gratification (wait to get 2 marshmallows) years later were demonstrated to be more positive and self-motivated; persistent in the face of difficulties. By adolescence they earned higher SAT scores and had better coping skills. By adulthood they were more successful in their marriages, earned higher incomes, were more satisfied with their careers, were healthier and handled interpersonal rejection better than others. People who are able to delay gratification are more successful and healthier mentally and emotionally.

Components of self-regulation: Impulse control Emotional regulation Delay of gratification Self-motivation

Self-regulated learning

Self-socialization (acting in accordance with society’s standard of behavior) In many cases success in school depends more on self-regulation than on native ability.

The influence of technology: We still don’t know what effect exposure to so much technology has on the developing brain. May be altering children’s personal and social development:

The ability to read non-verbal social cues and to empathize with others Have we lost the ability to pay attention to detail and concentrate for extended periods of time?

This is an area in need of study for the future!

End of lecture for Chapter 1

For the constructive instructional strategy, a Socratic model was employed wherein students were provided with instructor-made study guides in advance, then were asked to explain their responses to the questions contained in the guides orally in class. They were also frequently asked to write their responses on the white board at the front of
the class, and then to provide an explanation to the class. Each student was expected to participate, and the instructor randomly selected students to present their explanations to the class. This instructional strategy was selected because self-explanation and explanation to others have been established to be effective constructive instructional methods (Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013; Rittle-Johnson, 2006). Again, within a classroom setting, it is not possible to assure that all students complied completely with the activity as assigned other than that the instructor observed the students as they referred to their study guides as they presented their answers to the class when asked to. The instructor followed the procedures that any good instructor would follow to assure that the conditions of the activity were adhered to. The study guides were intended to structure the class discussions and to provide study aids to guide the students’ pre-exam studying, so they were not collected, but were kept by the students to guide their studying. An example of the study guide for Chapter 1 follows.

**Unit 1—Chapter 1 Study Guide**

Come to class prepared to identify and discuss the following:

What factors within the school setting contribute most to children’s learning and development?

How does the effectiveness of teachers effect student? Provide statistics.

Describe the characteristics of experts and of effective teachers. What is the purpose of educational psychology?

What is meant by “professional knowledge”?
Review and discuss the “Learning and Teaching Inventory” contained on page 7 of your text.

Describe what is meant by the term “pedagogical knowledge”. What is general pedagogical knowledge?

Describe various ways that content areas can be presented in the classroom. What is the purpose of instructional strategies?

Why are classroom management strategies important?

Describe reflective practice and how it can be used to improve teacher performance in the classroom.

List and explain the five types of educational research covered in the text. What are theories, how are they developed and how are they useful?

What are the roles and responsibilities of the teacher beyond imparting knowledge of a content area?

What are the components of self-regulation?

What are the possible effects of technology on children?

End of Study Guide

For the interactive instructional strategy, the class was divided into small groups, with two to four members each, and each was assigned a part of the text to present to the class. Small groups have been demonstrated to be effective for collaboration, and to assure that each participant carries his or her weight (Chi et al., 2008). In preparing to present their information to the class, the groups were instructed to prepare a presentation, a class participation activity and a short quiz for the class. Questions from the student-
made quizzes were incorporated into study guides for the class, which were used for exam preparation, and some questions were selected to be included in the unit exam. Student presentations were evaluated on the basis of quality of instructional materials, organization, clarity of concept explanation, amount of student participation elicited, and the quality of the quiz questions submitted. All members of the group received the same score on the group evaluations. During the course of the student presentations, the instructor checked off the information presented against her own lecture notes to assure that all relevant points were presented. If a piece of relevant information was omitted from the presentation, the instructor presented it prior to the conclusion of the class. This assured that all groups received the same information across instructional strategies. Group participants also rated each other on the amount of participation each member provided to the group on a scale of 1 to 5, with 1 being no participation and 5 being full participation, to assure that all members of the group participated equally. However, for the purposes of this study, only the participants’ score on the unit exams were used to determine learning outcomes, so that each instructional strategy had the same evaluation procedure. This allowed for equal comparisons across instructional strategies. Although every effort was made to assure that all members of the group participated equally, the fact that the groups had minimal time to learn how to work together and to plan their presentations may have limited the effectiveness of their interactions.

**Rubric for Class Presentations: 25 points each**

- Presentation was well prepared 5 points
- Information was presented clearly and thoroughly 5 points
Appropriate visual aids were utilized, either PowerPoint or dry erase board  
Class was encouraged to participate  
Exam questions coincided with the presentation  

**Assessment Method**

A post-test only (quasi experimental) design was employed to assess the effectiveness of each instructional strategy. Instructor-made unit exams were given at the conclusion of each unit to assess learner outcomes for each unit. Exams consisted of multiple-choice, True/False and short answer questions. All questions were of a factual nature and reflected the content presented in the Unit. Exams were administered in the regular classroom at the regular class time, and the full class period was allowed for the completion of each exam, to eliminate any perception of time pressure on the participants. Each exam was worth a total of 100 points, and was scored by hand by the class instructor, comparing the participants’ responses to the answer key. Every effort was made to prevent any subjectivity in scoring, with all questions having a specific correct response. An example of the Unit 1 exam, which covered Chapter 1, along with Chapter 4, follows.
Multiple Choice Questions: Each worth 2 points (circle the correct answer)

1. Of the following factors, which contributes most to students’ learning and development?
   a. The curriculum the students follow
   b. The size of the classes the students are in
   c. The students’ school facilities and extracurricular activities
   d. The students’ teachers

2. Which of the following best describes effective teachers?
   a. Teachers who are defined as highly effective by federal mandates, such as No Child Left Behind
   b. Teachers who are highly knowledgeable in a content area, such as math, science, or American literature
   c. Teachers who are both knowledgeable in their content area and able to present the information in such a way as to produce more learning in their students than would otherwise be expected
   d. Teachers who are well organized and possess professional skills

3. Which of the following best describes expert teaching?
   a. Expert teaching is essentially instinctive, and it is virtually impossible to acquire the skills needed to be an expert teacher I the absence of a great deal of natural ability
   b. Some teachers possess more natural ability than others, but expertise can be acquired through study and practice
   c. Expertise in teaching is acquired solely through experience in classrooms, and formal study of teaching is largely a waste of time
   d. Expert teaching in elementary schools can be developed with study and practice, but expert teaching in middle and secondary schools depends primarily on teachers’ knowledge of content

4. What is the area of study that studies human teaching and learning, and focuses on the professional knowledge and skills essential for teaching effectively?
   a. Pedagogy
   b. Educational psychology
   c. Behaviorism
   d. Social psychology
5. The body of information and skills unique to an area of study such as law, medicine or teaching is known as:
   a. Professional knowledge
   b. Research
   c. Psychology
   d. Assessment knowledge

6. According to the text, what is the most effective classroom management strategy?
   a. Punishment
   b. Stop disruptions as quickly as possible
   c. Prevent management problems before they occur
   d. Praise students frequently

7. An understanding of how to represent topics in ways that make the content understandable to learners is called:
   a. Content knowledge
   b. Pedagogical knowledge
   c. Expertise
   d. Factual knowledge

8. The process of conducting a critical self-examination of one’s teaching to help improve instructional strategies is known as:
   a. Reflective practice
   b. Qualitative research
   c. Psychological practice
   d. Correlational research

9. Which is NOT a type of research used in education?
   a. Descriptive research
   b. Experimental research
   c. Qualitative research
   d. Developmental research

10. The process of looking for relationships between variables that enables researchers to predict changes in one variable based upon changes in another variable is what kind of research?
    a. Experimental research
    b. Correlational research
    c. Action research
    d. Qualitative research

11. Applied research designed to answer a specific school or classroom related question is what kind of research?
a. Experimental research  
b. Correlational research  
c. Action research  
d. Qualitative research

12. What are developed from the results of research?  
   a. Principles  
   b. Lessons  
   c. Theories  
   d. Actions

13. A person’s ancestry and the way they identify with the country that they or their ancestors came from is known as:  
   a. Stereotype  
   b. Ethnicity  
   c. Background  
   d. Dialect

14. Which of the following does NOT contribute to learner diversity?  
   a. Gender  
   b. Language  
   c. Being educated in the United States  
   d. Culture

15. Examining ways that students’ culture influences learning and trying to use this information to improve instruction is known as:  
   a. Equity pedagogy  
   b. Prejudice  
   c. Multicultural education  
   d. Diversity

16. Which of the following is not an aspect of a person’s culture:  
   a. Customs  
   b. Race  
   c. IQ  
   d. Ethnicity

17. A clash between a child’s home culture and the culture of the school that creates conflicting expectations is known as:  
   a. Ethnicity  
   b. Cultural mismatch  
   c. Resistance culture  
   d. Multicultural education
18. The anxiety felt by members of a group because they are afraid their behavior might conform to a stereotype is known as:
   a. Stereotype threat
   b. Multicultural education
   c. Resistance culture
   d. Cultural mismatch

19. A variation of standard English associated with a particular regional or social group is a:
   a. Language
   b. Speech impairment
   c. Accent
   d. Dialect

20. Which of the programs designed for English Learners involves putting the student into the general education population in the hopes that the student will pick up the language by being exposed to it?
   a. Sheltered English
   b. Transitional
   c. Maintenance
   d. Immersion

21. Which of the following is an advantage of single gender classrooms?
   a. Boys stop bullying
   b. Girls talk less in class
   c. Girls will take more math and science classes
   d. Boys become more distracted

22. Which of the following does not comprise socio-economic status:
   a. Parents’ income
   b. Age at which parents got married
   c. Parents’ level of education
   d. Kinds of jobs parents have

23. Cultures with beliefs, values and behaviors that reject the value of mainstream culture are known as:
   a. Cultural mismatch
   b. Stereotype threat
   c. Multicultural
   d. Resistance cultures

24. Education that looks at ways that culture influences learning and the ways that culture can be used to enhance learning is known as:
a. Immersion
b. Multicultural education
c. Transitional education
d. Bidialectism

25. Which of the following is NOT a way that SES influences learning?
   a. Influences amount of parental involvement
   b. Influences truancy and dropout rates
   c. Influences attitudes towards school
   d. Influences student’s religion

True or False: Each worth 2 points (circle the correct answer)

26. The quality of a school is determined by the quality of its teachers.
    True
    False

27. According to the current research, even with many years of expert teaching, the gap between advantaged and disadvantaged students can never be closed.
    True
    False

28. Students generally understand how much they know about a topic.
    True
    False

29. To increase students’ motivation to learn, teachers should praise as much as possible
    True
    False

30. By high school, most students are able to think abstractly.
    True
    False

31. It is possible to be an expert teacher and still not be effective.
    True
    False

32. To get students to understand information, a teacher simply needs to explain it to them.
    True
    False
33. Frequent, thorough assessment is one of the most powerful and positive influences on learning.
   True
   False

34. Student safety is one important goal of classroom management.
   True
   False

35. Children at any specific grade level can be expected to be very similar developmentally.
   True
   False

36. Instruction should be matched to learners’ capabilities and needs.
   True
   False

37. Experimental research describes phenomenon, using data such as words and pictures.
   True
   False

38. Theories are useful because they allow us to predict behavior and events.
   True
   False

39. Race does not contribute to an individual’s culture.
   True
   False

40. It is not always possible to see the ways in which people are diverse.
   True
   False

41. When considering gender differences between students, girls have been demonstrated to be both more extroverted and more anxious.
   True
   False

42. There is some evidence indicating that single gender classrooms are actually more distracting than mixed gender classrooms.
   True
   False
43. In general, boys and girls score equally on tests of general IQ.
   True
   False

44. The socio-economic status of a student's parents does not influence a student’s achievement.
   True
   False

45. According to the statistics cited in the text, hunger has been eradicated in the United States.
   True
   False

**Short Answer: Each worth 5 points (1 point for each item)**

46. List the five types of programs for English Learners:

   ______________________________________________________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________

47. List five ways that high SES parents differ from low SES parents in the way they interact with and teach their children:

   ______________________________________________________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________

End of Exam 1
Statistical Analysis Procedures

A quasi-experimental design will be employed, using non-random, intact groups as the convenience sample. The purpose of the study is to determine whether there are differences in the learning outcomes for the groups when presented with different instructional strategies. At the end of each instructional unit each class’s exam results will be compiled for each of the instructional strategies. Analysis will proceed in a two phases intended to provide a complete picture of the data.

Phase One

The first phase will be comprised of a group level analysis examining the effectiveness of each instructional strategy within each group. Within each group, unit exam scores will be converted to z-scores. This allows for equitable comparisons across exam scores. Each instructional strategy is utilized for two units. The z-scores for the two units with the same instructional strategy will be averaged to formulate a composite z-score representing each instructional strategy. It is this composite z-score that will be included in the data analysis. A one-way repeated measures ANOVA will be run across the composite z-scores, repeated across the three instructional strategies. Thus, the ANOVA contains one within-subjects factor, which is instructional strategy (active, constructive, interactive), and the composite z-scores for the units taught with the respective strategies will be the dependent variable. Since the unit exam scores have been standardized, this methodology allows comparison of the strategies to determine which one or ones are more effective. This design will be applied individually to each group. The dependent variable in this phase of analysis will be the composite z score for each
instructional strategy: active constructive and interactive, to determine whether one is superior to the others in terms of its effectiveness.

**Phase Two**

The second phase of the analysis will be unit level of analysis and will examine each instructional method within each unit. The analysis within each unit will include whatever specific instructional strategies that were utilized. Only Unit 2 was taught with all three instructional strategies across the groups. This is a limitation, in that the three instructional strategies cannot be compared for each unit, but each strategy can be compared with the other strategies, and taken in sum, this will provide further evidence as to the relative effectiveness of the three instructional strategies. For each unit the instructional strategies will be compared using the following tests:

- Unit 1—t-test comparing active and constructive;
- Unit 2—one way ANOVA comparing active, constructive and interactive;
- Unit 3—t-test comparing constructive and interactive
- Unit 4—t-test comparing active and constructive
- Unit 5—t-test comparing active and constructive
- Unit 6—t-test comparing constructive and interactive

At the conclusion of the analyses, it will be possible to determine whether any one of the instructional strategies is superior to any of the other strategies when employed in a classroom setting.

This research represents a significant attempt to apply the taxonomy of learning activities described by Chi (2009) into the classroom by describing the type of
instructional strategies that can be employed to elicit each of the learning activities in the classroom and to determine their effectiveness. Although preliminary results do not appear to confirm the expected superiority of interactive instruction over constructive and constructive instruction over active, this can be viewed as the beginning of a larger attempt to determine just which instructional strategies can be effectively employed within a classroom setting, and what the effectiveness of each instructional strategy can be expected to be. Thus this is merely the beginning of a more extensive body of research that is to come.
CHAPTER IV

RESULTS

As stated in Chapter One, the study reported here addressed the question of the effectiveness of three instructional strategies: active, constructive and interactive (Chi, 2009) within a natural classroom setting. The analyses evaluated whether Interactive instruction was superior to Constructive instruction and whether Interactive and/or Constructive instruction was superior to Active instruction. This chapter will describe the various ways that the results of the study were analyzed and then will discuss the conclusions drawn from these analyses.

Descriptive Statistics

Tables 2, 3 and 4 describe the means and standard deviations of the exams administered to the participants for each instructional strategy. Table 2 presents test results for each class by exam and instructional strategy. Table 3 presents the combined means and standard deviations for each instructional strategy employed within each class. Table 4 presents each instructional strategy, the means and standard deviations earned for each, along with the composite mean for each.
### Table 2

**Mean Exam Scores by Class and Instructional Strategy**

<table>
<thead>
<tr>
<th>Class 1; N = 27</th>
<th>Instructional strategy</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam 1</td>
<td>Constructive</td>
<td>84.07</td>
<td>6.81</td>
</tr>
<tr>
<td>Exam 2</td>
<td>Active</td>
<td>87.00</td>
<td>8.65</td>
</tr>
<tr>
<td>Exam 3</td>
<td>Interactive</td>
<td>82.70</td>
<td>11.28</td>
</tr>
<tr>
<td>Exam 4</td>
<td>Constructive</td>
<td>83.11</td>
<td>8.46</td>
</tr>
<tr>
<td>Exam 5</td>
<td>Active</td>
<td>85.62</td>
<td>7.73</td>
</tr>
<tr>
<td>Exam 6</td>
<td>Interactive</td>
<td>81.78</td>
<td>10.04</td>
</tr>
<tr>
<td>Composite Mean</td>
<td></td>
<td>84.05</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class 2; N = 34</th>
<th>Instructional strategy</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam 1</td>
<td>Active</td>
<td>86.15</td>
<td>6.60</td>
</tr>
<tr>
<td>Exam 2</td>
<td>Interactive</td>
<td>88.76</td>
<td>7.30</td>
</tr>
<tr>
<td>Exam 3</td>
<td>Constructive</td>
<td>88.33</td>
<td>6.83</td>
</tr>
<tr>
<td>Exam 4</td>
<td>Active</td>
<td>88.43</td>
<td>6.13</td>
</tr>
<tr>
<td>Exam 5</td>
<td>Interactive</td>
<td>88.42</td>
<td>6.35</td>
</tr>
<tr>
<td>Exam 6</td>
<td>Constructive</td>
<td>82.70</td>
<td>8.53</td>
</tr>
<tr>
<td>Composite Mean</td>
<td></td>
<td>87.13</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class 3; N = 34</th>
<th>Instructional strategy</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam 1</td>
<td>Active</td>
<td>90.18</td>
<td>9.10</td>
</tr>
<tr>
<td>Exam 2</td>
<td>Interactive</td>
<td>84.10</td>
<td>10.38</td>
</tr>
<tr>
<td>Exam 3</td>
<td>Constructive</td>
<td>85.53</td>
<td>11.46</td>
</tr>
<tr>
<td>Exam 4</td>
<td>Active</td>
<td>78.99</td>
<td>13.99</td>
</tr>
<tr>
<td>Exam 5</td>
<td>Interactive</td>
<td>86.44</td>
<td>12.92</td>
</tr>
<tr>
<td>Exam 6</td>
<td>Constructive</td>
<td>86.76</td>
<td>11.14</td>
</tr>
<tr>
<td>Composite Mean</td>
<td></td>
<td>85.33</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class 4; N = 24</th>
<th>Instructional strategy</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam 1</td>
<td>Active</td>
<td>91.25</td>
<td>6.79</td>
</tr>
<tr>
<td>Exam 2</td>
<td>Constructive</td>
<td>88.25</td>
<td>8.89</td>
</tr>
<tr>
<td>Exam 3</td>
<td>Interactive</td>
<td>81.33</td>
<td>11.71</td>
</tr>
<tr>
<td>Exam 4</td>
<td>Constructive</td>
<td>83.92</td>
<td>11.42</td>
</tr>
<tr>
<td>Exam 5</td>
<td>Active</td>
<td>89.92</td>
<td>8.01</td>
</tr>
<tr>
<td>Exam 6</td>
<td>Interactive</td>
<td>86.42</td>
<td>10.35</td>
</tr>
<tr>
<td>Composite Mean</td>
<td></td>
<td>86.85</td>
<td></td>
</tr>
</tbody>
</table>
Table 3

*Combined Means by Class and Instructional Strategy*

<table>
<thead>
<tr>
<th>Instructional strategy</th>
<th>Class 1</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Class 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td></td>
<td>86.30</td>
<td>8.19</td>
</tr>
<tr>
<td>Constructive</td>
<td>83.59</td>
<td></td>
<td>7.64</td>
</tr>
<tr>
<td>Interactive</td>
<td>82.24</td>
<td></td>
<td>10.66</td>
</tr>
<tr>
<td>Class 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td></td>
<td>87.29</td>
<td>6.37</td>
</tr>
<tr>
<td>Constructive</td>
<td>85.51</td>
<td></td>
<td>7.68</td>
</tr>
<tr>
<td>Interactive</td>
<td>88.59</td>
<td></td>
<td>6.83</td>
</tr>
<tr>
<td>Class 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td></td>
<td>84.59</td>
<td>11.55</td>
</tr>
<tr>
<td>Constructive</td>
<td>86.15</td>
<td></td>
<td>11.30</td>
</tr>
<tr>
<td>Interactive</td>
<td>85.27</td>
<td></td>
<td>11.65</td>
</tr>
<tr>
<td>Class 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td></td>
<td>90.59</td>
<td>7.40</td>
</tr>
<tr>
<td>Constructive</td>
<td>86.09</td>
<td></td>
<td>10.16</td>
</tr>
<tr>
<td>Interactive</td>
<td>83.88</td>
<td></td>
<td>11.03</td>
</tr>
</tbody>
</table>
Table 4

Means and Standard Deviations by Instructional Strategy

<table>
<thead>
<tr>
<th>Instructional Strategy</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>87.00</td>
<td>8.65</td>
</tr>
<tr>
<td></td>
<td>85.62</td>
<td>7.73</td>
</tr>
<tr>
<td></td>
<td>86.15</td>
<td>6.60</td>
</tr>
<tr>
<td></td>
<td>88.43</td>
<td>6.13</td>
</tr>
<tr>
<td></td>
<td>90.18</td>
<td>9.10</td>
</tr>
<tr>
<td></td>
<td>78.99</td>
<td>13.99</td>
</tr>
<tr>
<td></td>
<td>91.25</td>
<td>6.79</td>
</tr>
<tr>
<td></td>
<td>89.92</td>
<td>8.01</td>
</tr>
<tr>
<td>Composite Mean</td>
<td>87.19</td>
<td></td>
</tr>
<tr>
<td>Constructive</td>
<td>84.07</td>
<td>6.81</td>
</tr>
<tr>
<td></td>
<td>83.11</td>
<td>8.46</td>
</tr>
<tr>
<td></td>
<td>88.33</td>
<td>6.83</td>
</tr>
<tr>
<td></td>
<td>82.70</td>
<td>8.53</td>
</tr>
<tr>
<td></td>
<td>85.53</td>
<td>11.46</td>
</tr>
<tr>
<td></td>
<td>86.76</td>
<td>11.14</td>
</tr>
<tr>
<td></td>
<td>88.25</td>
<td>8.89</td>
</tr>
<tr>
<td></td>
<td>83.92</td>
<td>11.42</td>
</tr>
<tr>
<td>Composite Mean</td>
<td>85.33</td>
<td></td>
</tr>
<tr>
<td>Interactive</td>
<td>82.70</td>
<td>11.28</td>
</tr>
<tr>
<td></td>
<td>81.78</td>
<td>10.04</td>
</tr>
<tr>
<td></td>
<td>88.76</td>
<td>7.30</td>
</tr>
<tr>
<td></td>
<td>88.42</td>
<td>6.35</td>
</tr>
<tr>
<td></td>
<td>84.10</td>
<td>10.38</td>
</tr>
<tr>
<td></td>
<td>86.44</td>
<td>12.92</td>
</tr>
<tr>
<td></td>
<td>81.33</td>
<td>11.71</td>
</tr>
<tr>
<td></td>
<td>86.42</td>
<td>10.35</td>
</tr>
<tr>
<td>Composite Mean</td>
<td>84.99</td>
<td></td>
</tr>
</tbody>
</table>

Initial data analysis compared exam grades by each instructional strategy to determine if there were differences between the classes. This analysis involved taking the raw scores for each exam and converting them to standardized scores at the group level. Once each exam score was standardized, a composite z score was computed for each instructional method. Because each student received each instructional method
twice, the composite z score represents the average of the two z scores from each respective instructional method per student. This allowed each student to have one composite z score for each instructional method: active, constructive and interactive. A repeated measures ANOVA was then run where the within subject variable is “instruction” which has three levels and no between subjects factors. The descriptive statistics for these results follow:

Table 5

*Composite Z Scores by Instructional Strategy*

<table>
<thead>
<tr>
<th>Instructional Strategy</th>
<th>Mean</th>
<th>SD</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructive instruction composite z score</td>
<td>.0118</td>
<td>.85723</td>
<td>116</td>
</tr>
<tr>
<td>Active instruction composite z score</td>
<td>.0166</td>
<td>.86391</td>
<td>116</td>
</tr>
<tr>
<td>Interactive instruction composite z score</td>
<td>.0189</td>
<td>.85255</td>
<td>116</td>
</tr>
</tbody>
</table>

Results of the ANOVA analysis indicate no significant effect for type of instruction among the groups, and no significant differences among the groups themselves. Please refer to Appendix D for the complete analysis.

Data analysis was then conducted at the unit level of analysis that examined each instructional method within each of the six units. The analysis within each unit includes comparisons of the specific instructional strategies utilized for that unit. Only Unit 2 was taught with all three instructional strategies across all groups. Therefore, for Units 1, 3, 4, 5, and 6 the data was analyzed using t-tests because only two instructional types were
administered. For unit 2, the data was analyzed using a 1-way ANOVA because all three types of instructional strategies were administered. The results of these analyses follow:

Table 6

*T-Test/ANOVA Comparisons of Instructional Strategies by Unit Exam*

<table>
<thead>
<tr>
<th>Unit</th>
<th>Strategies</th>
<th>Test</th>
<th>t</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Active/Constructive</td>
<td>T test</td>
<td>(66.38) = -.366</td>
<td>.715</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Constructive/Interactive</td>
<td>T test</td>
<td>(116) = 2.478</td>
<td>.015</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Active/Constructive</td>
<td>T test</td>
<td>(117) = -.195</td>
<td>.917</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Active/Constructive</td>
<td>T test</td>
<td>(115) = .147</td>
<td>.836</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Constructive/Interactive</td>
<td>T test</td>
<td>(116) = .416</td>
<td>.679</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Active/Constructive/Interactive</td>
<td>ANOVA</td>
<td>(2,116) = .437</td>
<td>.647</td>
<td></td>
</tr>
</tbody>
</table>

In this unit level analysis, only Unit 2 was able to compare all three instructional strategies for one unit. All other units only had two instructional strategies utilized. The ANOVA conducted on Unit 2 indicated no significant differences among the three instructional strategies. T-test comparisons were conducted for each of the other units, comparing the two instructional strategies used for each. The equal variances assumption was violated for Unit 1, so an adjustment was necessitated for this unit only, resulting in a decreased degree of freedom statistic. The equal variances assumption was not violated for any other unit, so no further adjustments were needed. Overall results yielded no significant differences in the t-test analyses except for Unit 3, which compared Constructive and Interactive instructional strategies, and which did demonstrate a
significant difference. The reason for this difference is unclear, especially since Constructive and Interactive instructional strategies were also compared for Unit 6, which did not reveal any significant difference.

**Summary**

Taken as a whole, there does not appear to be any significant effect attributable to the type of instructional strategy employed. The results may be confounded by the fact that, although every effort was made to keep the implementation of instructional strategies consistent across groups, there is no way within a classroom setting to assure that there are no differences in instruction implementation among the classes. Different students may present different questions and classroom discussions vary accordingly. This is consistent with studies conducted in a naturalistic setting where not all aspects of the environment can be controlled. Because of the differences inherent within each classroom, results attributable solely to instructional strategy are difficult to interpret. In the unit comparison, there was an observed difference between Constructive and Interactive instruction, but the difference did not appear the second time the two strategies were compared with one another. Although the data do not clearly indicate that one instructional strategy is superior to any other, one conclusion that can be drawn from the data is that each of the instructional strategies was effective in producing similar learning outcomes. Thus the instructional strategies appear to be more similar than different in their effects on learner outcomes. This result will be discussed in Chapter 5 to follow.
CHAPTER V
DISCUSSION

This study looked at the effectiveness of three instructional strategies, applied in a natural classroom setting, on learning outcomes. Based upon previous research conducted in a laboratory setting, it was expected that the different instructional strategies would result in differences in learning outcomes. However, the results obtained did not support these expected outcomes. The findings of this study indicated that there were no significant differences between learning outcomes that could be attributed to the type of instructional strategy employed within the classroom. This chapter provides a summary of the research conducted in this study and the conclusions that arose from it. It will also discuss the implications of the current research as well as recommendations for further research.

Summary/Overview of the Problem

According to the research conducted in a laboratory setting by Chi and others (Muldner, Lam & Chi, 2014; Chi, 2009; Chi, Roy & Hausmann, 2008; Chi et al., 1994), Constructive instruction has been demonstrated to be superior to that which is simply Active, while Interactive instruction has been demonstrated to be superior to Constructive. However, since the ultimate goal of research into the effectiveness of instructional strategies must be to inform educators in the field as to what works best within the classroom, it is essential to extend these findings in actual classrooms, and with a clear understanding of the strategies used to elicit each type of instruction along with the learning resulting from each.
Research Question

The question addressed by this study was: Does Constructive instruction yield better learning outcomes than Active and does Interactive instruction yield better learning outcomes than either Active or Constructive in a real classroom setting (per Chi, 2009)?

Findings Related to the Literature

Previous research into the effectiveness of Active instruction within the classroom has demonstrated that Active instruction, which built learner participation into the class, resulted in superior learner outcomes when compared to instruction that allowed the learner to passively listen to lectures (McConnell et al., 2003; Michel et al., 2009). Research into Constructive instructional activities has included self-explanation, which is considered an important, effective, and domain-general means to improve learning (Rittle-Johnson, 2006). Providing an explanation is considered helpful to the person who is doing the explaining because it helps him or her organize material so that the explanation can be formulated. In the present study students were asked to formulate responses to study guide questions and to be prepared to explain their answers to the class. Although Constructive learning activities were not demonstrated to be superior to Active instructional strategies, they were, in fact, equally effective. One key difference between the work of other researchers into the effectiveness of self explanation (Chi et al., 1994; Rittle-Johnson, 2006) and the results achieved here is that this is the only study that attempted to utilize self-explanation on a class wide basis. In studies looking at pairs or small groups, the subjects had far more opportunity to express themselves and to provide comprehensive self-explanations. In the present study, although all students were
provided with study guides and were expected to provide their own answers to the study guide questions, only a minority of students actually provided their explanations to the class verbally. Therefore the actual time spent in self-explaining varied among students.

According to the research into the effectiveness of Interactive instructional strategies, the goal of this form of instruction is for the learners to jointly construct or produce a shared mental model through processes such as discussion, argumentation and negotiation (Chi, 2009; Goncu & Gauvain, 2011). Ideally, in interactive activities, the learner has the benefit of the interactions with another learner, which may provide additional information, new perspectives, corrective feedback, and possibly a new line of reasoning to pursue (Goncu & Gauvain, 2011). Studies that have looked at the benefits of Interactive instruction have demonstrated that collaborating with other learners allows learners to share knowledge, which increases learners’ common knowledge (Jeong & Chi, 2006). Because of this sharing of knowledge, it has been proposed that Interactive instruction yields superior learning outcomes to either Active or Constructive instruction (Stahl, 2003; Young et al., 2003). Although in the present study, Interactive instruction was not demonstrated to be superior to either Active or Constructive instruction, it was demonstrated to be equally effective to both of the other studied instructional strategies. Again, however, the results may be attributable to the fact that, in the current study, Interactive instruction was conducted within the larger classroom context, whereas other research into the effectiveness of Interactive instruction has generally studied dyads (Jeong & Chi, 2006) or small groups (Goncu & Gauvain, 2011). In the present study, in attempting to elicit Interactive instruction in the classroom, the class was divided into
small groups and each group was assigned a section of the class materials to present or teach to the class. Unfortunately it was not possible to determine whether each student participated equally in the interactive activities. This demonstrates one difficulty in implementing Interactive instruction within the classroom setting: it is very difficult to assure that each member of the group participates at all and that all members of the group interact with each other (Bruning, Schraw & Norby, 2011).

**Differences Between This Study and Previous Studies**

The major difference between this study and those reported previously is that, to my knowledge, this is the first to attempt to incorporate all three instructional strategies into an actual classroom during the course of a semester and to compare the results on learning outcomes. This meant that each instructional strategy had to be operationally defined so that actual instructional strategies could be devised that could readily be incorporated into actual classroom instruction. Every attempt was made to assure that each instructional strategy complied with the requirements stipulated by Chi’s (2009) taxonomy, so that researchers in the future would be able to replicate the strategies in other classrooms. This effort is more far reaching than the studies previously reported, which generally selected one instructional strategy, and either reported its effectiveness or compared it to Passive instruction (McConnell et al., 2003; Michel, et al., 2009; Rittle-Johnson, 2006; Chi et al., 1994; Jeong & Chi, 2006; Hron & Fredrich, 2003; Schmidt et al., 2007).

Other studies that compared instructional strategies were limited by the fact that they were conducted within a laboratory setting and were difficult to generalize into a
classroom setting (Chi, Roy & Hausmann, 2008; Muldner, Lam & Chi, 2014). This study demonstrates the difficulties inherent in devising specific instructional strategies that can readily be implemented within a classroom environment as opposed to devising strategies that can be implemented within the laboratory setting.

Despite these differences, the results of the current study are not completely incompatible with those of previously reported studies. Each of the instructional strategies employed herein was demonstrated to be effective in eliciting positive learning outcomes as demonstrated by subjects’ performance on unit exams.

Although the literature does indicate the kinds of instructional strategies that can be used to elicit the desired learning activities for each of the types of learning described in Chi’s taxonomy, the classroom implementation of all three within an actual classroom setting has not been demonstrated before. Although this study was not successful in demonstrating significant differences between the instructional strategies in terms of learning outcomes, it can be seen as a significant first step into the development of more effective, empirically supported, instructional strategies that can be implemented within the classroom.

**Limitations**

The conclusions that can be drawn from this study are that translating learning activities into the classroom that can effectively elicit Constructive or Interactive learning is not an easy or clear cut proposition. Specifically, the strategy to elicit Constructive learning, having students answer study guide questions and then explain their answers to the class, may not have been a sufficiently effective Constructive instructional method.
Although all students in the class were given the study guides and were assigned the task of providing answers to the study guide questions, there is no way to guarantee that all of the students put forth equal effort in complying with this assignment. Also, for each study guide question, an individual student was called on to explain his or her answer to the class. Thus only a limited number of students actually were afforded the opportunity to provide a verbal explanation to the class and there was no measurement of fidelity to assure that the same information was presented to each class in the same way. This is a weakness of the research design as applied to this instructional strategy. Further, in an effort to provide students with an opportunity to engage in Interactive instruction, the students were assigned to small groups and were assigned a section of the text to prepare a presentation on. They then presented their presentation to the rest of the class, explaining the concepts contained in their assigned section of the text. There are several potential problems with this method of eliciting Interactive learning activities. First, there is no way to assure that all members of the group participated in the group process equally, or to assure that all members contributed to the shared construction of knowledge necessary for Interactive instruction to be effective.

There may also be a limitation due to the amount of time each group was allotted to develop their presentation. Previous research has indicated that, in order for Interactive instruction to be effective, students must be given adequate time to be trained and familiarized with the interactive process (Gokhale, 1995; Schmidt et al., 2007). Due to the time constraints created by imposing each of the three instructional strategies twice during the course of each semester, there may not have been sufficient time to allow the
groups to develop adequate collaborative strategies that would allow them to co-construct knowledge. Also, each group presented their section of the text to the rest of the class, therefor making the rest of the class at best Active participants, not Interactive participants. The issue of fidelity again arises in that there was no way to insure that the group presentations all provided the same information as the instructor lectures to the class.

These considerations are consistent with the assertion that the instructional strategies utilized to elicit Active learning did in fact elicit Active learning in that the class was encouraged to ask and answer questions, and to take notes based upon the information written during lecture on the dry erase board at the front of the classroom. However, the instructional strategies utilized to elicit Constructive and Interactive learning may, in fact, have been successful in simply eliciting Active learning. This would explain the similarities in the results of the comparisons between the three instructional strategies. These results illustrate the difficulties inherent in taking strategies that are effectively implemented in a controlled setting and attempting to translate them into a far less controlled natural setting. Thus the next step indicated by this study is to further evaluate the instructional strategies used to elicit each of the types of learning and to revise them so that each more accurately reflect the instructional strategy described by Chi’s (2009) taxonomy desired learning outcome.

Another possible limitation of the present research design is that the same assessment method was employed for every instructional strategy. It is possible that assessments tailored to the type of instruction given might have yielded different results.
For example, an objective exam featuring multiple choice, true/false and short answer items may not be the optimum means of assessing the effectiveness of Interactive instruction. However, tailoring the type of assessment to the instructional strategy would have the result of confounding the ability to compare the assessments across instructional strategies, thus necessitating this limitation.

A final limitation may be due to the fact that each instructional strategy was employed twice for each class during the course of a single semester. Therefore there may not have been enough time for the students to adapt to the requirements of each instructional strategy. It is possible that more time is required for the students to fully master the demands of the instructional strategy being implemented to fully demonstrate its efficacy.

**Conclusions**

From the above discussion, it is apparent that implementing and comparing the instructional strategies delineated within Chi’s taxonomy in a classroom environment is not a simple task. But this does not mean that the task should be abandoned. The goal of creating a learning environment that employs the most effective, empirically supported instructional strategies available is an important one; one that deserves further study.

What are the next steps indicated by the present research? First, as was previously noted, although the instructional strategies implemented to elicit Active learning did appear to be successful in doing so, for both Constructive and Interactive instruction, it is unclear if the desired learning activities were actually elicited by the instructional strategies utilized. In fact, the learning activities that actually resulted may have been Active, but not
Constructive or Interactive. Thus step one for further research is the development of instructional strategies that are more effective in eliciting the types of learning activities described by Chi as Constructive and Interactive and that are capable of being implemented within a real university classroom setting. For Constructive instructional activities, learners must be required to explain to themselves or to others the required information in a way that can collected, coded and analyzed, and can be demonstrated to have occurred in some way beyond simply answering study guide questions. To demonstrate that effective Interactive instruction has occurred, it is possible that more time needs to be devoted to the Interactive instructional activity so that group members have an opportunity to effectively engage in collaborative knowledge sharing and building. It may also be necessary to adapt the assessment to get a more accurate assessment of the learning that has occurred in the Interactive learning environment.

Once the issues of improved instructional strategies and appropriate assessment strategies have been addressed, the next question to be dealt with is: Can all three of these instructional strategies be effectively evaluated within the course of one semester in a single class? This appears to be another potential weakness of the present research design: each instructional strategy was implemented in quick succession to the next and for an extremely limited time. It is quite possible that more time is needed for the learners to adapt to the requirements of the instructional strategy, and by the time that they have determined what is required of them for a specific instructional strategy, the class has moved on to the next, creating an atmosphere of uncertainty and anxiety within the classroom. Although this supposition is not supported by the student evaluations
submitted at the conclusion of each class, it cannot be discounted as a possible contribution to the results obtained in the present study.

Future research should either implement each instructional strategy only once per semester, allowing the learners to acclimate to the demands of each strategy as it is introduced, or utilize different instructional strategies for different classes that are extended for an entire semester. The option to utilize different instructional strategies for different classes, however, introduces the additional difficulty inherent in making comparisons between different subject populations, which would need to be addressed.

The above observations indicate the need for a great deal more research into the effectiveness of the instructional strategies described by the taxonomy resulting from Chi’s (2009) research, and indicate avenues for future research. Each of the above described weaknesses of the current research should be addressed in future research to adequately address the original research question: Does Constructive instruction yield better learning outcomes than Active and does Interactive instruction yield better learning outcomes than either Active or Constructive in a natural classroom setting? The results of these follow-up studies will have real world implications because they will help to inform classroom teachers of the efficacy of different instructional strategies that can be employed in the classroom to improve the ultimate learning outcomes of their students, an important goal in education.
APPENDIX A

EXAMPLE SYLLABUS
Appendix A

Example Syllabus

Kent State University

ESPY 29525 Educational Psychology Spring 2015 Syllabus

Instructor: Connie Romig, M.Ed., Ed.S., J.D.
Office: 116 White Hall
E-mail: cromig1@kent.edu
Hours: Tuesday and Thursday 11:00-12:00 and 3:30-5:00 or by appointment

Can be purchased online at: http://www.coursesmart.com/IR/6611629/9780132782746?hdv=6.8

Course Description: This course examines major theories of human development and learning, instructional strategies, assessment, similarities and differences in learners, teaching, classroom applications and an emphasis on the “teacher as reflective practitioner”. The goal of this course is to increase students’ understanding of educational psychology and child development, which will be useful to students as they train to become educators themselves.

Learner Objectives: By the end of this course, students should be able to demonstrate mastery of the following learning objectives:
1. Define and apply the content and methodology of educational psychology and child development
2. Evaluate and synthesize the major milestones of cognitive and social-emotional development
3. Identify the special cognitive and linguistic skills necessary for successful learning in the formal instructional setting
4. Describe and explain the differences between the major theories of cognitive development and learning
5. Understand how theories of learning and developmental characteristics of children can be combined to make teaching more effective

Instructor Expectations: My role as your instructor is to organize the material and present it in a way that demonstrates its relevance and makes it easier to learn. Please note that I have not said that it will be easy to learn; many of the concepts will be new to you and some of you may find them difficult to understand and apply. My role is NOT to simply tell you what the book said so that you don’t have to read. Often, my in-
class presentations will vary from the material that the book covered, so both reading and attendance are important. Please let me know if you are having trouble. I want to help you, but I cannot do that if I do not know what your concerns are.

**Teaching Philosophy:** I believe in student-centered active learning. Therefor, I will not spend every class period lecturing. Students bring a wealth of personal experiences, knowledge and theories to the classroom and if you can relate new information to your personal experiences through an active learning method, your learning is greatly enhanced. I also like to vary my teaching methods to insure that the coursework is accessible to all students. Thus I will utilize lecture, active class discussion, small group activities and PowerPoint presentations to help facilitate your learning process. I feel strongly that students should leave this class with a stronger skill set that they entered it with, so I will do everything I can to insure that that happens.

**Student Expectations:** Attendance is important, since not all of the information that will be tested is contained in the book, but will be presented in class. Students are expected to come to class prepared to be active participants. This means that you should have read your assigned readings before class and be prepared to discuss. Students should also listen to, and be respectful of, others. Classroom participation is an important component of this class and everyone should feel that their opinions are valued and respected. Please turn off your cell phones during class and arrive on time. Also, please do not use class time to update your Facebook page, check on your NCAA tournament brackets, or check your e-mail. This is disrespectful to those who came to class to learn. Students are expected to complete all assignments in a timely manner.

**Ethical Conduct:** Any form of cheating is prohibited. If you use an idea, statistic, or a quote or a paraphrased quote from a source that is not you, you must cite the source! No exceptions! If you do not cite the source of your idea, statistic, quote or paraphrased quote, it will be considered plagiarism and will result in you receiving an F on the paper in question or possibly an F for the course, and you will be reported to college officials. The bottom line here is do not do this! Cite and reference your work appropriately.

**Human Relations:** As stated by the American Psychological Association (APA) ethics code, I as the instructor and you as the student will not engage in any unfair discrimination based on age, gender, gender identity, race, ethnicity, culture, national origin, religion, sexual orientation, socioeconomic status or any basis proscribed by law. In this course, we may address some of the above issues. I expect all of you to adhere to the above APA code.

**American Disabilities Act (ADA) Compliance:** If there is any student who has special needs because of a disability, please go directly to the Office of Student Disability Services, 181 Michael Swartz Student Center, or you can call them at 330-672-3391. Please inform me of any accommodations that you may require, and provide supportive documentation from the Office of Student disabilities.
Class Attendance: Attendance will benefit you in several ways. First, material will be presented in class that is not covered in the text, but will appear on exams. Second, your understanding of the course material is heightened by double exposure to the material. Third, you are responsible for material covered in class even if you were not there. Thus failure to attend class can have a real and negative impact on your final grade.

Research Participation:
Research is a strong focus at Kent State University. Faculty and graduate students from the Educational Psychology/Instructional Technology program are actively engaged in widely diverse research projects. Participating in research projects is an important component for undergraduate students enrolled in EPSY 29525. In order to effectively use research in your profession, it is helpful to know how research is generated. To provide this experience the Educational Psychology program has established the Educational Psychology research participant pool. This course will include collecting data about you, the members of this course, in IRB approved studies. This pool allows students to participate (not to exceed 2 hours) in research that has been approved by the Kent State University Institutional Review Board (IRB). For your participation, you will earn course credit.

All of the data is aggregated and anonymous. The data collection may include filling out questionnaires, completing some learning tasks in a laboratory, and/or in-class activities.

There are two options for fulfilling the research requirement.

Option 1: Participation in IRB approved research. Students visit the Ed Psych Research Sign-up System (http://kent-ehhs.sona-systems.com) and request a new participant account. From there you can choose how you would like to fulfill the two hours of research participation from the studies listed in the sign-up system.

When registering for studies in the Ed Psych Research Sign-up System you must sign up at least 24 hours before the time you would like to participate. NO WALK INS ARE ALLOWED. There are times when no participates have been scheduled. If no one is scheduled lab staff may not be in the lab. YOU MUST SIGN UP 24 HOURS IN ADVANCE.

Option 2: Alternatively, you may complete the research requirement by reading two book chapters on educational research methodology and taking a multiple-choice test on each selection (The total length of each selection is approximately 30 pages, and we assume each should take 1 hour to read). Each selection has a corresponding multiple-choice test (15 questions each). We assume that taking the two tests should take about an hour. Our goal is that this alternative consumes as much time as participating in faculty directed research. To receive credit you must average an 80% or better on the two tests. If you
choose to participate in a portion of faculty directed research but decide to withdraw as a research participant for any reason, you may complete the requirement by completing the alternative (option 2). If you select Option 2, please register for the Research Alternative study in the Ed Psych Research Sign-up System (http://kent-ehhs.sona-systems.com) and follow the directions.

**Class Assignments:** Reading assignments will be assigned on a weekly basis. Students are expected to complete the reading assignments before attending class and be prepared to participate in class discussions.

**Exams:** Six exams will be given throughout the course of the semester. Each exam may consist of multiple-choice, true-false, fill in the blank or short answer questions or any combination of the above. Exams will be completed in class and without the use of your notes or textbook. The content will come from your readings and the work we do together in class. You will be given the full class time to complete each exam. See the course schedule for dates.

**Missed Exams:** If you should miss an exam, you must have a valid excuse and notify me of your intent to take a make-up exam within 24 hours. Failure to notify me of your reason for missing the exam and your desire to make it up in a timely manner will result in your being unable to make up the exam. No exceptions!

**Class presentations:** Each of you will be assigned a partner and will be required to present a section of the assigned reading material to the class. Your presentation should include a Power Point presentation and/or student handouts as well as an oral presentation of the information. You must also submit ten exam questions to me covering the information that you presented. These questions may be included in the Unit Exam after the unit has been completed.

**Grading Policies:**

<table>
<thead>
<tr>
<th>Grade Component</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each exam</td>
<td>100</td>
</tr>
<tr>
<td>Research participation</td>
<td>50</td>
</tr>
<tr>
<td>Presentations (with partner)</td>
<td>25 each</td>
</tr>
<tr>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Total possible points</td>
<td>700</td>
</tr>
</tbody>
</table>

600 points
50 points
50 points
50 points
Grading Scale:

644-700 = A
630-643 = A-
616-629 = B+
574-615 = B
560-573 = B-
490-559 = C
455-489 = D
454 or less = F

Rubric for Class Presentations: 25 points each

Presentation was well prepared 5 points
Information was presented clearly and thoroughly 5 points
Appropriate visual aids were utilized, either PowerPoint or dry erase board 5 points
Class was encouraged to participate 5 points
Exam questions coincided with the presentation 5 points
APPENDIX B

SAMPLE EXAMS
Appendix B

Sample Exams

EPSY 29525
Fall 2014
Exam #2
Chapters 2 & 6

Name: _______________________________ Date: _______________________________

Multiple Choice Questions: Each worth 2 points

1. What are the three types of development?
   a. Physical, social and cognitive
   b. Walking, crawling, talking
   c. Physical, mental spiritual
   d. Listening, speaking reading

2. Which of the following is NOT a principle of development?
   a. It depends on both heredity and the environment
   b. It proceeds in a generally orderly, predictable pattern
   c. It occurs at different rates for different people
   d. All children go through the same stages at the same time

3. The cells in the brain that send signals are called:
   a. Platelets
   b. Neurons
   c. Corpuscles
   d. Cortex

4. The covering of the cerebrum which is the site of much of our thinking, problem solving and language is called:
   a. Synapses
   b. Neurons
   c. Cerebral cortex
   d. Pituitary gland

5. According to Piaget, people construct ____________, which are mental operations that help them to understand the world.
   a. Schema
   b. Equilibrium
   c. Assimilation
   d. Accommodation
6. Which of Piaget’s four stages of development do some people never reach?
   a. Sensory-motor
   b. Pre-operational
   c. Concrete operational
   d. Formal operational

7. According to Piaget, the process of using existing schema to interpret new experiences is known as:
   a. Accommodation
   b. Assimilation
   c. Equilibrium
   d. Cognitive development

8. According to Piaget, the process of creating new schema or changing old ones when they no longer account for new experiences is known as:
   a. Accommodation
   b. Assimilation
   c. Equilibrium
   d. Cognitive development

9. Which of Piaget’s stages is characterized by the concept of object permanence?
   a. Sensori-motor
   b. Preoperational
   c. Concrete operational
   d. Formal operational

10. Which of Piaget’s stages is characterized by the ability to think logically when using concrete materials?
    a. Sensori-motor
    b. Preoperational
    c. Concrete operational
    d. Formal operational

11. The idea that the amount of a substance stays the same regardless of its shape or the number of pieces into which it is divided is known as:
    a. Conservation
    b. Transformation
    c. Preoperation
    d. Reversibility

12. The ability to infer a relationship between two objects based on their relationship with a third is known as:
    a. Egocentrism
    b. Transitivity
    c. Internalization
    d. Learning
13. The theory that asserts that knowledge is acquired through the child’s interaction with a more knowledgeable other and that emphasizes the role of social interaction on the child’s developing mind is known as:
   a. Behavioral theory
   b. Piaget’s theory of development
   c. Cognitive development theory
   d. Sociocultural theory

14. The process through which learners incorporate external, society-based ideas into internal cognitive structures is known as:
   a. Internalization
   b. Egocentrism
   c. Equilibrium
   d. Accommodation

15. According to Vygotsky, which of the following is NOT a role of language in development?
   a. It gives learners access to knowledge that others already possess
   b. It allows the child to see himself as separate from others
   c. It is a cognitive tool that people use to help make sense of their experiences
   d. It is a means for regulating and reflecting on our own thinking

16. According to Vygotsky, children should be taught in their ________________, which is a range of tasks that the child cannot do alone, but can do when helped by a more capable person.
   a. Executive function
   b. Private speech
   c. Zone of proximal development
   d. Scaffolding

17. The assistance that helps children complete tasks that they cannot complete independently is known as:
   a. Executive function
   b. Private speech
   c. Zone of proximal development
   d. Scaffolding

18. The theory of language development that asserts that all humans are genetically wired to learn language is known as:
   a. Social theory
   b. Nativist theory
   c. Learning theory
   d. Cultural theory

19. Which of the following is NOT a role of language in development?
   a. It gives learners access to knowledge that others already possess
b. It is a cognitive tool that people use to help make sense of their experiences
c. It allows the individual to ignore the influences of others
d. It is a means for regulating and reflecting on our own thinking

20. Theories that explain learning in terms of people’s thinking and the processes involved in acquiring, organizing and using knowledge are known as:
   a. Behavioral theories
   b. Theories of moral development
   c. Theories of psychosocial development
   d. Cognitive learning theories

21. Which of the following statements is not true of Cognitive Learning Theories?
   a. People construct knowledge to make sense of their experiences
   b. People learn that which has been reinforced
   c. Social interaction facilitates learning
   d. People need to make sense of their experiences

22. The ability to understand someone else’s point of view is known as:
   a. Constructivism
   b. Interaction
   c. Perspective taking
   d. Learning

23. A learning environment in which teachers and students work together to help everyone learn is known as:
   a. A community of learners
   b. Social constructivism
   c. Student focused learning
   d. Cognitive apprenticeships

24. Which of the following is NOT a component of social constructivism?
   a. Modeling
   b. Memorization
   c. Scaffolding
   d. Verbalization

25. A learning environment in which less skilled learners work with experts in developing cognitive skills such as reading comprehension or math is known as a:
   a. Community of learners
   b. Social interaction
   c. Scaffold
   d. Cognitive apprenticeship

26. The idea that learning depends on, and cannot be separated from, the context in which it occurs is known as:
   a. Situated learning
b. Modeling  
c. Scaffolding  
d. A community of learners

27. The process of gathering information and making decisions about a student’s learning process is known as:

a. Constructivism  
b. Teaching  
c. Interaction  
d. Assessment

28. We know that students need to be cognitively __________ to construct knowledge.

a. Passive  
b. Active  
c. Disinterested  
d. None of the above

29. The extent to which experience and information are connected is known as:

a. Learning  
b. Meaningfulness  
c. Language  
d. Thinking

30. Which of the following is a misconception that teachers commonly hold?

a. Explaining alone helps students understand a topic  
b. The teacher just needs to know the content  
c. High school students have reached formal operations so can be taught abstractly  
d. All of the above

**True/False Questions: Each worth 2 points**

31. Piaget considered experience to be extremely important in development.

   True  
   False

32. Piaget, but not Vygotsky, considered culture to be important in development.

   True  
   False

33. NeoPiagetians have rejected all aspects of Piaget’s theory

   True  
   False
34. According to Vygotsky, knowledge is acquired through the child’s interaction with a more knowledgeable other.
   True
   False

35. Private speech is that which is carried on between the child and his or her teacher.
   True
   False

36. Learning occurs when an individual becomes cognitively active, which results in changing thoughts.
   True
   False

37. Social interaction interferes with learning.
   True
   False

38. The most effective way for a teacher to impart information is simply to explain it.
   True
   False

39. Demonstrating skills such as how to solve a problem is an example of modeling.
   True
   False

40. Misconceptions are easily changed, once students are presented with explanations that disagree with the misconceptions.
   True
   False

41. The use of assessments in the classroom interferes with learning.
   True
   False

42. Constructivism is an established, effective teaching method.
   True
   False

43. Learning and development are dependent on experiences.
   True
   False
44. Sociocultural theory emphasizes the cultural context in which learning occurs.
   
   True
   False

45. A learning environment in which teachers and students work together to help everyone learn is an ineffective learning environment.

   True
   False

**Short Answer—each worth 5 points**

46. List five principles of Cognitive Learning Theory:

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

47. List five characteristics of a learning community:

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
Multiple Choice—2 Points Each

1. Which of the following is NOT a characteristic of motivated students?
   a. They have positive attitudes towards school
   b. They generally require more teacher guidance than other students
   c. They persist in difficult tasks
   d. They process information in depth and cause few classroom management problems

2. A student who is involved in an activity for its own sake, not just for a good grade, is exhibiting what kind of motivation?
   a. Intrinsic motivation
   b. Autonomy
   c. Extrinsic motivation
   d. Self-efficacy

3. Learners are intrinsically motivated by all of the following types of experiences EXCEPT:
   a. Ones that present a challenge
   b. Ones that promote autonomy
   c. Ones that evoke curiosity
   d. Ones that are easily completed

4. Which of the following is a reason that students might NOT be motivated?
   a. They like their teachers
   b. School attendance is compulsory and students don’t get to pick what they study
   c. They see the personal benefits of studying
   d. They control their own learning

5. What describes the match between a learning activity and a learner’s prior knowledge?
   a. Unconditional positive regard
   b. Sociocultural views of motivation
   c. Motivational zone of proximal development
   d. Match.com

6. Which of these is NOT a theory of motivation?
   a. Behaviorist view
   b. Motivational theory
   c. Humanistic view
   d. Cognitive theories
7. The theory of motivation that states that people are motivated by the need to understand and make sense of their experiences is the __________ theory of motivation:
   a. Behaviorist theory
   b. Sociocultural theory
   c. Humanistic theory
   d. Cognitive theory

8. The theory of motivation that emphasizes the role of social interaction in motivation is the __________ theory of motivation
   a. Behaviorist theory
   b. Sociocultural theory
   c. Humanistic theory
   d. Cognitive theory

9. What is defined as independence and the ability to alter the environment when necessary?
   a. Self-esteem
   b. Survival
   c. Need for approval
   d. Competence

10. According to Maslow’s hierarchy of needs, which of the following must be met first, before any others can be addressed?
    a. Survival
    b. Belonging
    c. Self-esteem
    d. Self-actualization

11. According to Kohlberg’s theory of moral development, the egocentric stage that occurs from age 0 to age 10 is known as __________
    a. Universal principles
    b. Pre-conventional ethics
    c. Conventional ethics
    d. Post-conventional ethics

12. The need to act on and control one’s environment is known as the need for _________
    a. Satisfaction
    b. Approval
    c. Self-determination
    d. Self-actualization

13. The ability to function effectively in the environment is known as the need for _________
    a. Competence
    b. Relatedness
    c. Approval
    d. Satisfaction

14. For a challenging task to increase student motivation, it has to be perceived as _________________
    a. Meaningful and worthwhile
    b. Very easy
    c. Too difficult
    d. Unfamiliar
15. The need for relatedness can sometimes have unintended consequences when students develop an unhealthy _________.
   a. Self-determination  
   b. Autonomy  
   c. Need for approval  
   d. Self-reliance

16. For assessment to enhance learning and motivation, it must _________.
   a. Compare students with each other  
   b. Be used sparingly  
   c. Let students know what their IQ is  
   d. Provide information about increasing competence

17. The belief that intelligence or ability can be increased with effort is known as _________.
   a. The incremental view  
   b. The self-efficacy view  
   c. The entity view  
   d. Wrong

18. Which of the following is NOT a factor influencing self-efficacy?
   a. Past performance  
   b. Social cognitive theory  
   c. Modeling  
   d. Emotional state

19. The beliefs, rewards or advantages the person believes can result from participating in an activity are known as _________.
   a. Cost  
   b. Goals  
   c. Value  
   d. Performance

20. Goals that focus on the learner’s ability and how learners compare to one another are known as _________.
   a. Performance goals  
   b. Mastery goals  
   c. Utility goals  
   d. Attainment goals

21. Which of the following is NOT a characteristic of high-efficacy learners?
   a. Accept more challenging tasks  
   b. Use more effective strategies  
   c. Generally perform worse  
   d. Exert more effort

22. Which of the following is the formula for the influence of expectations on motivation?
   a. Length x Width  
   b. Beliefs x expectations  
   c. Modeling x self-efficacy  
   d. Expectancy x Value theory

23. Which of the following characteristics is NOT found in a mastery focused classroom?
   a. The teacher demonstrates personal qualities to increase student motivation to learn
b. The learning environment or climate is motivating for learning to occur
   c. Instruction develops interest
   d. Competition among students is encouraged

24. Teachers’ beliefs that they can help all students learn, regardless of their prior knowledge, ability or personal backgrounds is known as ____________
   a. Caring
   b. Personal teaching efficacy
   c. Modeling
   d. Collective efficacy

25. Teachers who blame low achievement on students’ lack of intelligence, home environment or other outside causes are known as ____________ teachers.
   a. Low-efficacy
   b. Traditional
   c. High-efficacy
   d. Modeling

26. Which of the following was not mentioned as a way for teachers to communicate caring for their students?
   a. Learn students’ names
   b. Tell students about personal problems
   c. Make eye contact, smile
   d. Demonstrate respect for students as individuals

27. One of teachers’ most important goals is to promote students’ beliefs in their ability to accomplish specific tasks. This is known as promoting ________________.
   a. Modeling
   b. Motivation
   c. Caring
   d. Self-efficacy

28. In a mastery-focused classroom, what teacher characteristic is NOT found?
   a. Teachers are more controlling and value student autonomy less.
   b. The teacher demonstrates personal qualities to increase student motivation to learn.
   c. The learning climate is motivating for learning to occur.
   d. Instruction develops interest.

29. The debilitating belief that one is incapable of accomplishing tasks and has little control of the environment is called ____________
   a. Attribution theory
   b. Learned helplessness
   c. Utility value
   d. Cost

30. Feedback indicating that competence is increasing contributes to self-efficacy and self-determination and is called ____________
   a. Self-determination theory
   b. Characteristic theory
   c. Attribution theory
   d. Modeling theory
True/False—2 Points each

31. Motivation is contextual and can change over time.
   True
   False

32. If teachers’ instruction is stimulating enough, students will always be intrinsically motivated.
   True
   False

33. Some research suggests that rewards decrease interest in tasks that are already intrinsically motivating.
   True
   False

34. An increase in the amount of time spent studying is viewed as evidence of motivation.
   True
   False

35. In Maslow’s theory, self-actualization is reaching one’s full potential, becoming what we are capable of.
   True
   False

36. A criticism of Kohlberg’s theory of moral reasoning is that it fails to take into account that moral reasoning depends on context.
   True
   False

37. Unconditional positive regard is treating students as if they are innately worthy because of their behavior.
   True
   False

38. When creating classroom rules and procedures it is good to solicit students’ input.
   True
   False

39. Assessments should NOT be given frequently.
   True
   False

40. Beliefs are cognitive ideas that we accept as true without necessarily having definitive evidence to support them.
   True
   False

41. The Entity View of Intelligence is the belief that intelligence or ability is not stable and can be increased with effort.
   True
   False
42. Self-efficacy is the belief that one is capable of accomplishing a specific task.  
   True  
   False  

43. All students have needs for competence, autonomy and relatedness.  
   True  
   False  

44. “This isn’t my favorite topic either” is a phrase that can motivate students.  
   True  
   False  

45. Assessments do not need detailed feedback because it is not essential for learning.  
   True  
   False  

**Short Answer—10 Points Total**

46. List 5 characteristics of high efficacy teachers and 5 characteristics of low-efficacy teachers.  
   ____________________________________________________________________________  
   ____________________________________________________________________________  
   ____________________________________________________________________________  
   ____________________________________________________________________________  
   ____________________________________________________________________________  
   ____________________________________________________________________________  
   ____________________________________________________________________________  
   ____________________________________________________________________________  
   ____________________________________________________________________________  
   ____________________________________________________________________________
APPENDIX C

SAMPLE STUDY GUIDE
Appendix C

Sample Study Guide

EPSY 29525

Study Guide Unit 6—Chapter 15

• 1. Define academic standards. What is meant by standards-based education?
• 2. What is accountability? How does standardized testing enter into accountability?
• 3. What are high-stakes tests? How are they used?
• 4. What are the criticisms of high-stakes tests?
• 5. What are standardized tests? What kinds of questions are standardized tests designed to answer? How are they used to answer these questions?
• 6. What are national norms?
• 7. List and describe the three functions of standardized tests.
• 8. What is the difference between norm-referenced and criterion-referenced tests?
• 9. List and describe in detail the four kinds of standardized tests.
• 10. What are readiness tests? How are they used?
• 11. What is validity in terms of standardized tests? What are the 3 kinds of standardized test validity? Describe each.
• 12. What is considered to be the major advantage of standardized tests?
• 13. Describe the following types of descriptive statistics: Frequency Distribution Measures of Central Tendency Variability Range Standard Deviation Normal distribution Percentile Rank
• 14. What is a Z score? What is a t score?
• 15. What is meant by the “true score”? What is the Standard Error of Measurement?
• 16. What are two unresolved issues regarding standardized testing with minority students?
• 17. What is meant by assessment bias? List 3 types of assessment bias that can detract from validity?
• 18. Define the following terms: Percentiles, Stanine, Grade equivalent, Standard score.
• 19. What are some of the accommodations for students with disabilities required by the Individuals with Disabilities Act (IDEA)?
APPENDIX D

ANOVA RESULTS OF WITHIN-SUBJECTS EFFECTS
Appendix D

ANOVA Results of Within-Subjects Effects

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sphericity Assumed</td>
<td>.003</td>
<td>2</td>
<td>.002</td>
<td>.007</td>
<td>.99</td>
</tr>
<tr>
<td>Greenhouse-Gasser</td>
<td>.003</td>
<td>1.958</td>
<td>.002</td>
<td>.007</td>
<td>.99</td>
</tr>
<tr>
<td>Huynh-Feldt</td>
<td>.003</td>
<td>1.991</td>
<td>.002</td>
<td>.007</td>
<td>.99</td>
</tr>
<tr>
<td>Lower-bound</td>
<td>.003</td>
<td>1.00</td>
<td>.003</td>
<td>.007</td>
<td>.93</td>
</tr>
<tr>
<td>Error (Instruction)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sphericity Assumed</td>
<td>47.361</td>
<td>230</td>
<td>.206</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greenhouse-Gasser</td>
<td>47.361</td>
<td>225.154</td>
<td>.210</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Huynh-Feldt</td>
<td>47.361</td>
<td>229.010</td>
<td>.207</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower-bound</td>
<td>47.361</td>
<td>115.000</td>
<td>.412</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
REFERENCES


