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Pre-Service Teachers' Beliefs Regarding Student Mistakes during Informal Assessments

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THE FLORIDA STATE UNIVERSITY
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PRE-SERVICE TEACHERS' BELIEFS REGARDING STUDENT MISTAKES
DURING INFORMAL ASSESSMENTS

By

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TABLE OF CONTENTS

LIST OF TABLES.....	iv
LIST OF FIGURES.....	v
ABSTRACT.....	vi
CHAPTER 1: INTRODUCTION.....	1
Goals and Hypotheses.....	3
CHAPTER 2: LITERATURE REVIEW.....	5
Beliefs and Practices.....	6
Informal Assessment.....	7
Mistakes in the Workplace.....	10
Handling Student Mistakes.....	11
Performance vs. Mastery.....	12
Characteristics Associated with Effective Mistake-Handling.....	14
The Current Study.....	16
CHAPTER 3: RESEARCH METHODS.....	18
Participants.....	18
Instrument Development.....	20
Mistake-handling items.....	21
PALS items.....	22
Data Collection.....	22
Demographic items.....	22
Response rates.....	23
Procedures.....	23
CHAPTER 4: RESULTS.....	25
Counterbalancing.....	28
Test-Retest Reliability.....	28
Concurrent Validity.....	28
Exploratory Analyses.....	29
CHAPTER 5: Discussion.....	33
Limitations.....	36
Implications and Directions for Future Research.....	37
APPENDICES.....	38
Appendix A: Interview Questions.....	38
Appendix B: Original Mistake-Handling Questionnaire with PALS Items.....	39
Appendix C: Demographic Questionnaire.....	43
Appendix D: IRB Approval and Pre-Service Teacher Consent Form.....	45
Appendix E: Final Mistake-Handling Questionnaire.....	48
REFERENCES.....	50
BIOGRAPHICAL SKETCH.....	55

LIST OF TABLES

Table 1: Participant Information.....	19
Table 2: Factor Loadings for Exploratory Factor Analysis with Direct Oblimin Rotation of Mistake-Handling Questionnaire Items.....	27
Table 3: Correlation Matrix for Scales.....	28
Table 4: Descriptive Statistics for Participants Fully Committed to Teaching vs. Not Fully Committed to Teaching.....	29
Table 5: Chi-square Values for Independent Variables.....	30

LIST OF FIGURES

Figure 1: Mean scores for subject areas.....	31
Figure 2: Interaction effect between chosen grade level and teaching commitment level.....	32

ABSTRACT

The goal of this study was to develop a valid and reliable questionnaire to assess pre-service teachers' beliefs about how to handle student mistakes, specifically examining its factor structure, test-retest reliability, concurrent validity, and exploring possible relationships between certain teacher characteristics and scores on the Mistake-Handling Questionnaire. Data from 328 students enrolled in at least one of the following required teacher education courses in the teacher education track were used: Educational Psychology, Classroom Assessment, and Introduction to Educational Technology. A reliable one factor structure representing a pro-incorporating mistakes perspective was found. The resulting questionnaire was found to have relatively high internal reliability ($\alpha = .767$), including for the holdout sample ($\alpha = .675$), and high test-retest reliability ($r = .775, p < .001$). Concurrent validity was established between the Mistake-Handling Questionnaire and the PALS Mastery Approaches scale ($r = .413, p < .001$). Exploratory analyses found no differences in scores on the Mistake-Handling Questionnaire based on the pre-service teachers' commitment to teaching, the grade or subject they thought about when completing the questionnaire, or if they had taken certain teacher training classes.

CHAPTER 1

INTRODUCTION

Student mistakes are an unavoidable occurrence in the classroom. When it comes to mistakes, there are two distinct approaches to dealing with them. First, there are those who believe mistakes should be limited as much as possible. According to this viewpoint, students should be taught the correct procedure and should be discouraged from making errors while learning the new material (Gagné, Briggs, & Wager, 1992; Ravaglia, Suppes, Stillinger, & Alper, 1995; Skinner, 1958; Valdman, 1975). Increasingly, however, researchers are finding that it may be beneficial for students to be encouraged to follow their own distinct thought process to arrive at the correct course of action (Gelman, 1994; Hartnett & Gelman, 1998; Palincsar & Brown, 1984). In this approach, the teacher treats mistakes as indicators that the students need to restructure their knowledge and the teacher will adapt his or her teaching strategies to account for the mistakes (Santagata, 2005). The belief is that getting students to think metacognitively (i.e., think about their thinking) will have a positive effect on students' understanding of the material.

Student mistakes can occur in several different contexts. Mistakes can be made in homework, tests, or informal assessments during the class. This study will be focused solely on mistakes students make during informal assessments. According to Oosterhoff (2008), informal assessment typically consists of "spontaneously probing students' understanding with oral questions" (p. 5). In the current study, pre-service teachers' beliefs about how to handle mistakes students make during informal assessments will be investigated.

The way teachers may potentially handle mistakes in the classroom is important because it may reveal something about their goals for instruction and perceived instructional goals have been shown to have an effect on the motivation and learning performance of students (Heinze, 2005; Lorenzet, Salas, & Tannenbaum, 2005; Nordstrom, Wendland, & Willams, 1998). Students who perceive that the goal of instruction is to have the students master the material have been shown to use more effective strategies, have a more positive attitude toward the class, and prefer more challenging tasks. On the other hand, students who believe that the goal of instruction is to have students perform better tend to evaluate their

own ability negatively and attribute their failures to lack of ability instead of the amount of effort (Ames & Archer, 1988). However, most of the research in this area has been on middle school students up through adult learners. There may be different results for younger students. The current study will focus on whether the ways K-12 teachers make use of informal assessments and handle students' mistakes that may arise might be related to the instructional goals they wish to set for their students.

Much has been made of how teachers' handling of mistakes affects students, and results have mostly shown that encouraging errors and exploration is beneficial (Heinze, 2005; Lorenzet, Salas, & Tannenbaum, 2005; Nordstrom, Wendland, & Willams, 1998). An example can be seen in the Lorenzet, Salas, and Tannenbaum study, where a group of trainees learning a computer program were led into mistakes and then shown how to fix them. It is important to note, however, that practicing incorrect strategies can be harmful (Moreno & Mayer, 2005). Moreno and Mayer found that students who reflected on their own incorrect answer instead of reflecting on the correct answer were more likely to give incorrect explanations. Teachers should correct the student's thought process as the errors are explored.

However, researchers have observed error avoidance (where teachers attempt to direct students away from making mistakes and/or quickly correct a student's mistake and move on), as opposed to error management (where teachers use student errors as learning opportunities and address the thought process that led to the mistake), in the classroom (Santagata, 2005; Schleppenbach, Flevaris, Sims, & Perry, 2007). It is important to find out why teachers may not be addressing students' errors in their lessons when research suggests that this would be beneficial.

The original goal in researching this topic was to understand pre-service teachers' beliefs about mistakes in the math classroom, as the studies that initially inspired this research were based on observations of mathematics teachers (Santagata, 2005; Schleppenbach, Flevaris, Sims, & Perry, 2007). However, later in the development of the questionnaire, it became clear that it might be of value to consider the broader population of pre-service teachers and explore whether there were any differences between pre-service teachers in various subject areas. A literature search was done using keywords of "errors" and "teaching

methods.” While this did result in some articles on error correction research in reading classrooms, most of these included samples of specific students populations, such as children with disabilities, which was not a focus of this study. In the literature review that follows, just a brief discussion of some of the error correction literature that focused on decoding errors of children with disabilities will be provided.

The purpose of this study is to develop a questionnaire focusing on pre-service teachers’ beliefs about the handling of student mistakes and the pre-service teachers’ goals of instruction. In order to effectively train pre-service teachers, it is important to know about the pre-service teachers’ beliefs (Wubbels, 1992). If the pre-service teachers believe in incorporating mistakes, it may be an indication to educators that the training of pre-service teachers should include *how* to incorporate mistakes. If pre-service teachers do not believe in incorporating mistakes, it may be beneficial for teacher training programs to include evidence of the benefits of incorporating mistakes along with instruction on how to incorporate mistakes.

Goals and Hypotheses

The main goal of this study was to create a valid instrument, called the Mistake-Handling Questionnaire, for measuring pre-service teachers’ beliefs about handling student mistakes during informal assessments and their goals of instruction. To achieve this aim, first, the factor structure of the Mistake-Handling Questionnaire was examined. A hold out sample was used in order to help establish the reliability of the factor structure, and then test-retest reliability was calculated. Next, in order to help establish the validity of the Mistake-Handling Questionnaire, correlations between scores on scales from the Patterns of Adaptive Learning Scales (PALS; Midgley et al., 2000) and on the Mistake-Handling Questionnaire were calculated. Items from the PALS instrument were included in the administration of the Mistake-Handling Questionnaire. The items from the PALS that were included in the questionnaire administration were those comprising the Mastery Approaches and Performance Approaches factors, which are teacher surveys addressing their Approaches to Instruction (Midgley et al., 2000). The items were slightly reworded to fit the context of the Mistake-Handling Questionnaire.

Beyond identifying the factors captured by the instrument and establishing concurrent validity with the PALS, an additional goal of this study was to identify whether pre-service teachers who differ in their characteristics (commitment level to teaching, whether they have taken certain courses, what grade level classroom they are considering when filling out the questionnaire, and what subject area they are considering when filling out the questionnaire) also differed in their ratings on the different factors. Because this is an exploratory goal, no a priori hypotheses about the differences between teachers were offered. The hypotheses for evaluating the concurrent validity of the Mistake-Handling Questionnaire were as follows:

- Pre-service teachers who more highly endorse mastery goals for instruction will more strongly endorse statements about the benefits of incorporating mistakes into instruction (e.g., to believe in encouraging students to feel comfortable making mistakes and that mistakes provide teachers with valuable information during informal assessments).
- Pre-service teachers who more highly endorse performance goals for instruction will more strongly endorse statements about minimizing mistakes (e.g., focusing on the correct answer and not dwelling on any mistakes students may make) when controlling for mastery goal scores.

CHAPTER 2

LITERATURE REVIEW

The goals and design of this study were informed by research and theory from a variety of areas, including informal assessment, motivational goals, and mistake-handling. The first issue concerning this study is the question of, “Why pre-service teachers?” The review of the pertinent literature shows that pre-service teachers’ beliefs often are related to their teaching practices in the classroom once they become teachers. Pre-service teacher education may provide an opportune time to try to influence the beliefs of pre-service teachers, and thus the practices of the pre-service teachers once they enter their classrooms. First, however, a valid measure of pre-service teachers’ beliefs about handling student mistakes during informal assessments is needed, as it would provide a means for describing their current beliefs and measuring any changes in beliefs following any teacher training intervention.

Another question concerning this study is, “Why informal assessment?” It will be shown that informal assessment is a useful tool in determining students’ thought processes. Informal assessments provide teachers with opportunities to give students immediate and informative feedback. Instructing the pre-service teachers to consider the questionnaire items in an informal assessment setting will give insight into how pre-service teachers believe mistakes should be handled in these informal settings as opposed to mistakes on tests or homework.

Research addressing different ways mistakes can be dealt with will be covered. This will include research on handling-mistakes in training programs for adults in the workplace as well as in K-12 classrooms. The research on the adult training programs shows promising results for encouraging errors that may be similar to the results one would hope to find in K-12 classrooms. Research in K-12 classrooms also suggests that incorporating errors into instruction is related to positive outcomes, such as better performance and enhanced self-efficacy (Loenzet, Salas, & Tannenbaum, 2005). Characteristics associated with effective-mistake handling strategies, found in the research, are also covered.

The issue of performance versus mastery instruction is addressed as well. In classes with a performance goal orientation, students tend to be concerned with outcomes; the final grade gets more attention than improving understanding (Dweck, 1996). Classes with a

mastery goal orientation, on the other hand, are more focused on improving knowledge, understanding, and skill (Dweck, 1996). Research shows that a mastery approach to learning is associated with positive student outcomes (Ames, 1992; Butler, 2006; Corpus, Ogle, & Love-Geiger, 2006; Pintrich, 2000; Rawsthorne & Elliot, 1999). It is hypothesized that pre-service teachers with mastery goals believe in encouraging students to feel comfortable making mistakes and that mistakes provide teachers with valuable information during informal assessments. This is based on the literature that states teachers with a mastery goal orientation are focused on improving knowledge and understanding rather than just getting the right answer in the end (Dweck, 1996). Teachers with performance goals are hypothesized to be more likely to believe in focusing on the correct answer and not dwelling on any mistakes students may make. The questionnaire developed for the current study includes items concerning pre-service teachers' beliefs about goal orientation, whether students' performance or mastery of the material (or both, or neither) are important.

The research demonstrates a positive relationship between incorporating student errors into instruction and student motivation and learning performance (Heinze, 2005; Lorenzet, Salas, & Tannenbaum, 2005; Nordstrom, Wendland, & Willams, 1998), but teachers often are not observed incorporating errors into instruction (Santagata, 2005; Schleppenbach, Flevaris, Sims, & Perry, 2007). This indicates a need to explore the beliefs pre-service teachers have about the role of errors in instruction, which this study attempts to do. The review of the literature on these topics (informal assessment, motivational goals, and mistake-handling) will provide the reasoning behind the development of the Mistake-Handling Questionnaire in the current study.

Beliefs and Practice

Research has shown that teachers' beliefs about instruction are positively related to their behaviors in the classroom. How a teacher believes students acquire knowledge is associated with the teacher's behavior and ultimately the learning of his or her students (Fang, 1996; Richards, Gipe, & Thompson, 1987). An example of this is illustrated in the research on reading instruction. Richards, Gipe, and Thompson found that teachers who view reading as rules for decoding text tend to emphasize mastery and have students reread for

comprehension. On the other hand, teachers who stress strategic aspects of reading promote storytelling, writing, and sharing of ideas (Nist & Mealey, 1991; Sturtevant & Spor, 1990; Winograd & Johnston, 1987).

Fang (1996) conducted a synthesis of the research on teacher beliefs and practices and found that the research indicates that a teacher's beliefs are shaped by several factors, many of which have to do with the pre-service experience. O'Brien and Stewart's (1990) qualitative study found that many pre-service teachers believe teaching is common sense and common practice. These findings indicate that pre-service training provides an important opportunity to educate the pre-service teachers about what strategies are effective in the classroom and why it is important to use these effective strategies over strategies with which they may be more familiar and/or comfortable. Using informal assessments is one such strategy.

Informal Assessment

Informal assessments are "classroom assessment activities used to get a quick and rough idea of student progress" (O'Donnell, Reeve, & Smith, 2009). They can be a tool for teachers that helps them determine what it is their students know and whether they actually understand the deeper meanings of what they are being taught. Potential benefits for focusing on deeper understanding by the students include: "an expanding conception of what students are able to do...the realization that although students' methods may appear different from a teacher's approach, students' methods may still be valid, and the development of abilities to interpret students' thinking in class and to make appropriate instructional decisions" (Chamberlin, 2005, p. 142). Students often do not get feedback on their tests or quizzes for over 24 hours (Cole, 1999). Informal assessments allow teachers to give students immediate feedback, and a study by Brosvic and Epstein (2007) shows the potential benefits of providing immediate feedback albeit in the context of a formal assessment.

In their study, Brosvic and Epstein (2007) randomly assigned college students to classes with four different time periods for feedback on tests: immediate feedback, end-of-test feedback, 24-hour feedback, and the control group that received feedback the next time the class met. All participants took five classroom exams and one final exam. In the immediate feedback group, students filled out their answers on the Immediate Feedback Assessment

Technique (IF AT) form while students in all of the other conditions filled out Scantron forms. On the IF AT form, there are four boxes for each question (A B C or D similar to a Scantron) and each box has an opaque waxy coating that can be scratched off. The student could scratch each box until they found the correct answer (there was a star under the waxy coating indicating a correct answer. Brosvic and Epstein then administered retention tests 3, 6, 9, and 12 months after the final examination. They found that, “immediate feedback is more effective for classroom learning, and the retention of classroom learning, than delayed feedback” (p. 405).

Gearhart and Saxe (2004) provide an illustration of an informal assessment and how useful this type of assessment can be in determining students’ thinking:

Mr. Waters is teaching *Seeing Fractions* lessons to support his students’ understanding of pieces as quantities that are fractional parts of wholes. He uses a fair share problem to introduce the notion of equivalence: *Six people will share 3 brownies. How much will each person receive if each receives a fair share?* He distributes worksheets with blank squares depicting the brownies. As the students work, he monitors children’s strategies and asks brief questions to probe students’ understandings and scaffold construction of new insights. He is pleased that many solutions suggest that the students understand important aspects of fractions. For example, most students partition the brownies without leaving a remainder, and they distribute parts of brownies equally among people. But he wonders if students can use equivalence concepts to interpret one another’s solutions. He brings the class together with a discussion question: “Is $\frac{1}{2}$ of *one* brownie just as fair a share as $\frac{1}{6}$ of *each* brownie ($\frac{1}{6} + \frac{1}{6} + \frac{1}{6}$)?” As the class discusses the two solutions in Figure 1, Mr. Waters discovers a pattern of understanding that he never anticipated: Some students agree that both solutions show fair shares, but believe that one share is more than the other! Gabriel argues that $\frac{1}{6} + \frac{1}{6} + \frac{1}{6}$ is ‘more pieces’ than one half; he is using whole number concepts to compare ‘3 pieces’ with ‘1 piece.’ Naomi argues that $\frac{1}{2}$ is a ‘bigger piece’ than the three little one sixths; she is focusing on the qualitative difference in size of pieces. Neither student is considering the fractional values of the pieces. (pp. 305-306)

This example demonstrates how important informal assessment is for understanding students’ thought processes. If Mr. Waters only used quizzes and tests to determine student knowledge, he would have likely missed the fact that the students lack a deep understanding of what the fractions actually represent. According to the opinion of the National Council of Teachers of Mathematics (NCTM, 2000), “Effective teaching involves observing students, listening carefully to their ideas and explanations, having mathematical goals, and using the information to make instructional decisions” (p. 19). The next step Mr. Waters should take is to

address this lack of knowledge in his lesson. After having the students share their reasoning with the class as described above, Mr. Waters could lead a class discussion on why the statements made were or were not valid.

Research in error correction that focuses on decoding also supports the idea that immediate feedback is beneficial. Barbetta, Heward, Bradley, and Miller (1994) found that, in primary classes with students with disabilities, having a teacher provide the correct word and having the student repeat the correct word immediately is superior to having the teacher provide the correct word at the end of the reading session and having the student repeat the word then.

Along this same line, research has found that student reading accuracy is positively related to instruction where, following reading errors, teachers provide the correct word and students must repeat it (Barbetta, Heron, & Heward, 1993). Also, it was more beneficial when teachers provided immediate whole-word correction as opposed to immediate phonetic prompts (Barbetta, Heward, Bradley, & Miller, 2003).

These studies just mentioned focused on decoding and reading accuracy. There is little to no research determining what reading comprehension instructional strategies are most efficient for student learning (Schisler, Joseph, Konrad, & Alber-Morgan, 2010), let alone error correction strategies in the context of reading comprehension instruction. The research that focuses on decoding and reading accuracy seems to focus on providing the correct answer. The teachers provide a correct answer for the student to repeat instead of getting at why the student is making the mistake. In this study, comparisons were made between ratings on the questionnaire of pre-service teachers with focuses on different subjects, as pre-service reading teachers (with a focus on decoding or reading accuracy) may differ from pre-service math teachers interested in problem solving, for example.

This study will measure pre-service teachers' beliefs about how to handle student mistakes during informal assessments as opposed to handling mistakes on tests or homework assignments. The reason this study is focusing on mistake handling beliefs in informal assessment is because the way teachers react to student answers is generally considered an important part of informal assessment practice (Oosterhoff, 2008). In the Mistake-Handling

Questionnaire, participants will be instructed to consider mistakes described in the items as mistakes made during “in-class activities.” This terminology is used because not all participants may be familiar with the term “informal assessment.”

Mistakes in the Workplace

Mistakes have been studied in and out of the classroom. There is a current interest in the use of errors in training adults in the work place. These studies tend to focus on computer program training for adults or college aged students. Several studies have been conducted to see whether error management training (EMT) has a positive effect on post-training outcomes when compared to error avoidant training (Keith & Frese, 2005; Keith & Frese, 2008; Nordstrom, Wendland, & Williams, 1998). There are two key characteristics that distinguish EMT from other training methods: participants are only given minimal direction and are otherwise encouraged to actively experiment on their own and EMT involves explicit encouragement of errors (Keith & Frese, 2008). Studies have found that EMT has positive effects on the trainees including enhanced performance, increased intrinsic motivation (the task is viewed as an end in itself) and decreased frustration (Nordstrom, Wendland, & Willams, 1998). These training results are the type of results that one would like to see in the K-12 classroom as well.

Keith and Frese (2005) conducted an experiment to find out what about EMT is beneficial to students. Their study identifies two elements of EMT that they believe are the most important: emotion control and metacognitive activity. Emotion control is defined as being able to keep performance anxiety and other negative emotional reactions at bay while engaging in a task, and metacognition is defined as the control over one’s cognitions, involving skills of planning and monitoring as well as evaluation of one’s progress during task completion. This analysis compared an EMT group to an error avoidant training group, in which participants were asked to follow the instructions closely and were told that following the instructions would allow them to learn the most important parts of the program in the shortest amount of time and that they would learn the correct functions from the very beginning if they followed the instructions. As in other studies (Keith & Frese, 2008; Nordstrom, Wendland, & Willams, 1998), Keith and Frese found that the EMT group performed better after the training than did

the other group. In addition, Keith and Frese were able to determine that this difference in performance was fully and independently explained by emotion control and metacognitive activity during training.

Whereas these studies are done with adult learners, the results that they have found to be associated with EMT (i.e., enhanced performance, increased intrinsic motivation, and decreased frustration) are the same results that are desired for K-12 students. Intrinsic motivation would be desired in K-12 students because it has been associated with creative task engagement (Amabile, 1982) and cognitive flexibility (McGraw & McCullers, 1979). More research is needed to determine if the use of teaching strategies comparable to those found in EMT produce similar desired outcomes in K-12 classrooms.

Handling Student Mistakes

Several studies have found common that students make common mistakes (Fiori & Zuccheri, 2005; Jitendra & Kameenui, 1996; Riccomini, 2005). This presents the problem of how to approach these common mistakes. In these situations, instructors and teachers are already aware of mistakes that the students or trainees are likely to make. The question is whether to guide students through the errors or to try and structure the instruction to avoid these types of errors. Lorenzet, Salas, and Tannenbaum (2005) conducted an experimental study in which college students were to learn a new software package. Students were randomly assigned to one of two groups: one that received guided errors and one that received error free training. Their study demonstrated that guided errors led to better and faster performance, as well as enhanced self-efficacy (belief in one's ability to perform a task (Bandura, Adams, & Beyer, 1977)) compared with training that purposefully excluded errors. These results suggest that it may be important for teachers and instructors to monitor student understanding as they are guided through the errors. This can be accomplished by asking students to explain their answers to the teacher.

Eggleton and Moldavan (2001) give an example illustrating how informing students of these common errors is not enough to get the desired results. The teacher, Mrs. Phillips, used to inform students of common errors and encouraged them to include an example of the common mistake in their notes. However, she found that students continued to make the

same mistakes. Mrs. Phillips decided to change her strategy by giving students an example of how someone incorrectly solved a problem and asking them to explain what is incorrect about the example and to solve the problem correctly. Eggleton and Moldavan suggest that by using this strategy, the teacher can verify that the students have gained new knowledge and that they know why the common mistake is incorrect, not just that it is incorrect.

Heinze (2005) explains that mistakes are needed to create “a line of demarcation” between what is correct and what is incorrect. He argues that mistakes should be used as counterexamples and that without knowing what is incorrect, students have no way of knowing at which point the correct ends and the incorrect begins. Heinze argues, like the Eggleton and Moldavan (2001) example, it is necessary for the students to be able to analyze and correct the mistake and to use the mistake to develop their own strategy for the prevention of future mistakes in order for the incorporation of mistakes to be truly helpful. These authors give examples of different ways mistakes can be incorporated into the classroom (e.g., see Mrs. Phillips example in previous paragraph). The Mistake-Handling Questionnaire attempts to measure pre-service teachers’ beliefs about different ways mistakes can be used in the classroom as well as whether these uses of mistakes are related to the instructional goals for the class. These instructional goals can include whether there is a mastery or performance goal orientation.

Performance vs. Mastery

Within informal assessments, teachers can portray to the students the goal orientation, whether it is performance or mastery, or both. Teachers with a performance goal orientation are concerned with outcomes. The final grade gets more attention than improving understanding (Dweck, 1996). Classes with a mastery goal orientation, on the other hand, are more focused on improving knowledge, understanding, and skill (Dweck, 1996). A study by Butler (2006) illustrates how a teacher can portray the goal orientation of the class. In Butler’s study of 7th and 8th grade students, students were either told before completing 10 problem-solving tasks (involving identifying the best strategy for filling a water jar) that they would be given a percentile score representing the percentage of students they scored better than or they would see a graph of how their scores the items improved, remained stable, or

deteriorated over the course of the assignment. Students in the second group, who received the mastery focused information, performed similarly to the first group on the early tasks (solving them primarily with simple strategies) but performed significantly better on the later tasks, employing more complex, and likely less familiar, strategies.

It is important to consider how teachers' words and actions can emphasize mastery or performance because the goal orientation of the teacher has been shown to be associated with a variety of student factors (for a review see Roehrig, Turner, McElhaney, Christesen, & Jakiel, under revision). Mastery goal orientation has been positively associated with self-efficacy, intrinsic motivation, persistence, heuristic and divergent thinking, and effective learning strategies (Ames, 1992; Butler, 2006; Corpus, Ogle, & Love-Geiger, 2006; McMillan & Hearn, 2008; Pintrich, 2000; Rawsthorne & Elliot, 1999). In contrast, performance goals have been associated with negative outcomes such as negative affect, challenge avoidance, superficial learning strategies, and self-handicapping (Ames, 1992; Corpus, Ogle, & Love-Geiger, 2006; Midgley & Urdan, 2001; Pintrich, 2000).

However, recently there has been a debate of whether performance goals can be beneficial. Harackiewicz, Barron, Pintrich, Elliot, and Thrash (2002) suggested that students who adopt both goals are "optimally motivated" (p. 642). Corpus, Ogle, and Love-Geiger (2006) found that comparing a student's performance to that of other students may benefit male students, but even for males this benefit only exists if the student performs above average, stays above average, and does not doubt that he will stay above average.

Butler (2006) suggests that students will perform well on familiar tasks when they focus on performance goals. According to Butler, academic performance is often measured on how well students can recall and perform familiar tasks, and this may be the reason why some studies have found performance goals to be associated with increased academic performance. With mastery goals, however, students are more likely to use divergent types of thinking and be able to solve problems where they have to come up with their own way to answer the problem.

Midgley, Anderman, and Hicks (1995) used the Patterns of Adaptive Learning Scales (PALS) instrument to examine differences among elementary and middle school teachers on several factors, including performance goals and mastery goals. They found that there was a

significant difference and that middle school teachers were more performance focused, while elementary teachers were more mastery focused.

For the purpose of this study, it will be possible to establish the concurrent validity of the mistake-handling dimensions of the questionnaire being developed if pre-service teachers with mastery goals for their students are more likely to believe that student mistakes should be incorporated into instruction. More specifically, it is hypothesized that pre-service teachers with mastery goals believe in encouraging students to feel comfortable making mistakes and that mistakes provide teachers with valuable information during informal assessments because incorporating the mistakes suggests that the pre-service teachers are concerned with improving students' knowledge, regardless of their thoughts on performance goals. This is based on the research that mastery goals are more associated with divergent thinking (Butler, 2006). Pre-service teachers with only high performance goals are hypothesized to be more likely to believe in focusing on the correct answer and not dwelling on any mistakes students may make. Also, based on the Midgley, Anderman, and Hicks (1995) results, exploratory analyses included grade level as an independent variable.

Characteristics Associated with Effective Mistake-Handling

Although it has been suggested in several studies that incorporating errors provides benefits to learners, including improved self-efficacy, increased intrinsic motivation, higher attribution to effort, more positive attitudes, and improved performance (Keith & Frese, 2005; Keith & Frese, 2008; Lorenzet, Salas, & Tannenbaum, 2005; Nordstrom, Wendland, & Williams, 1998), it is important to note that these results might not be the same for every individual. Gully, Payne, Koles, and Whiteman (2002) found that the effectiveness of what they call "error-encouragement training," which is based on the same idea as EMT, is dependent on the characteristics of adult trainees, including their cognitive abilities and conscientiousness. Individuals who are highly conscientious tend to be careful, thorough, organized, hardworking, achievement oriented, and persevering (Gully et al., 2002). Conscientiousness and openness were measured using Saucier's (1994) Mini-Markers, while cognitive ability was measured by Scholastic Assessment Test (SAT) scores. According to their research, individuals who are more open or who have a higher cognitive ability seem to benefit more from the training than those

with lower cognitive ability or those who are more conscientious. Highly conscientious individuals' self-efficacy was shown to suffer from error-encouragement training and to benefit most from no-error instruction. This could have important implications for how teachers respond to mistakes in the classroom, depending on the student who is making the mistake. Teachers may want to use no-error instruction with highly conscientious individuals.

With all of the possible benefits that seem to come with incorporating mistakes on informal assessments into (Keith & Frese, 2005; Keith & Frese, 2008; Lorenzet, Salas, & Tannenbaum, 2005; Nordstrom, Wendland, & Williams, 1998), it is surprising that teachers do not seem to be implementing this strategy. Researchers who observe classrooms have found that when students make mistakes, teachers, especially in the United States, rarely address these mistakes and instead focus on finding the correct answer (Santagata, 2005; Schleppenbach, Flevares, Sims, & Perry, 2007). By not addressing the mistakes the students are making, the teachers may not be making optimal use of the informal assessments they use in their classrooms. However, it is also important to note that the studies associated with the benefits of incorporating mistakes have for the most part been conducted with adults and college students. To be able to say that incorporating mistakes are beneficial for school aged children, more research is needed. The purpose of the current study is to provide a basis for future research in this area.

Santagata (2005) conducted her study from the perspective that American classrooms are more influenced by Behaviorist theories when it comes to mistakes. Teachers with a Behaviorist perspective, Santagata suggests, may want to avoid mistakes because their presence can reinforce wrong answers. On the other hand, those with a Constructivist perspective may view mistakes as unavoidable and necessary and that mistakes signal a need for students to restructure their knowledge. She used 60 videos of eighth grade mathematics classrooms in the United States and Italy from the Third International Mathematics and Science Study (TIMSS) to construct a coding system to describe the nature of mistakes and mistake-handling strategies. After observing that many teachers did not use student mistakes as teaching opportunities, Santagata speculated about several reasons why the teachers in her study may not have spent time on students' mistakes, including preserving student self-esteem,

keeping students' attention, or possibly because teachers, in the United States particularly, believe that learning happens through the reinforcement of correct answers and the avoidance of mistakes.

Currently, there is very little research on teacher attitudes toward student mistakes. In most of the current literature, teachers' handling of mistakes is observed and the ways the teachers handle the mistakes are described. Often in the discussion sections of these articles the authors give possible explanations of why they think the teachers handled mistakes in the ways that were observed. These possible explanations, as well as the hypothesized reasons for why EMT programs are so successful, provided the basis for the early drafts of the Mistake-Handling Questionnaire developed for the current study. The goal of this study was to begin to explore why teachers seem to avoid addressing mistakes their students make in the classroom.

The Current Study

The main goal of this study was to create a valid instrument, called the Mistake-Handling Questionnaire, for measuring pre-service teachers' beliefs about handling student mistakes during informal assessments and their goals of instruction. To achieve this aim, first, the factor structure of the Mistake-Handling Questionnaire was examined. A hold out sample was used in order to help establish the reliability of the factor structure, and then test-retest reliability was calculated. Next, in order to help establish the validity of the Mistake-Handling Questionnaire, correlations between scores on scales from the PALS and on the Mistake-Handling Questionnaire were calculated. Items from the PALS instrument were included in the administration of the Mistake-Handling Questionnaire. The items from the PALS that were included in the questionnaire administration were those comprising the Mastery Approaches and Performance Approaches factors, which are teacher surveys addressing their Approaches to Instruction (Midgley et al., 2000). The items were slightly reworded to fit the context of the Mistake-Handling Questionnaire.

Beyond identifying the factors captured by the instrument and establishing concurrent validity with the PALS, an additional goal of this study was to identify whether pre-service teachers who differ in their characteristics (commitment level to teaching, whether they have taken certain courses, what grade level classroom they are considering when filling out the

questionnaire, and what subject area they are considering when filling out the questionnaire) also differed in their ratings on the different factors. These four categories (commitment to teaching, courses taken, grade level, and subject area) were chosen based on the research. Commitment level to teaching was considered because there might be a difference between those who are planning to become teachers and those who are just taking classes that on the teacher education track (Pop, 2008). The courses taken were included because it was thought that pre-service teachers' beliefs may be affected by what they learn in these teacher education courses (Fang, 1996; O'Brien & Stewart, 1990; Wilke, 2008). Grade level and subject area were considered because much of the research that the questionnaire was based on focused on older learners and math or computer training classes. There may be differences in what pre-service teachers believe is appropriate for different age groups, mistakes may be seen as more or less beneficial based on the type of content covered in different subject areas. Because this is an exploratory goal, no a priori hypotheses about the differences between teachers were offered. The hypotheses for evaluating the concurrent validity of the Mistake-Handling Questionnaire were as follows:

- Pre-service teachers who more highly endorse mastery goals for instruction will more strongly endorse statements about the benefits of incorporating mistakes into instruction (e.g., to believe in encouraging students to feel comfortable making mistakes and that mistakes provide teachers with valuable information during informal assessments).
- Pre-service teachers who more highly endorse performance goals for instruction will more strongly endorse statements about minimizing mistakes (e.g., focusing on the correct answer and not dwelling on any mistakes students may make) when controlling for mastery goal scores.

CHAPTER 3

RESEARCH METHODS

Participants

Data were collected from 335 students at a public university in the south east. Seven questionnaires that were filled out were excluded from all the following descriptive reports and analyses because participants stopped responding part way through the questionnaire or responses seemed to be selected in an arbitrary pattern (e.g., all 3s selected). Participants were enrolled in at least one of the following required teacher education courses in the teacher education track: Educational Psychology, Classroom Assessment, or Introduction to Educational Technology. Most of the participants (see Table 1) were female (79%), 52 percent were in a traditional teacher education program, and the majority were white (52%). When filling out the survey, participants were instructed to think of one grade and subject area and to think of either a special education class or general education class and whether the class had a number of English Language Learners (ELLs) or no ELLs. Eighty percent chose a non-ELL class, 97 percent chose a non-special education class, 9th-12th grade was the most popular grade range (47%), and English/Language Arts was the most popular subject (45%).

Table 1
Participant Information

Demographic Information			Pre-Questionnaire Information		
Item	n		Item	n	
Gender			English Language Learner		
	Male	64		ELL class	63
	Female	240		non-ELL class	251
	Total	304		Total	314
Race			Special Education		
American Indian or Alaskan				Special ed class	10
	Native	6		Non-special ed class	316
	Asian	11		Total	326
	African American	36	Grade Level		
	Hispanic or Latino	18		Pre-K - 5th grade	116
Native Hawaiian or Pacific				6th - 8th grade	43
	Islander	1		9th - 12th grade	142
	White	259		Total	301
	Other	9	Subject Area		
	Total	340		Art	3
Program				English/LA	143
Math/Science Teaching				Mathematics	53
	Program	17		Music	2
	Minor	31		Physical Education	12
	Traditional	166		Science	16
	Not Teacher	67		Social Science	88
	Graduate	39		Total	317
	Total	320			
Semester in Teaching					
Program					
	First	96			
	Second	53			
	Third	42			
	Fourth	21			
	Total	212			
Commitment to Teaching					
Fully committed to					
	teaching	228			
	Undecided	73			
Not interested in teaching		25			
	Total	326			

Note . The total *n* for race is larger than the total sample size because participants were allowed to select more than one race. Also, totals for other items are less than the total sample size due to missing values

Sample size for this study was based on the literature concerning the sample size needed to run an EFA (Comfrey & Lee, 1992; Costella & Osborne, 2005). Comfrey and Lee believe there are minimum acceptable sample sizes and suggest that “the adequacy of sample size might be evaluated very roughly on the following scale: 50 – very poor; 100 – poor; 200 – fair; 300 – good; 500 – very good; 1000 or more – excellent” (p.217). Costella and Osborne, however, believe that the item to subject ratio is preferable when determining the appropriate sample size. They identify the current rule-of-thumb to be a ratio of 10:1, though they note that 62.9% of the studies they examined between 2003-2005 performed analyses with subject to item ratios of 10:1 or less. For this study, there were 328 participants. However, in order to have a holdout sample, the EFA’s were conducted with 228 participants (the entire sample of 328 participants was used in all other analyses). This is slightly below the desired 280 (since the original form of the Mistake-Handling Questionnaire had 28 items), but it does exceed the acceptable cutoff of 200 as suggested by Comfrey and Lee.

Instrument Development

After the first draft of the Mistake-Handling Questionnaire was created by the author based on the descriptions found in the literature, two interviews of expert teachers (teachers with more than five years of teaching and who were graduate students in the College of Education) were conducted (see Appendix A for interview questions). The expert teachers who were interviewed made a couple of suggestions that were added to the questionnaire. First, an expert teacher noted that when she filled out the questionnaire she was only thinking of how she would handle mistakes in the math classes that she teaches and that she might feel differently about how mistakes should be handled in other classes. Because of this, instructions were added to the questionnaire that tell the participant to think of their subject area when answering the questions. Also, two questions were added addressing whether mistakes should be incorporated in the subject the participant plans to teach and whether mistakes should be incorporated in other subjects. Another comment made by an expert teacher was that she felt discouraging mistakes would not allow the students to be as creative. Based on this statement, an item was added concerning whether discouraging mistakes hinders academic creativity.

In addition to the expert teachers, the Mistake-Handling Questionnaire was piloted with five undergraduate psychology students to make sure the questionnaire was clear. For the most part, the undergraduate participants said that they were able to understand the items and that the questionnaire took somewhere between five and ten minutes to complete. However, one point made by two of the participants was that they were unsure whether they should be thinking of a whole class lesson when considering how to handle mistakes or whether they should be considering how to handle mistakes on a one-on-one or small group basis. To address this problem, instructions were added to the beginning of the questionnaire telling participants to consider these items in the context of a whole class lesson.

An additional edit was made due to feedback from an academic expert in the field of educational psychology. The academic expert suggested that participants' ratings may vary based on what grade level they are considering when answering the questions and that the participants may not be thinking of the same grade throughout the questionnaire. Based on this feedback, the Mistake-Handling Questionnaire asks participants to select one grade and one subject that they are considering when filling out the questionnaire.

Mistake-handling items. The items in this main section of the Mistake-Handling Questionnaire fell into three main categories: classroom atmosphere, incorporating mistakes, and reasons for mistake-handling. These were conceptual categories of items that emerged as the instrument was developed. However, since there was no research on which to base these categorizations, an Exploratory Factor Analysis (EFA), instead of a Confirmatory Factor Analysis (CFA), was run in the data analysis (see Appendix B for the Mistake-Handling Questionnaire, including PALS items). The items in this section, along with the items from all other sections, including the PALS section, were on a 5-point Likert-type scale: 1 = Strongly Disagree; 3 = Somewhat Agree; 5 = Strongly Agree.

The five classroom atmosphere items (see items 2, 4, 5, 6, and 8 in Appendix B) were concerned with how accepting of errors pre-service teachers believe a classroom environment should be. For example, one item read, "Teachers should allow their students to feel comfortable making mistakes as they try to learn the material." The incorporating mistakes category contained eight items (see items 1, 7, 15, 16, 20, 28, 30, and 31 in Appendix B)

concerning the use of mistakes. An example of one such item was, “Teachers should actively try to incorporate mistakes students make during class discussion into their instruction.” The 11 items in the reasons for mistake-handling category (see items 9, 12, 13, 14, 19, 21, 23, 26, 29, 35, and 36 in Appendix B) were aimed at measuring pre-service teachers’ beliefs about why mistakes should be dealt with a certain way. One item within this category read, “Teachers should not focus instruction on a student’s mistake because the other students may become bored.” Four items were written to assess a more general goal of instruction (see items 3, 11, 17, and 25 in Appendix B). An example item from this category was, “Teachers should focus instruction on students developing a rich understanding of the material.”

PALS items. In order to help establish the construct validity of the questionnaire, 13 items from the Patterns of Adaptive Learning Scales (PALS; Midgley et al., 2000) were added and slightly reworded to fit the context of the Mistake-Handling Questionnaire. For example, one original PALS item was “I give special privileges to students who do the best work.” This was reworded to say “Teachers should give special privileges to students who do the best work” to make it more applicable to pre-service teachers. The PALS items included in this questionnaire were all items from the Mastery Approaches factor (see items 10, 22, 24, and 37 in Appendix B; $\alpha = .69$) and Performance Approaches factor (see items 18, 27, 32, 33, and 34 in Appendix B; $\alpha = .69$; Midgley et al., 2000). The Mastery Approaches and Performance Approaches factors are conceptually independent scales. Therefore, it is possible for participants to score high on both. These items from the PALS were thought to be correlated with the items from the “goal of instruction” category developed for this questionnaire.

Data Collection

Demographic items. Demographic information was collected from all of the participants (see Appendix C). The demographic data included semester in teacher education program, gender, ethnicity, major, specific classes they have taken or are currently enrolled in, whether the participant plans to teach (to identify pre-service teachers from other students who may be taking the courses from which participants were recruited), grade level(s) the participant plans to teach, and subject area(s) the participant plans to teach.

Response rates. For the initial administration of the questionnaire, 328 out of a possible 361 participants (91%) filled out the questionnaire and provided usable data. Data were also collected for test-retest reliability. After a class first took the questionnaire, a third of the students in that class were randomly selected and sent e-mails asking if they would be willing to take the questionnaire again. Of the students who were contacted, 7 out of 79 agreed to fill out the questionnaire. Due to this low response rate, other methods to collect retest data were used: retest data were obtained from students who were in two classes where the questionnaire was originally administered ($n = 15$) and the questionnaire was administered a second time to two entire classes (a total of 34 out of a possible 44 students (77%) in those two classes filled out the questionnaire two times). A total of 56 students took the questionnaire a second time, but 3 were not included in the test-retest analysis because their second questionnaire was not filled out properly.

Procedures

Data were collected using paper/pencil versions of the questionnaire. Three different versions of the questionnaire were given out with the same items in three different randomized orders. All items, including the PALS items, were randomized. The three versions of the questionnaire were passed out in a counterbalanced order (version 1, 2, 3, 1, 2, 3, etc.) to the participants by row at their desks. The author, or in some cases the teacher of the class, handed out the questionnaire to the students in undergraduate teacher education courses in Educational Psychology, Classroom Assessment, and Introduction to Educational Technology and a graduate course in Classroom Assessment. If students chose to participate (see Appendix D for IRB approval and the consent form), it took them approximately 15 minutes to fill out the questionnaire during class. No extra credit was given.

When conducting the EFA and calculating Cronbach's alpha, it was necessary to address the issue of missing values at the item level. Two items allowed participants to check a box if they were "unsure," as these items referred to Behaviorism and Constructivism, and participants might not be familiar with those terms. For each of those items, 41 percent of the participants checked the unsure box (which was counted as missing data for the EFA) and less than 0.5 percent of participants left one of these questions blank. There were 370 missing

values for the other 26 items (3% of the values were missing). For the EFA and Cronbach's alpha calculations only, missing values were replaced with the mean of a participant's existing data for the 28 items. When the score on the Mistake-Handling Questionnaire was calculated in order to run exploratory analyses, the mean of the non-missing data was calculated.

CHAPTER 4

RESULTS

The overall mean for the original 28-item Mistake-Handling Questionnaire (with reverse scored items) was 3.25, with a standard deviation of .28, a skewness statistic of .44 (standard error = .14), and a Kurtosis of .60 (standard error = .27). The z-scores for skewness (3.14) and Kurtosis (2.22) were significant, suggesting that the data is positively skewed and is very pointed. An EFA was run on the original 28 items of the Mistake-Handling Questionnaire. A principal axis factoring extraction was used along with a direct oblimin rotation. Direct oblimin rotation was used because it was assumed that factors would be correlated with each other. Factors were chosen based on having Eigenvalues greater than one and based on an interpretation of the Scree plot. Items with no loadings on any factor above .4 were deleted and the EFA was run again. This was repeated several times until the factor structure shown in Table 1 was left for the remaining 18 items. The seven factors accounted for 49.45% of the scale variance. To test the reliability of the factors, Cronbach's alpha was calculated for each factor using the holdout sample (see Table 1). Only one alpha was greater than .6 (that alpha was .602), suggesting that the factors were not internally consistent.

Because there were three main categories of items (classroom atmosphere, incorporating mistakes, and reasons for mistake-handling) that were considered when creating the questionnaire, an EFA was run that restricted the number of factors to three. However, the resulting factor structure was messy, with a large number of items having no loadings above .4.

It was then determined that the Mistake-Handling Questionnaire might not have underlying factors, but may instead measure one single factor. Some items were reverse scored based on the original EFA loadings and based on which items the author expected to load negatively on the one factor (Items 2, 4, 11, 12, 14, 17, 21, 26, 30, and 35 were reverse scored. See Appendix B). Cronbach's alpha was calculated for the original items and items were deleted one at a time based on whether the output said alpha would increase if the items were deleted. Most of the items that were supposed to measure the pre-service teachers' beliefs about the goal of instruction were deleted. The final Mistake-Handling Questionnaire with the remaining 16 items (and without the PALS items) is shown in Appendix E. The bold

items are the items that were reverse scored. The alpha was .767 for the test sample ($n = 228$) and was .675 for the holdout sample ($n = 100$). This revised version of the Mistake-Handling Questionnaire was used for all subsequent analyses.

Table 2

Factor Loadings for Exploratory Factor Analysis With Direct Oblimin Rotation of Mistake-Handling Questionnaire Items

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Alpha
25. Students' mistakes provide the teacher with important information about the student.	.657							0.525
5. Teachers should allow their students to feel comfortable making mistakes as they try to learn the material.	.626							
10. Addressing student mistakes in classroom lessons is relevant to the subject area(s) I plan to teach.	.555							
12. Teachers should structure lessons to try to get students to understand the reasoning behind their mistakes on homework and written assignments.	.551							
1. Teachers should focus instruction on students developing a rich understanding of the material	.451							
28. Teachers should focus instruction on students' mistakes because other students are likely to make similar mistakes.		.928						0.579
27. Teachers should focus instruction on students' mistakes so that the students may understand how to correctly solve the problem.		.420						
17. Teachers should encourage student mistakes only when students are first learning the material.			-.804					0.408
15. Teachers should plan instruction to set up their students to make certain errors so that the class can discuss these common errors.			-.705					
21. Teachers should not focus instruction on a student's mistake because staying on pace with the lesson plan is an important concern.			.510					0.602
20. Teachers should not focus instruction on a student's mistake because the other students may become bored.			.502					
9. Lessons should be structured to avoid student mistakes, so students do not learn incorrect procedures.				.637				0.295
26. Teachers should focus instruction on students' mistakes so that they may understand what the students are doing wrong.				.571				
23. I believe in a Behaviorist approach to learning. (If you are unsure, please check this box)						-.765		0.481
24. I believe in a Constructivist approach to learning. (If you are unsure, please check this box)						.518		
2. Students developing a rich understanding of the material is more important than scores on tests such as the FCAT.						.568		0.56
3. A student's performance on a test such as the FCAT is important.						-.523		
4. In order for students to perform well on the FCAT, there must be instruction focused on the FCAT.						-.411		

Counterbalancing

To determine that there were no differences in scores for the three randomized orders of the questionnaire, an ANOVA was run. There was not a significant between groups difference for questionnaire order $F(2,324) = 1.26, p = .284$. Therefore, questionnaire orders were collapsed for the following analyses.

Test-Retest Reliability

Test-retest reliability was also conducted using a sample of 53 participants who took the Mistake-Handling Questionnaire twice. The full 28-item version of the questionnaire was retaken between 1 – 2 weeks after the initial administration of the questionnaire. A correlation of .775, $p < .001$, was obtained. Because of the low response rate, the means of those who took the questionnaire a second time were compared to those who only took the questionnaire once. The two groups' mean scores (on the original administration) were not significantly different, $F(1,325) = 2.04, p = .154$.

Concurrent Validity

First, Cronbach's alpha was also calculated for both PALS scales. The alpha for the Mastery Approaches scale was .545 and the alpha for the Performance Approaches scale was .651. To determine concurrent validity, correlations between the Mistake-Handling Questionnaire factor and the PALS scales were conducted (see Table 2). The only significant correlation was between the Mastery Approaches and the Mistake-Handling Questionnaire factor, with a correlation of .413, $p < .001$, which is consistent with the hypothesis that the Mistake-Handling Questionnaire would be positively correlated with the PALS Mastery Approach scale.

Table 3

Correlation Matrix for Scales

Scales	1	2	3
1. Mistake-Handling Questionnaire	1		
2. PALS Mastery Approach	.413**	1	
3. PALS Performance Approach	0.05	-0.026	1

** $p < .01(2\text{-tailed})$

Exploratory Analyses

The overall mean on the revised version of the Mistake-Handling Questionnaire was 3.64, with a standard deviation of .44 a skewness statistic of .18 (standard error = .14) and a Kurtosis of .12 (standard error = .27). The z-scores for skewness (1.35) and Kurtosis (0.45) were not significant, suggesting that the distribution was normal. Table 3 shows the means for the participants who were fully committed to teaching (i.e., they selected that option on the demographic questionnaire) and those who were not fully committed to teaching (i.e., they identified themselves as undecided about entering the teaching profession after graduation or as not currently interested in teaching on the demographic survey).).

Table 4

Descriptive Statistics for Participants Fully Committed to Teaching vs. Not Fully Committed to Teaching

	Fully Committed			Undecided/Not Committed			Total			
	Mean	SD	<i>n</i>	Mean	SD	<i>n</i>	Mean	SD	<i>n</i>	
Gender										
Male	3.7	0.43	41	3.59	0.32	23	3.66	0.4	64	
Female	3.65	0.47	174	3.6	0.44	66	3.64	0.46	240	
Race										
Non-White	3.65	0.38	48	3.66	0.49	26	3.65	0.42	74	
White	3.66	0.47	180	3.6	0.38	72	3.64	0.45	252	
Program										
Math/Science										
Teaching Program	3.72	0.45	15	3.06	0	2	3.64	0.47	17	
Minor	3.52	0.52	14	3.69	0.36	17	3.62	0.44	31	
Traditional	3.7	0.46	136	3.56	0.35	30	3.68	0.45	166	
Not Teacher	3.55	0.42	28	3.68	0.48	39	3.62	0.46	67	
Graduate	3.56	0.41	31	3.41	0.28	8	3.53	0.39	39	
Subject										
Elective	3.83	0.45	10	3.48	0.4	7	3.69	0.46	17	
English/LA	3.67	0.48	97	3.67	0.39	45	3.67	0.46	142	
Mathematics	3.68	0.5	36	3.64	0.42	17	3.67	0.47	53	
Science	3.86	0.32	10	3.8	0.69	6	3.84	0.47	16	
Social Science	3.56	0.39	70	3.48	0.32	18	3.54	0.38	88	

Exploratory comparisons between groups were conducted on the factors based on the grade the participants chose to consider, the content area the participants chose to consider, how committed the participant was to teaching, and whether they were taking or completed

specific teacher education courses. There were not enough participants for each grade level to be identified, therefore the grades were grouped into the categories elementary, middle, or high school. Likewise, for subject area, participants who chose Art, Music, or Physical Education, were grouped into one category called “Elective.”

Separate two by two chi-square tests were run on the six independent variables that were of interest. Because every variable had a significant chi-square test with at least one other variable (see Table 4), a six factor ANOVA was run.

Table 5
Chi-square values for Independent Variables

Variable	1	2	3	4	5	6
1. Grade Level						
2. Subject Area	47.88**					
3. Teacher Commitment	0.952	5.57				
4. Educational Psych	11.81*	6.08	0.597			
5. Classroom Assessment	45.65**	17.45*	6.093*	60.29**		
6. Intro to Educational Tech	11.26	35.55**	14.68**	95.36**	67.69**	

* $p < .05$ (2-tailed), ** $p < .05$ (2-tailed)

The six factor ANOVA was run with chosen grade level, $F(2, 327) = .95, p = .388$, chosen subject area, $F(4, 327) = 2.73, p = .032$, level of commitment to teaching, $F(1, 327) = 1.12, p = .292$, and whether they took or were taking Educational Psychology, $F(2, 327) = .58, p = .563$, Classroom Assessment, $F(2, 327) = .65, p = .523$, or Introduction to Educational Technology, $F(2, 327) = 2.02, p = .135$, as the independent variables and the score on the Mistake-Handling Questionnaire as the dependent variable. The main effect for chosen subject area was the only significant main effect (see Figure 1). Because of the differences in sample size for the different subject areas, Gabriel’s procedure, which accounts for variations in group sample sizes, was used for post hoc analyses. The post hoc analyses indicated no significant differences between any two subject areas, although there was a non-significant trend for Social Science pre-service teachers to score lower than Science pre-service teachers ($p = .076$).

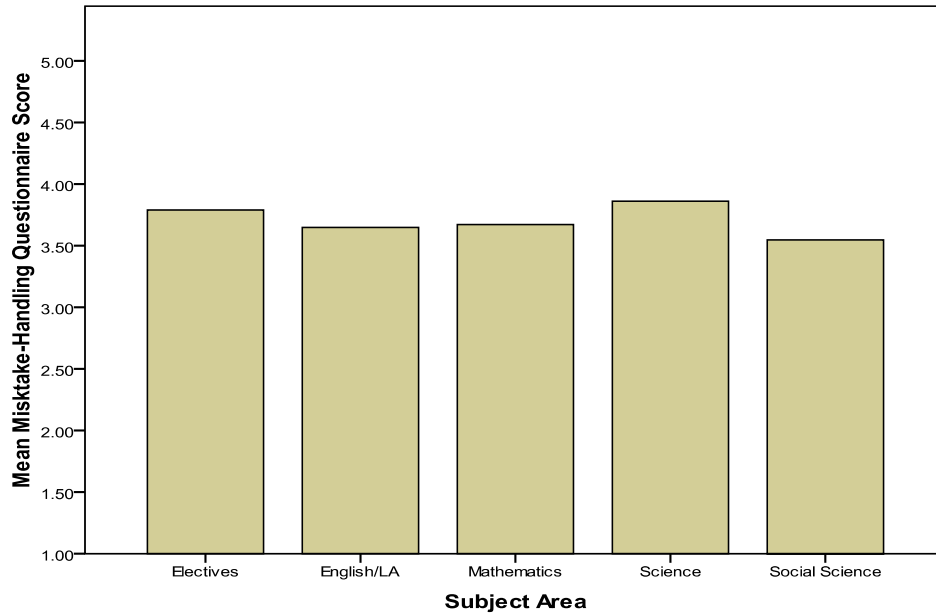


Figure 1. Mean scores for subject areas.

One significant interaction was also found, the interaction between level of commitment to teaching and chosen grade level, $F(2,327) = 4.08, p = .019$ (see Figure 2). Looking at the graph of the interaction, it looks as though the difference in mean scores on the Mistake-Handling Questionnaire based on level of commitment to teaching was due to pre-service teachers interested in teaching middle school. Follow-up ANOVA's indicated that there were not significant differences between teacher commitment levels for pre-service teachers considering elementary ($F(1, 131) = .181, p = .671$), middle ($F(1, 41) = .648, p = .425$), or high school ($F(1,139) = .242, p = .623$) grades.

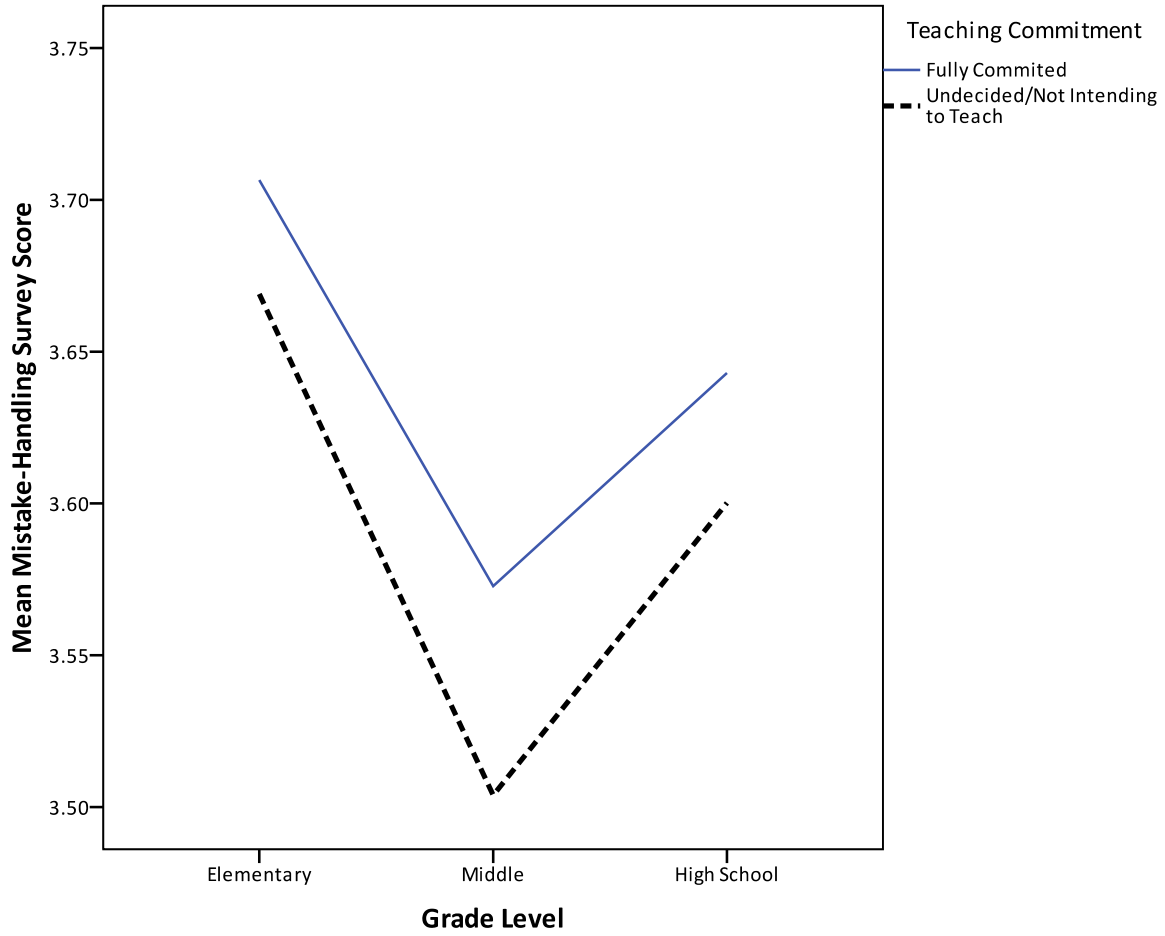


Figure 2. Interaction effect between chosen grade level and teaching commitment level.

CHAPTER 5

DISCUSSION

The goal of this study was to develop a valid and reliable questionnaire to assess pre-service teachers' beliefs about how to handle student mistakes, specifically examining its factor structure, test-retest reliability, concurrent validity, and exploring possible relationships between certain teacher characteristics and scores on the Mistake-Handling Questionnaire. Several EFA's were run to determine an underlying factor structure, but no reliable multiple factor structure was found. However, a reliable one factor structure representing a pro-incorporating mistakes perspective was found. The resulting questionnaire was found to have relatively high internal reliability, including for the holdout sample, and high test-retest reliability. Concurrent validity was established between the Mistake-Handling Questionnaire and the PALS Mastery Approaches scale. Exploratory analyses found no differences in scores on the Mistake-Handling Questionnaire based on the pre-service teachers' commitment to teaching, the grade or subject they thought about, or if they had taken certain teacher training classes.

It is interesting that a majority of participants at least somewhat agreed ($M=3.64$, $SD=.44$ on the MHQ) with a pro-incorporating mistakes stance. In studies that observed practicing teachers in the classroom, teachers were not observed incorporating errors into instruction (Santagata, 2005; Schleppenbach, Flevares, Sims, & Perry, 2007). This suggests that the reasons teachers do not incorporate errors could be due to reasons other than their beliefs about how student mistakes should be handled. Teachers may not incorporate student mistakes because they lack the knowledge and/or skills to do so, or because of the logistics of teaching a class (such as staying on a lesson plan) that pre-service teachers have yet to experience. O'Brien and Stewart (1990) found that pre-service teachers think of teaching as being common sense. They may not realize how difficult it can be to incorporate mistakes into the lesson.

Another explanation for the relatively high overall mean is that saying mistakes are acceptable may be the socially desirable response. The pre-service teachers may have been answering in a way that had less to do with their beliefs about how useful mistakes are and

more to do with what they viewed to be socially desirable. The teacher education courses they were enrolled in tended to have more of a Constructivist slant, so this may have influenced how they thought they were “supposed” to answer.

During the analysis of the one factor structure of the Mistake-Handling Questionnaire, the items that were cut tended to be those concerned with pre-service teachers’ beliefs about goal of instruction (Dweck, 1996), while the items that were kept had more to do with incorporating student mistakes (Lorenzet, Salas, & Tannenbaum, 2005; Keith & Frese, 2005). While this means the Mistake-Handling Questionnaire does not measure pre-service teachers’ beliefs about goal orientation, it was found to be positively correlated with scores on the PALS Mastery Approaches scale. This provides concurrent validity, as it was hypothesized that pre-service teachers who have a mastery approach would also believe in the usefulness of incorporating student mistakes. There was no significant, negative correlation between the PALS Performance Approaches scale and the Mistake-Handling Questionnaire, which is inconsistent with the second hypothesis of this study. These results suggest that believing in the usefulness of mistakes and/or having a mastery approach is not related to having a performance approach (Harackiewicz, et al., 2002). This lends support to the idea that beliefs in mastery and performance goals are not mutually exclusive. A person who scores high on mastery goals could also score high on performance goals.

Test-retest reliability was encouraging, as there was a large positive correlation between when a pre-service teacher first filled out the questionnaire and the second time they filled out the questionnaire. This suggests that these beliefs are stable over time, though it is important to keep in mind that the second questionnaire was taken only 1 to 2 weeks after the first administration.

Most of the previous research on handling student mistakes has been done in Mathematics classrooms (Fiori & Zuccheri, 2005; Gearhart and Saxe, 2004; Jitendra & Kameenui, 1996; Riccomini, 2005; Santagata, 2005; Schleppenbach, Flevares, Sims, & Perry, 2007) or in computer training scenarios (Keith & Frese, 2005; Keith & Frese, 2008; Nordstrom, Wendland, & Williams, 1998). In both cases, there are concrete correct answers and it can be easier to identify where a mistake occurs by having students show their work. Based on this,

eexploratory analyses were used to determine if there may be a difference in scores on the Mistake-Handling Questionnaire based on what type of subject pre-service teachers were considering. A significant main effect was found, but post hoc tests did not show a significant difference between any two subjects.

A significant interaction was also found between commitment level to teaching and grade level, such that the difference in mean scores on the Mistake-Handling Questionnaire based on level of commitment to teaching is greatest for pre-service teachers interested in teaching middle school. This interaction may be aligned with the Midgley, Anderman, and Hicks (1995) finding that elementary school teachers were more mastery focused, although more research that focuses on this interaction is needed. It might also be the case that middle school means were lower due to respondents' perceptions about students. Pre-service teachers considering a middle school classroom may have been taking into account the social implications of students having their mistakes discussed in front of other students, and this might not have been as much of a concern for pre-service teachers considering elementary or high school classrooms. Future research in this area might include studies that use similar sample sizes for each commitment level/grade level group or qualitative research that includes interviews with teachers from different commitment level/grade level groups.

There were no significant differences found based on the grade level the participant considered while filling out the questionnaire, or whether they had taken or were currently taking classes in Educational Psychology, Classroom Assessment, and/or Introduction to Educational Technology. This suggests that these core teacher education courses, as currently designed may not be related to the beliefs pre-service teachers have about handling student mistakes. As O'Brien and Stewart (1990) found in their study, teachers have many ideas about teaching before they enter their teacher education courses, and their beliefs about how to handle student mistakes may come more from their own experiences as a student and less from their teacher education courses.

It is also possible that these teacher education courses teach about informal assessment with a different goal in mind. They may treat informal assessments as a way to get information,

to see if students are making errors, instead of using informal assessments as a learning opportunity for students.

Limitations

The internal consistency reliability was above the generally agreed upon .7 cutoff, but the reliability for the holdout sample was slightly below the cutoff level. This could be due to the fact that the holdout sample of 100 participants is a relatively low sample size. In the future, it would be necessary to administer the Mistake-Handling Questionnaire to additional samples to confirm the reliability of the instrument.

In terms of test-retest reliability, the correlation between when students first took the questionnaire and the second time the students took the questionnaire was relatively high. However, it is important to note that the majority of students who took the questionnaire a second time were not randomly selected. Random selection was attempted, but not enough participants agreed to participate a second time. This could have led to sampling bias and may have inflated the test-retest reliability because the students who agreed to fill out the questionnaire may have had stronger, more established beliefs about how student mistakes should be handled. However, an ANOVA was run, and there was no significant difference in scores between participants who completed the questionnaire once and those who filled it out twice.

Because the final version of the Mistake-Handling Questionnaire only included “mistake-handling” items, concurrent validity was determined by calculating the correlation between the questionnaire and the PALS: Mastery Approaches scale. A moderate, positive correlation between the Mistake-Handling Questionnaire and the PALS items was found. However, the alpha level for the PALS: Mastery Approaches scale (as well as for the PALS: Performance Approaches scale) was below the .7 cutoff. Therefore, the correlation between the Mistake-Handling Questionnaire and the PALS: Mastery Approaches scale may not be reliable. The reason for the low reliability of the PALS scales may be due to the rewording of the items or because the items were originally developed for practicing teachers.

The results of the current study are generally encouraging with respect to the validity and reliability, but there are several limitations mentioned above: holdout sample size,

sampling for retest, and unreliability of the reworded PALS scales. In order to more conclusively determine the validity and reliability of the instrument, more studies replicating these results are needed.

Implications and Directions for Future Research

Having an instrument that measures pre-service teachers' beliefs about how to handle student mistakes is important because it can provide teacher educators with valuable information about the pre-service teachers in their classes that might affect how and what they cover in their classes. However, this area of research is still in the very early stages. There still need to be experimental research studies at the elementary through high school grade levels that determine how important it is for teachers to incorporate student mistakes into the classroom, and whether there is a difference between guiding students to make mistakes versus using mistakes that come up in the classroom randomly as learning experiences. So far, most of the experimental research in this area has been conducted at the college level or above and have dealt with training on computer software.

Another important area for research is to develop a similar survey for practicing teachers, as the teaching experience may present obstacles for mistake-handling that do not affect pre-service teachers. Alternatively, with increased teaching experience may come greater skills and self-efficacy (Darling-Hammond, 2001). Thus, it also would be interesting to consider how teachers' openness to handling mistakes in a more instructional way may change over time. In addition, it would also be important to test whether teachers' beliefs about handling student mistakes are ultimately related to a variety of student outcomes.

APPENDIX A

INTERVIEW QUESTIONS

1) What are some questions that you think should be added to the questionnaire? Please explain your reasoning.

2) What are some questions on the questionnaire that you feel should be reworded? Please explain your reasoning.

3) What are some questions on the questionnaire that should be deleted? Please explain your reasoning.

4) Do you think the questions are grouped appropriately? If not, please explain.

5) Are the labels of these groups appropriate? If not, please explain.

APPENDIX B

ORIGINAL MISTAKE-HANDLING QUESTIONNAIRE WITH PALS ITEMS

When reading the following statements, please imagine these in the context of a course and grade you have taught or plan to teach. The student mistakes described in the items should be considered to be mistakes students make during in-class activities.

Circle the grade you will be thinking of for this questionnaire (Please circle only ONE):

Pre-K K 1 2 3 4 5 6 7 8 9 10 11 12

Circle the subject/content area you will be thinking of for this questionnaire (Please circle only ONE):

Mathematics English/LA Science Social Science Physical education Art Music

FOR THE SAKE OF THIS SURVEY, please imagine this is either a special ed class or a general ed class (Please circle one):

Special education class General education class

Also, FOR THE SAKE OF THIS SURVEY, please imagine this is either an ELL class or not an ELL class (Please circle one):

ELL class Non-ELL class

To what extent do you agree with the following statements?	Strongly Disagree		Somewhat Agree		Strongly Agree
1. Addressing student mistakes in classroom lessons is relevant to the subject area(s) I plan to teach.	1	2	3	4	5
2. Expressing to students that mistakes are bad hinders students' academic creativity.	1	2	3	4	5
3. Students developing a rich understanding of the material is more important than scores on tests such as the FCAT.	1	2	3	4	5
4. Structuring lessons to avoid student mistakes hinders students' academic creativity.	1	2	3	4	5
5. Teachers should actively encourage students to make mistakes so that they can learn from them.	1	2	3	4	5

6. Lessons should be structured to avoid student mistakes, so students do not learn incorrect procedures.	1	2	3	4	5
7. Teachers should encourage student mistakes only when students are first learning the material.	1	2	3	4	5
8. Teachers should allow their students to feel comfortable making mistakes as they try to learn the material.	1	2	3	4	5
9. Students' mistakes provide the teacher with important information about the student.	1	2	3	4	5
10. During class, teachers should often provide several different activities so that students can choose among them.	1	2	3	4	5
11. In order for students to perform well on the FCAT, there must be instruction focused on the FCAT.	1	2	3	4	5
12. Teachers should not focus instruction on a student's mistake because it may embarrass the student who made the mistake.	1	2	3	4	5
13. Teachers should focus instruction on students' mistakes so that they may understand what the students are doing wrong.	1	2	3	4	5
14. Teachers should not focus instruction on a student's mistake because the other students may become bored.	1	2	3	4	5
15. When a student makes a mistake, the teacher should try to quickly point them to the correct procedure.	1	2	3	4	5
16. Teachers should structure lessons to try to get students to understand the reasoning behind their mistakes on homework and written assignments.	1	2	3	4	5
17. A student's performance on a test such as the FCAT is important.	1	2	3	4	5
18. Teachers should give special privileges to students who do the best work.	1	2	3	4	5
19. I feel more comfortable staying on my lesson plan than	1	2	3	4	5

focusing instruction on student mistakes.					
20. Teachers should plan instruction to set up their students to make certain errors so that the class can discuss these common errors.	1	2	3	4	5
21. I believe in a Behaviorist approach to learning. (If you are unsure, please check this box <input type="checkbox"/>)	1	2	3	4	5
22. Teachers should make a special effort to recognize students' individual progress, even if they are below grade level	1	2	3	4	5
23. I believe in a Constructivist approach to learning. (If you are unsure, please check this box <input type="checkbox"/>)	1	2	3	4	5
24. Teachers should give a wide range of assignments, matched to students' needs and skill level	1	2	3	4	5
25. Teachers should focus instruction on students developing a rich understanding of the material	1	2	3	4	5
26. Teachers should not focus instruction on a student's mistake because it may confuse that student and/or the other students.	1	2	3	4	5
27. Teachers should display the work of the highest achieving students as an example.	1	2	3	4	5
28. Teachers should structure lessons to try to get students to understand the reasoning behind mistakes they make during class discussions and activities.	1	2	3	4	5
29. Teachers should focus instruction on students' mistakes because other students are likely to make similar mistakes.	1	2	3	4	5
30. Teachers should not acknowledge student mistakes in the classroom.	1	2	3	4	5
31. Addressing student mistakes in classroom lessons is relevant to subject areas other than the area(s) I plan to teach.	1	2	3	4	5
32. Teachers should point out those students who do well as a model for the other students.	1	2	3	4	5

33. Teachers should encourage students to compete with each other.	1	2	3	4	5
34. Teachers should help students understand how their performance compares to others.	1	2	3	4	5
35. Teachers should not focus instruction on a student's mistake because staying on pace with the lesson plan is an important concern.	1	2	3	4	5
36. Teachers should focus instruction on students' mistakes so that the students may understand how to correctly solve the problem.	1	2	3	4	5
37. Teachers should consider how much students have improved when teachers give them report card grades.	1	2	3	4	5

7. If you were to teach, what would be your primary instructional area? Please CHECK only ONE.

- Art Early childhood Elementary education English/Language arts
Mathematics Music Physical education Science Social science Special
education Other: _____

8. If you were to teach, what grade(s) would you teach? Circle all that apply.

Pre-K Kindergarten 1 2 3 4 5 6 7 8 9 10 11 12

9. How many full years of teaching experience do you have (if any)? _____ years

If you HAVE taught:

9a. In what instructional area(s) have you taught? CHECK all that apply.

- Art Early childhood Elementary education English/Language arts
Mathematics Music Physical education Science Social science Special
education Other: _____

9b. If you have had teaching experience, what grade(s) have you taught? Circle all that apply.

Pre-K Kindergarten 1 2 3 4 5 6 7 8 9 10 11 12

APPENDIX D
IRB APPROVAL LETTER

Office of the Vice President For Research
Human Subjects Committee
Tallahassee, Florida 32306-2742
(850) 644-8673 · FAX (850) 644-4392

APPROVAL MEMORANDUM

Date: 2/18/2009

To: Eric Christesen

Address: 2784 Westbrook Ct., Tallahassee, FL 32303
Dept.: EDUCATIONAL PSYCHOLOGY AND LEARNING SYSTEMS

From: Thomas L. Jacobson, Chair

Re: Use of Human Subjects in Research
Mistake-Handling Beliefs of Pre-Service Teachers

The application that you submitted to this office in regard to the use of human subjects in the proposal referenced above have been reviewed by the Secretary, the Chair, and two members of the Human Subjects Committee. Your project is determined to be Expedited per 45 CFR § 46.110(7) and has been approved by an expedited review process.

The Human Subjects Committee has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval does not replace any departmental or other approvals, which may be required.

If you submitted a proposed consent form with your application, the approved stamped consent form is attached to this approval notice. Only the stamped version of the consent form may be used in recruiting research subjects.

If the project has not been completed by 2/15/2010 you must request a renewal of approval for continuation of the project. As a courtesy, a renewal notice will be sent to you prior to your expiration date; however, it is your responsibility as the Principal Investigator to timely request renewal of your approval from the Committee.

You are advised that any change in protocol for this project must be reviewed and approved by the Committee prior to implementation of the proposed change in the protocol. A protocol change/amendment form is required to be submitted for approval by the Committee. In addition, federal regulations require that the Principal Investigator promptly report, in writing any unanticipated problems or adverse events involving risks to research subjects or others.

By copy of this memorandum, the Chair of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

This institution has an Assurance on file with the Office for Human Research Protection. The Assurance Number is IRB00000446.

Cc: Alysia Roehrig, Advisor
HSC No. 2008.2145

**Florida State
UNIVERSITY**
Tallahassee, Florida 32306-4450

Educational Psychology & Learning Systems
College of Education
307 Stone Building

Phone: (850) 645-8401

INFORMED CONSENT

I freely, voluntarily, and without element of force or coercion, consent to be a participant in the research project entitled "Mistake-Handling Beliefs of Pre-Service Teachers."

This research is being conducted by Eric Christesen, a graduate student in the Department of Educational Psychology and Learning Systems at Florida State University and supervised by Dr. Alysia Roehrig. I understand the purpose of the research project is to better understand pre-service teachers' beliefs concerning how student mistakes should be handled. The anticipated time commitment is approximately twenty (20) minutes. I understand that I will be asked to fill out a demographic questionnaire as well as a questionnaire on pre-service teacher beliefs.

I understand my participation is completely voluntary, and that I may stop my participation at anytime. All of my answers to the questionnaires will be kept confidential, to the extent allowed by law, and identified by a subject code number. My name will not appear on any of the surveys or the results.

I understand that there is little known risk associated with my participation. If I have any questions about my rights as a participant in this study, or if I feel that I have been placed at risk because of my participation, I can contact the chair of Human Subjects Committee, Institutional Review Board, through the FSU Office of the Vice President for Research at (850) 644-8633 or by e-mail: phaire@fsu.edu.

I understand there is a benefit for participating in this research project. I will have the ability to reflect on my own thoughts about how mistakes should be handled in class.

I understand that this consent may be withdrawn at any time without prejudice, penalty, or loss of benefits to which I am otherwise entitled. I have been given the right to ask and have answered any inquiry concerning this study. Questions, if any, have been answered to my satisfaction.

I understand that I may contact Eric Christesen, graduate student in the Department of Educational Psychology and Learning Systems, at (850) 645-8401 or emc07c@fsu.edu, or his supervising professor, Dr. Alysia Roehrig at (850) 644-9080 or aroehrig@fcr.org, for answers to questions about this research or my rights. Results from the study will be sent to me upon my request.

I have read and understand this consent form.

Participant

Date

APPENDIX E

FINAL MISTAKE-HANDLING QUESTIONNAIRE

When reading the following statements, please imagine these in the context of a course and grade you have taught or plan to teach. The student mistakes described in the items should be considered to be mistakes students make during in-class activities.

Circle the grade you will be thinking of for this questionnaire (Please circle only ONE):

Pre-K K 1 2 3 4 5 6 7 8 9 10 11 12

Circle the subject/content area you will be thinking of for this questionnaire (Please circle only ONE):

Mathematics English/LA Science Social Science Physical education Art Music

FOR THE SAKE OF THIS SURVEY, please imagine this is either a special ed class or a general ed class (Please circle one):

Special education class

General education class

Also, FOR THE SAKE OF THIS SURVEY, please imagine this is either an ELL class or not an ELL class (Please circle one):

ELL class

Non-ELL class

To what extent do you agree with the following statements?	Strongly Disagree		Somewhat Agree		Strongly Agree
1. Teachers should focus instruction on students developing a rich understanding of the material	1	2	3	4	5
2. Teachers should allow their students to feel comfortable making mistakes as they try to learn the material.	1	2	3	4	5
3. Addressing student mistakes in classroom lessons is relevant to the subject area(s) I plan to teach.	1	2	3	4	5
4. Addressing student mistakes in classroom lessons is relevant to subject areas other than the area(s) I plan to teach.	1	2	3	4	5
5. Teachers should structure lessons to try to get students to	1	2	3	4	5

understand the reasoning behind their mistakes on homework and written assignments.					
6. Teachers should structure lessons to try to get students to understand the reasoning behind mistakes they make during class discussions and activities.	1	2	3	4	5
7. When a student makes a mistake, the teacher should try to quickly point them to the correct procedure.	1	2	3	4	5
8. Teachers should not acknowledge student mistakes in the classroom.	1	2	3	4	5
9. Teachers should not focus instruction on a student's mistake because it may confuse that student and/or the other students.	1	2	3	4	5
10. Teachers should not focus instruction on a student's mistake because it may embarrass the student who made the mistake.	1	2	3	4	5
11. Teachers should not focus instruction on a student's mistake because the other students may become bored.	1	2	3	4	5
12. Teachers should not focus instruction on a student's mistake because staying on pace with the lesson plan is an important concern.	1	2	3	4	5
13. Students' mistakes provide the teacher with important information about the student.	1	2	3	4	5
14. Teachers should focus instruction on students' mistakes so that they may understand what the students are doing wrong.	1	2	3	4	5
15. Teachers should focus instruction on students' mistakes so that the students may understand how to correctly solve the problem.	1	2	3	4	5
16. Teachers should focus instruction on students' mistakes because other students are likely to make similar mistakes.	1	2	3	4	5

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