Levels of exit slip feedback in secondary mathematics

Mitch Berenson
ABSTRACT

LEVELS OF EXIT SLIP FEEDBACK IN SECONDARY MATHEMATICS

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The purpose of this mixed-methods study was to examine various levels of feedback provided on exit slips and how both a high school mathematics teacher and her students utilized them to advance the learning process. The study focused on three different pre-calculus classes, made up of 42 participants, over a period of two units of study that included two pretests and posttests. Each class received verbal feedback on their exit slips, one class also received process feedback, and one class also received task feedback. In addition, the mathematics teacher participated in three 30-minute interviews with the researcher, which focused on her instructional experiences utilizing various levels of feedback on exit slips in her pre-calculus classes.

Quantitative data examined the growth each class made from the pretest scores to the posttest scores. In addition, student survey responses were studied regarding students’ perceptions of exit slips and their use of exit slips for preparation for the posttests. Qualitative data were also studied regarding the teacher’s perceptions of providing various levels of feedback on exit slips and the feedback’s instructional use as an intervention.

Although the quantitative data did not reveal significant findings about one level of feedback, it did provide insight into the need for future research on more units of study.
However, the qualitative data did provide insight on a potential different level of feedback that could be explored in future studies as well as how teachers might go about preparing their classes to utilize exit slips. It is hoped that the research presented in this study can provide teachers in mathematics and other disciplines at the high school level with insight into the use of a potential intervention to advance student learning in their classrooms.
LEVELS OF EXIT SLIP FEEDBACK IN SECONDARY MATHEMATICS

BY

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# TABLE OF CONTENTS

| LIST OF TABLES | vii |
| LIST OF FIGURES | viii |
| LIST OF APPENDICES | ix |

Chapter

1. INTRODUCTION TO THE STUDY ........................................................................... 1
   Problem Statement ........................................................................................ 5
   Purpose Statement and Research Questions ................................................. 6
   Theoretical Framework ............................................................................... 7
   Significance of Study ................................................................................. 8
   Limitations ................................................................................................. 9
   Definition of Terms ................................................................................ 9
   Organization of the Study ........................................................................ 10

2. LITERATURE REVIEW ................................................................................ 12
   Introduction .............................................................................................. 12
   Feedback .................................................................................................. 12
   Definition .................................................................................................. 12
   Levels of Feedback ................................................................................. 13
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceptions of Feedback</td>
<td>15</td>
</tr>
<tr>
<td>Questions</td>
<td>16</td>
</tr>
<tr>
<td>Instructional Feedback Techniques</td>
<td>18</td>
</tr>
<tr>
<td>Referencing Feedback</td>
<td>18</td>
</tr>
<tr>
<td>Descriptive Feedback</td>
<td>19</td>
</tr>
<tr>
<td>Timing of Feedback</td>
<td>21</td>
</tr>
<tr>
<td>Delivery of Feedback</td>
<td>22</td>
</tr>
<tr>
<td>Types of Written Feedback in Mathematics</td>
<td>23</td>
</tr>
<tr>
<td>Feedback in Classrooms</td>
<td>31</td>
</tr>
<tr>
<td>General</td>
<td>31</td>
</tr>
<tr>
<td>Mathematics Classroom</td>
<td>35</td>
</tr>
<tr>
<td>Formative Assessments</td>
<td>37</td>
</tr>
<tr>
<td>Definition</td>
<td>37</td>
</tr>
<tr>
<td>Research on Formative Assessment</td>
<td>41</td>
</tr>
<tr>
<td>Exit Slips</td>
<td>43</td>
</tr>
<tr>
<td>Definition</td>
<td>43</td>
</tr>
<tr>
<td>Research on Exit Slips</td>
<td>46</td>
</tr>
<tr>
<td>Student Use of Feedback</td>
<td>48</td>
</tr>
<tr>
<td>Self-Regulation, Self-Efficacy, and Motivation</td>
<td>48</td>
</tr>
<tr>
<td>3. METHODOLOGY</td>
<td>51</td>
</tr>
<tr>
<td>Chapter</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Introduction</td>
<td>51</td>
</tr>
<tr>
<td>Research Questions</td>
<td>52</td>
</tr>
<tr>
<td>Research Design</td>
<td>53</td>
</tr>
<tr>
<td>Context of Study</td>
<td>54</td>
</tr>
<tr>
<td>Teacher Participant</td>
<td>55</td>
</tr>
<tr>
<td>Reasons for Selecting This Teacher</td>
<td>55</td>
</tr>
<tr>
<td>Teacher Preparation</td>
<td>56</td>
</tr>
<tr>
<td>Classes in the Study</td>
<td>58</td>
</tr>
<tr>
<td>Recruitment and Consent</td>
<td>59</td>
</tr>
<tr>
<td>Veteran Teacher Verifier</td>
<td>60</td>
</tr>
<tr>
<td>Researcher’s Role</td>
<td>60</td>
</tr>
<tr>
<td>Intervention</td>
<td>61</td>
</tr>
<tr>
<td>Overview</td>
<td>61</td>
</tr>
<tr>
<td>Levels of Feedback Provided</td>
<td>62</td>
</tr>
<tr>
<td>Verification</td>
<td>64</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>65</td>
</tr>
<tr>
<td>Overview</td>
<td>65</td>
</tr>
<tr>
<td>Pretest</td>
<td>67</td>
</tr>
<tr>
<td>Posttest</td>
<td>68</td>
</tr>
<tr>
<td>Survey</td>
<td>68</td>
</tr>
<tr>
<td>Teacher Interviews</td>
<td>69</td>
</tr>
<tr>
<td>Chapter</td>
<td>Page</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Data Analysis</td>
<td>70</td>
</tr>
<tr>
<td>Summary</td>
<td>73</td>
</tr>
<tr>
<td>4. RESULTS</td>
<td>77</td>
</tr>
<tr>
<td>Introduction</td>
<td>77</td>
</tr>
<tr>
<td>Analysis of Quantitative Data</td>
<td>78</td>
</tr>
<tr>
<td>Research Question 1</td>
<td>79</td>
</tr>
<tr>
<td>Research Question 2</td>
<td>81</td>
</tr>
<tr>
<td>Additional Survey Data</td>
<td>83</td>
</tr>
<tr>
<td>Analysis of Qualitative Data</td>
<td>84</td>
</tr>
<tr>
<td>Learn from the Process</td>
<td>84</td>
</tr>
<tr>
<td>Inform Instruction</td>
<td>88</td>
</tr>
<tr>
<td>Utilization of Process and Task Feedback</td>
<td>90</td>
</tr>
<tr>
<td>Summary</td>
<td>94</td>
</tr>
<tr>
<td>5. DISCUSSION</td>
<td>96</td>
</tr>
<tr>
<td>Introduction</td>
<td>96</td>
</tr>
<tr>
<td>Integration of Mixed-Methods Data</td>
<td>97</td>
</tr>
<tr>
<td>Important Findings</td>
<td>99</td>
</tr>
<tr>
<td>Factors That May Have Influenced Results</td>
<td>105</td>
</tr>
<tr>
<td>Recommendations for Future Research</td>
<td>106</td>
</tr>
<tr>
<td>Relationship of the Study to Past Literature</td>
<td>108</td>
</tr>
<tr>
<td>Chapter</td>
<td>Page</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Recommendations for High School Mathematics Teachers</td>
<td>110</td>
</tr>
<tr>
<td>Final Thoughts</td>
<td>113</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>118</td>
</tr>
<tr>
<td>APPENDICES</td>
<td>128</td>
</tr>
</tbody>
</table>
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Research Question Alignment</td>
<td>63</td>
</tr>
<tr>
<td>2. Study Task Timeline</td>
<td>66</td>
</tr>
<tr>
<td>3. Unit 4 Results</td>
<td>80</td>
</tr>
<tr>
<td>4. Unit 5 Results</td>
<td>80</td>
</tr>
<tr>
<td>5. Survey, Unit 4</td>
<td>82</td>
</tr>
<tr>
<td>6. Survey, Unit 5</td>
<td>83</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Color-Coded Responses</td>
<td>76</td>
</tr>
<tr>
<td>2. Exit Slip with Process Feedback</td>
<td>93</td>
</tr>
<tr>
<td>3. Exit Slip with Task Feedback</td>
<td>94</td>
</tr>
<tr>
<td>4. Sample of Process Feedback, Unit 4, Day 8</td>
<td>149</td>
</tr>
<tr>
<td>5. Sample of Task Feedback, Unit 4, Day 8</td>
<td>149</td>
</tr>
<tr>
<td>6. Sample of Process Feedback, Unit 5, Day 5-6</td>
<td>150</td>
</tr>
<tr>
<td>7. Sample of Task Feedback, Unit 5, Day 5-6</td>
<td>150</td>
</tr>
<tr>
<td>8. Sample of Process Feedback, Unit 4, Day 13</td>
<td>151</td>
</tr>
<tr>
<td>9. Sample of Task Feedback, Unit 4, Day 13</td>
<td>151</td>
</tr>
<tr>
<td>10. Sample of Process Feedback, Unit 5, Day 1</td>
<td>152</td>
</tr>
<tr>
<td>11. Sample of Task Feedback, Unit 5, Day 1</td>
<td>152</td>
</tr>
<tr>
<td>Appendix</td>
<td>Page</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>A. TEACHER INTERVIEW 1: QUESTIONS</td>
<td>129</td>
</tr>
<tr>
<td>B. TEACHER INTERVIEW 2: QUESTIONS</td>
<td>131</td>
</tr>
<tr>
<td>C. TEACHER INTERVIEW 3: QUESTIONS</td>
<td>133</td>
</tr>
<tr>
<td>D. SCHOOL ADMINISTRATOR FORM FOR RESEARCH</td>
<td>135</td>
</tr>
<tr>
<td>E. TEACHER PARTICIPANT RECRUITMENT FLYER</td>
<td>137</td>
</tr>
<tr>
<td>F. TEACHER PARTICIPANT CONSENT FORM</td>
<td>139</td>
</tr>
<tr>
<td>G. PERMISSION FORM FOR PARENTS/GUARDIANS FOR MINORS</td>
<td>141</td>
</tr>
<tr>
<td>H. STUDENT ASSENT/CONSENT FORM</td>
<td>144</td>
</tr>
<tr>
<td>I. SAMPLE EXIT SLIPS</td>
<td>146</td>
</tr>
<tr>
<td>J. EXIT SLIP FEEDBACK SAMPLES</td>
<td>148</td>
</tr>
<tr>
<td>K. PRETESTS</td>
<td>153</td>
</tr>
<tr>
<td>L. POSTTESTS</td>
<td>158</td>
</tr>
<tr>
<td>M. STUDENT SURVEY QUESTIONS</td>
<td>163</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION TO THE STUDY

Civil rights leader Moses (2001) argues that mathematics education is a civil rights issue. According to Moses, any students lacking mathematics skills entering the workforce are likely to struggle to compete for higher-level positions with higher salaries and are likely to be offered only lower-level positions with lower salaries, thus steering them toward a second-class economic status.

The points raised by Moses (2001) are further supported by the Organisation for Economic Co-operation and Development (OECD) (2014), which indicates that several countries all over the world have conducted studies on student performance in math on the Programme for International Student Assessment (PISA) and have found that proficiency in mathematics is a strong predictor of the ability of young adults to participate in post-secondary education opportunities. In addition, the OECD also suggests that employment opportunities and expected future earnings of young adults may be linked to their participation in post-secondary education opportunities. A possible concern with this information is determining what it means for the future of young adults who struggle with proficiency in mathematics.

As mentioned earlier, Moses (2001) points out that students who struggle with mathematics are at a great disadvantage in their ability to compete for higher-level positions. This information appears to indicate the significance of mathematics education in grades K-12.
because students build on mathematics levels from grade level to grade level. It also reveals a problem. Cusick (2014) argues that student failure is a result of teacher failure and that teachers are the most direct way to improve student learning. Cusick believes that teachers are responsible for improving student learning and that student failure is more of a reflection of them, not the students. In other words, a math teacher’s curriculum may be set by his or her school, but the way a teacher delivers the curriculum to students may be based on his or her pedagogical style and content knowledge.

Cusick’s (2014) claim is further exacerbated by the new teacher evaluation system in Illinois that mandates that at least 30% of teachers’ evaluations have to have a student-growth component in it (Illinois State Board of Education [ISBE], 2014). Again, just as teachers have no control over the curriculum, teachers also do not have control over the students enrolled in their classrooms and do not have any control over the various family environments of their students. Therefore, not all students come to school ready to learn with their best efforts to be successful. If teachers are the most direct way to improve student learning, as Cusick claims, then the need for interventions that are proven to be successful are crucial not only for student learning but for teacher survival and longevity in the profession based on student success.

Schoenfeld and Törner (2014) make the point that students need the opportunity to both practice skills and receive feedback on their practice to alert them to how they are doing. Teachers have many ways to deliver feedback to students in mathematics classes. One way is through the use of exit slips, which are slips of paper on which students respond to a prompt that covers previously learned material (Leigh, 2012). Exit slips provide students space to digest ideas and thoughts they may have had in class or about an assignment on which they have
worked (Leigh, 2012). In the current study, the exit slip consisted of two mathematical problems, which the students were to solve within five minutes and then turned in to the teacher as they exited the class.

Exit slips document learning and emphasize the process of learning so they can be used by a teacher to provide students with various levels of feedback to help them grow academically (Bafle, 2004; Fisher & Frey, 2004). According to Hattie and Timperley (2007), two levels of written feedback are task and process feedback, based on a student’s academic level. For example, Hattie and Timperley suggest that novice students tend to respond positively to task feedback because it provides the students with information about whether they answered a question correctly or incorrectly. However, Hattie and Timperley point out that students who tend to understand the mathematics above a novice level respond positively to process feedback, which provides students with specific information about the task on which they have been working.

These issues raised by Moses (2001) and OECD (2014) can be traced back to the correlation that Adelman (1999) drew regarding American students who attain mathematics skills by taking intensive courses beyond Algebra 2, such as pre-calculus. These students more than double the odds that they will complete requirements for a bachelor degree. Schoenfeld (2002) has suggested that it is a national obligation to afford all students the right to sound mathematics instruction to provide them with opportunities in the workforce. Trusty and Niles (2003) also point out that the effects of taking higher level mathematics courses, such as pre-calculus, are independent of the influences of socioeconomic status and racial-
ethnic group membership. Trusty and Niles conclude that students who take more intensive mathematics courses in high school are more likely to earn a college degree.

According to Bonham and Boylan (2011), when American students enter college, basic algebra is the most difficult college course to pass. In addition, Bonham and Boylan’s study validates previous research that found that the inability of students to pass a basic algebra course often leads to students not earning their degrees. Thus, Bonham and Boylan’s research supports the idea of students taking more advanced mathematics courses in high school to pass and move beyond basic algebra in college.

To answer these mathematics issues beyond blaming teachers, the education system in the United States has more recently tried to identify skills students are supposed to have to be successful in mathematics at any level (Cusick, 2014). These skills are identified through the Common Core State Standards Mathematics (CCSSM) (Schoenfeld & Törner, 2014). According to the CCSSM, students are supposed to be able to solve problems, critique mathematics arguments, and much more (Schoenfeld & Törner, 2014). Because these skills can be applied in K-12, they are considered foundational to success in mathematics courses at any level, but again, Schoenfeld and Törner contend that “students won't get good at these things unless they have an opportunity to practice them in the classroom and get feedback on how they’re doing” (p. 747). Spadano’s (1996) research identified the same point. Spadano contends that students in secondary math courses learn a great deal of material on a daily basis and are often given homework but the teacher provides little to no feedback on the homework to the students. Only when the students take a test or quiz are they given the opportunity to receive feedback on their
work. Unfortunately, the students are unable to utilize the feedback because they are typically moving on to another lesson, concept, or topic.

Schoenfeld and Törner’s (2014) claim about the need for students to receive feedback was suggested by Hattie (2008) to be one of those interventions that has a better-than-average influence on student achievement. Hattie’s data were compiled from 15 years of research that included 800 meta-analyses relating to influences on academic achievement in school-aged children. This claim was identified by Black and Wiliam (1998), who, earlier, had completed a meta-analysis of over 250 feedback studies conducted in schools prior to 1988. Black and Wiliam also found that feedback helped produce overwhelmingly significant achievement gains across all areas of content. More recently, Wiliam (2011) suggested that feedback can double the rate of learning. Therefore, it would appear that feedback given to students in mathematics classes could have a positive influence on student growth.

**Problem Statement**

Post-secondary opportunities have been linked to success in mathematics at the high-school level, and a lack of success or skill attainment in mathematics has been found to be detrimental to students in their pursuit of postsecondary opportunities. Based on the meta-analysis research by Hattie (2008), Black and Wiliam (1998), and Wiliam (2011), the use of feedback as an intervention has been considered to be strongly correlated with student achievement. Therefore, it would appear that feedback is one of those interventions that could be highly useful for teachers to use with students to help them learn and be successful in a mathematics class.
There has been limited research on the use of exit slips as a tool for teachers to deliver written feedback to students (Leigh, 2012; Sterrett & Fiddner, 2007; Sterrett, Fiddner, & Gilman, 2010). In addition, the researcher was unable to find any research on the use of exit slips in a higher-level mathematics class such as pre-calculus. Research on feedback using exit slips could provide mathematics teachers with tools to help students grow academically. Success in mathematics courses such as pre-calculus could increase students’ chances of earning college degrees and having more job opportunities that could lead to a higher socioeconomic status.

Purpose Statement and Research Questions

The purpose of this study was to examine whether a certain level of written feedback on exit slips influenced student learning, student studying, and a teacher’s instructional approach. This study was guided by the following research questions:

1. Does providing students in a pre-calculus mathematics course with process feedback on their exit slips result in a higher average of growth from their pretest to their posttest than for students who received task feedback on their exit slips or students who receive only verbal feedback on their exit slips?

2. Do students who receive process feedback on their exit slips refer more to their exit slips as part of their independent study and preparation for a posttest than do students who receive task feedback or students who received only verbal feedback on their exit slips?
3. How does a high school mathematics teacher utilize exit slips, using both *process* and *task feedback*?

3a. What can a high school mathematics teacher learn from the process of using exit slips over time?

3b. How does the use of exit slips inform his/her subsequent instruction?

Theoretical Framework

The theoretical framework for this study is based on the Self-Regulation Theory, which addresses the ability to alter one's behavior (Baumeister & Vohs, 2007). According to Brookhart, “Self-regulation is the process students use to monitor and control their own learning. Self-regulation can lead to students seeking, accepting, and acting on feedback information or not” (p. 21). In other words, students’ ability to self-regulate could make the difference in whether they utilize feedback to adjust, learn, and grow or whether they simply ignore it.

Baumeister and Heatherton (1996) believe that goals do not mean anything unless one is willing to monitor one’s own behavior. In other words, some students may not be ready for feedback because they are not ready to deal with the challenges that can be associated with growth. As Brookhart mentions, students are more likely to act on the feedback they are given when they have a mindset of acceptance regarding making changes based on it. Those who do not have a desire to utilize feedback to make changes are not likely to accept it. More information and elaboration on the Self-Regulation Theory is explored in Chapter 2.
Significance of the Study

The results of this study can add to the literature on exit slips and whether certain levels of feedback have more influence on student learning than do others. This study is important because teachers throughout the United States are under greater pressure to be successful than at any other time in the country’s history. In Illinois, teachers are evaluated on the growth their students make from the beginning until the end of the year (ISBE, 2014). Thus, successful interventions are more critical because teachers’ jobs as well as student achievement are impacted.

High school mathematics teachers who are charged with the responsibility of helping their students learn and grow can use the data from the students’ pretest and posttest comparisons to assess whether a specific level of feedback assists in student learning more than in another one. Mathematics teachers can also gain insight into how the teacher in the study utilized exit slips with feedback and what, if any, adjustments she made to the instruction based on what she learned by providing regular feedback on exit slips to her students. School administrators can use these same data to create professional development opportunities for teachers to learn about how to deliver feedback on exit slips. It is clear, based on Adelman’s (1999) and Trusty and Niles’s (2003) research, that student success in mathematics in high school is strongly correlated with postsecondary success; therefore, providing teachers with research-based intervention tools can be invaluable in their efforts to help their students be successful in their mathematics classes.
Limitations

A convenience sample drawn from students enrolled in the pre-calculus course at one high school was used for this study. Therefore, its size cannot represent the experiences of all pre-calculus students and the results cannot be generalized. The students may not be the same age, depending on the level of mathematics at which they started in high school. In addition, the pretests and the posttests were written by the teacher to assess the objectives of the unit, but neither test has been proven reliable. The length of the intervention was relatively short as the two units combined were about seven weeks. In addition, changes in student growth and maturity later in the school year were not taken into account.

Definition of Terms

For the purpose of clarity, the following terms are important for understanding this study.

Effect size: The mean difference between an experimental group and a control group (Coe, 2002). It helps quantify the effectiveness of one intervention in comparison to another intervention (Coe, 2002). In other words, it helps measure whether an intervention is helping or having little to no effect.

Feedback: An objective description that is value neutral and provides information on what one has done correctly and incorrectly. Feedback can also include information about what one can do to improve (Miser, 1983; Wiggins, 1998).

Growth expectation: The outcome that students are expected to achieve by the end of an instructional period of time, which includes a reference to previously acquired knowledge and an end goal for the level of achievement to be attained (ISBE, 2014).
Measurement model: The analysis of two or more assessment scores to identify a change in a student’s level of knowledge or skills over a period time (ISBE, 2014).

Process feedback: Feedback that provides students with information that describes strategies that they might use or ways in which to draw connections (Hattie & Timperley, 2007). For example, a teacher may inform students that they were correct in the first three steps of a problem, but in the last step, they forgot to take the square root of a number.

Student growth: A demonstrable change in one student’s or multiple students’ knowledge or skills, as evidenced by a gain on at least two assessments, between at least two points in time (ISBE, 2014).

Task feedback: Feedback that provides students surface knowledge and informs students whether the answers they have given are right or wrong (Hattie & Timperley, 2007). For example, students may have completed a five-step problem, but the teacher merely informs the students what was wrong, with no other feedback.

Organization of the Study

This study includes five chapters. In Chapter 1, the researcher presented the introduction, problem and purpose statements, research questions, definitions of key terms, and the significance of the study. Chapter 2 includes a literature review on feedback and the characteristics of effective feedback that have positively influenced student growth. Chapter 2 also includes the characteristics of the influence of ineffective feedback on student growth. Chapter 3 includes details about the research methods. Unit 4 includes the results of the data
collected from the research. In Chapter 5, the discussion, important findings, recommendations, and suggestions for future research are presented.
CHAPTER 2
LITERATURE REVIEW

Introduction

Based on Hattie’s (2009, 2012) and Black and Wiliam’s (1998) meta-analyses, feedback is strongly correlated with student achievement. This chapter presents studies on students’ perceptions of feedback, various types of feedback, the use of exit slips, and the role teachers play in giving students feedback in mathematics classrooms. Various levels of feedback are explored because not all feedback has a positive impact on student success in the classroom, regardless of whether it is mathematics or any other discipline. Therefore, the purpose of this literature review is to critique and synthesize research studies examining feedback in general and feedback that could be used in a mathematics classroom.

Feedback

Definition

Student success is defined by continual improvement over a long period of time (Stiggins & Chappuis, 2005). Students grow and develop over time, and where they start is not necessarily where they finish as a result of the hard work and interventions from their teachers. According to Hattie and Timperley (2007), feedback is a “consequence” of performance (p. 81)
They explain that feedback is information provided by a teacher, peer, or parent regarding an individual’s performance. According to Hattie and Timperley (2007), the main purpose of feedback is to help students understand the discrepancy between their performance and the objective or goal they are trying to attain. In other words, the purpose of feedback is to help students improve their performance (Ackerman & Gross, 2010).

Levels of Feedback

Hattie and Timperley (2007) contend that feedback can be defined by four different levels: task, process, self-regulation, and self-level feedback. Each level of feedback is different, so to be most helpful, it is important that teachers understand the level at which the students are performing instructionally. More specifically, teachers need to determine if the students are novices, proficient, or highly competent with the assignment on which they are working. This is significant because each level of feedback provides students with a certain type of information based on their readiness to pursue the standard, goal, or objective.

According to Hattie and Timperley (2007), novice students need task feedback to be successful because the students need to be able to distinguish between right and wrong. Task feedback provides students surface knowledge about the answers they have given by letting them know if they are right or wrong. Task feedback is quite specific about the ways in which students can improve their performance. For example, if teachers tell students they are not to refer to a particular person by their nickname in a paper they are writing, the students are receiving specific but limited information. Thus, students are able to process the feedback
from their teacher and make the necessary adjustments because they are able to comprehend and understand the feedback as it relates to their performance.

Students who are proficient in the area in which they are working need process feedback (Hattie & Timperley, 2007). Process feedback provides students with information that describes strategies students might use or ways in which to draw connections. Process feedback provides students with ideas about ways in which to figure out an answer in one area and then realize the ways in which it is connected to another area on which they are working. According to Balzer, Doherty, and O’Connor (1989), process feedback appears to be more effective than task-level feedback because of its potential to enhance deeper learning for students. However, Earley, Northcraft, Lee, and Lituchy (1990) believe that feedback aimed at more surface-task information can improve students’ task confidence and self-efficacy, which could lead to strategy-searching to enhance their learning.

A third level of feedback, according to Hattie and Timperley (2007), is self-regulation feedback. This level of feedback is about the students being able to monitor themselves and self-assess. This level of feedback requires students to go beyond making connections, as they would in process feedback, and take their learning to another level. For example, teachers may have students figure out how they arrived at a wrong answer and try to use another strategy they know to find a right answer. Hattie and Timperley (2007) point out that feedback at this level encourages students not to settle for minimal information and reinforces that they should put forth maximum effort to accomplish the standard, goal, or objective. However, according to Hattie and Timperley (2007), some learners possess minimal self-regulation strategies and need external factors provided by a teacher in the form of task feedback. Therefore, teachers need to
determine if the students are novices, proficient, or highly competent with the assignment on which they are working.

The fourth level of feedback, according to Hattie and Timperley (2007), is self-level feedback. They believe that this is the least effective level of feedback because it typically focuses on positive or negative evaluations of the student. In other words, self-level feedback does little to address information that provides attention to the task and focuses more on students’ self-worth. For example, a teacher may tell students that they made a great effort on an assignment or that they did a good job, but neither comment helps students determine information from which they need to learn or reflect, as found with the other levels of feedback.

For purposes of this study, only process and task feedback are studied. These two levels of feedback are reviewed by the researcher in comparison to each other. Each level was chosen based on its practicality to implement with high school students.

Perceptions of Feedback

According to Steelman, Levy, and Snell (2004), the more consistently feedback is delivered, the more likely individuals are to respond to it and want to use it. Stiggins (2005) points out that students use available feedback to determine if learning is worth the effort. Students must have confidence in the source of the feedback to take it seriously and to use it to make adjustments to improve (Giffin, 1967). The students must believe that the teacher knows the subject material and understands the various struggles and efforts to grow students make in that particular class. According to Steelman et al. (2004), people tend to be satisfied with feedback if they believe it is helpful for the task they are trying to accomplish and is not
redundant of information they already have. In contrast, if students do not have confidence in their teacher, the feedback becomes mostly useless. The students lack the desire to use the feedback because they perceive no potential benefits or gain.

Burnett and Mandel (2010) focus on students’ perceptions of oral feedback. They gathered data by conducting classroom observations and individual and group interviews with both teachers and students. Burnett and Mandel categorized feedback into four oral categories observed in the classroom: ability, effort, general praise, and negative statements. They found that younger students (Grades 1 to 4) preferred ability feedback, which told them how well they were doing and how close they were to the target. The older students (Grades 5 to 7) wanted to hear more about their effort over any other feedback. Unfortunately, Burnett and Mandel found that the teachers used general praise more than any other type of feedback, and they used ability and effort praise less than 10% of the time. It would appear that more research needs to be done on ability and effort feedback to determine if there is a strong correlation between the preference of feedback type and the age group of the students. It is possible that information on these kinds of verbal feedback could be invaluable for teachers’ awareness of the classroom environment and the attitudes of their students.

Questions

According to Hattie (2012), feedback should ask three questions to stimulate students’ learning to another level, as found in self-regulation feedback. Hattie’s (2012) first question, “Where am I going?” (p. 116), requires students to ask what the standard, goal, or objective
looks like. In other words, this question asks what success looks like. An exemplar should be provided for the students so they can compare their work to it.

Hattie (2012) explains that the second question, “How am I going?” (p. 116), asks where a student is performing in terms of his/her individual growth. Students have to be able to address the gaps they have, in addition to their strengths, to answer this question. This is an opportunity for a teacher to provide students with a status update regarding their progress. The students can use feedback from the teacher to determine if they are going in the right direction or if they need to reevaluate their progress to make changes.

Hattie’s (2012) third question is "Where to next?" (p. 116). This question asks how students can proceed to improve and move toward attaining the standard, goal, or objective. This provides the teacher with an opportunity to give the students specific feedback on what they need to do to move forward. The feedback is tailored to the students’ learning capabilities. In other words, when a teacher answers this question, he or she is providing the students with feedback based on their ability and exactly what the students need to do. Feedback should show how far apart the performed level is from the expected level and attempt to minimize the difference (Sadler, 1989). Therefore, students have a guide and a measuring stick to reference in their pursuit of accomplishing the standard, goal, or objective they have in front of them.

Feedback that has characteristics of self-regulation and answers Hattie’s (2012) three questions needs to be delivered in a format that is conducive to students’ success. As mentioned earlier, providing feedback with grades can be detrimental to students and is seen as judgmental and evaluative (Gipps, 1999). Instead, the feedback needs to be something students can hear and understand so they develop the self-efficacy to become involved with their learning. The
feedback needs to provide students with information about where they are in their learning, without judgment, and provide guidance on where they need to be.

Instructional Feedback Techniques

Referencing Feedback

Brookhart (2008) recommends that feedback should be based on criterion referencing, which provides students with an understanding of what the next goal should be based on a standard or criterion by which all students know they are evaluated. In addition, Brookhart points out that feedback based on criterion referencing helps students determine how close they are to achieving the goal or objective on which they are working. In other words, the students are able to monitor their progress and also be aware of what they need to do. The students can take ownership of their learning because they know what they need to do to accomplish the goal or objective on which they are working and are also aware of the next goal or objective of the class.

Feedback that uses norm referencing has teachers comparing students to each other (Cauley & McMillan, 2010). In other words, students learn how they compare to their peers and determine if it is worth trying to match or keep up with them. Brookhart (2008) points out that norm-referenced feedback creates winners and losers and can lead students to believe that ability and not strategic work is the key to their success. Students may not believe that their learning is within their control.
Descriptive Feedback

According to Gipps (1999), feedback that is not judgmental, provides students with written comments by which to grow, and allows them to dialogue with their teacher is called descriptive feedback. “Descriptive feedback points out to students their works’ strengths and weaknesses before it is too late–before the final grade–and it models the kind of thinking we want them to do by themselves about their work” (Stiggins, Arter, Chappuis, & Chappuis, 2006, p. 236). The main objective of descriptive feedback is to provide students with an opportunity to utilize and learn from feedback given to them to make adjustments and improvements before they are given a summative assessment of the goals or objectives of the class. Students are presented with an opportunity to learn and grow without the consequences of an evaluative grade.

Students are also provided with an opportunity to learn how they learn best by examining the feedback given to them and to determine if the feedback connects with their learning style (Rodgers, 2006). Regardless of the type of feedback, students need to know how to use it to help themselves or it has no viable purpose for them. Therefore, because descriptive feedback is not evaluative, it provides students with an opportunity to explore ways in which the specific feedback works for them.

Descriptive feedback also needs to be the right amount of feedback to be effective so students can utilize it to their benefit. Brookhart (2008) points out that it is important for teachers to prioritize the points as they relate to the goal or the objective. Brookhart (2008) also advises that descriptive feedback should focus both on the work and the process for achieving the goal or objective of the class. This prevents students from being overwhelmed or confused.
by which focus is important. In addition, the students’ level of understanding needs to be considered because the feedback cannot have much value if the students are not able to comprehend and internalize it, preventing them from making improvements.

Gipps (1999) breaks descriptive feedback into two subtypes. One subtype describes the progress students have made and compares where the students are presently performing in relation to the goal or objective. Again, this subtype of feedback provides students with a measuring stick by which to compare where they are and where they are trying to go. The other subtype is given by working with students in ways in which they can move forward toward the goal or the objective. Gipps points out that this feedback should be given with an understanding of collaboration between the teacher and the students. In other words, the teacher is trying to promote a deeper understanding and the students are encouraged to pursue reflection of their work as they move forward.

Rodgers (2006) also believes that descriptive feedback provides a teacher with an opportunity to form a partnership with students because a dialogue can be established. The students are placed in a position to converse back and forth with the teacher to understand better where they are performing. The teacher should also be open to the possibility that what he or she might have observed might not be the students’ perceptions (Dewey, 1933). Because descriptive feedback is not evaluative, it leaves opportunity for the students to respond to their teacher with differences of opinions based on their learning experiences.

Rodgers (2006) points out that the dialogue between the students and teacher creates a sense of trust and community in the classroom. In addition, Rodgers’s claims are also aligned with those of Stiggins et al. (2006) in that descriptive feedback helps students develop authority
over their internal learning experiences, thus moving them toward self-efficacy. Therefore, a teacher who is providing students with descriptive feedback has an expectation that the students will internalize the descriptive feedback and pursue it or they will respond to their teacher with questions and differences of opinions. The dialogue provides an opportunity for students to clarify any feedback that does not make sense to them. Descriptive feedback appears to be the type of feedback that can be used in any classroom or discipline of study, including mathematics, because it focuses on the process and how to move students forward in their learning.

Timing of Feedback

According to Mason and Bruning (2001), students who are struggling with a learning task benefit more from immediate feedback because it provides them with the necessary direction to move forward in the learning process. Chappuis (2012) asks how long teachers should allow students to hold a misconception and repeat mistakes before they provide corrective feedback. In other words, students who are less comfortable with the learning task may benefit from immediate feedback because they may be afraid to proceed further with the task if they do not know they are going in the right direction. Students’ lack of confidence in the learning task may also make them believe that the learning task is not manageable unless they are getting regular feedback to convince them otherwise.

Brookhart (2012) identifies that it is critical that students have the opportunity to use feedback to support the work in which they are currently engaged: “When students get feedback on a performance that’s not followed up by an opportunity to demonstrate the same knowledge
or skills, feedback will fail” (p. 28). If students can take the feedback and use it to make adjustments and improvements, then they can see the value and purpose of it.

Wiggins (2012) makes the point that the more feedback students receive in real time, the better their performance is likely to be later and that video games are a model for giving feedback. In video games, the players receive frequent instant feedback about their performance, and they sometimes are able to pick up right where they left off without having to start over. The players are able to see why they were eliminated from the game and can go back and make adjustments so that they are not eliminated by the same thing.

In contrast to immediate feedback, Mason and Bruning (2001) found that students who are confident in their understanding of the learning task benefit more from delayed feedback than immediate feedback; they may not need regular reassurance that they are proceeding in the right direction. They may prefer to work toward the learning goal for a period of time and then receive feedback to help them reflect on their work so they can improve and reach the learning goal. Students who are confident in their ability usually see the learning task as manageable and one that they can achieve.

**Delivery of Feedback**

Feedback can be delivered orally, visually, or in writing (Brookhart, 2008). However, a teacher has to determine what is most likely to benefit the students at any given time. For the purposes of this study, the mode for delivery of the descriptive feedback is written feedback. Written feedback provides both the students and the teacher with the opportunity to address students’ needs, specifically and privately, without the knowledge of peers. It also sends the
message to students that the teacher values their learning (Brookhart, 2008). In addition, written feedback provides students with the opportunity to review the feedback as many times as they like, as opposed to oral feedback that can be forgotten after it is told to the student (Tuttle, 2007).

Oral feedback and feedback demonstrated visually on a board often puts the students in front of their peers, which could make them uncomfortable because their peers are able to see what they know and do not know. According to Brookhart (2008), if feedback is given orally in front of the entire class or is visually demonstrated on a board, it should be done with the intent to benefit the entire class because it is something they all can learn. Therefore, to build self-efficacy, written feedback should be used because it can be tailored to each individual student, and the other modes of feedback can be used for the benefit of the whole class.

Types of Written Feedback in Mathematics

As noted earlier, several elements make up effective written descriptive feedback that helps students make progress toward achieving a classroom goal or objective. Assuming that all elements of effective written descriptive feedback are met, a teacher still has to determine how he or she wants to give the written descriptive feedback. For example, various problems in mathematics may require various types of written descriptive feedback due to the ways students go about solving them. Again, students need to have confidence in the teacher, and the teacher needs to deliver the written descriptive feedback in a considerate tone that is timely and targets objectives or goals without overwhelming the student.

“The teacher’s instructional task is to take students to the edge of their capabilities, to encourage growth” (Stiggins & Chappuis, 2005, p. 12). Therefore, a teacher has to determine
what he or she needs to do to promote that kind of culture of learning. For example, some students who are struggling in the class may tend to value merely finding the correct answer rather than the process of figuring out the answer (Santos & Pinto, 2011). The feedback for the struggling student may require written descriptive feedback with motivational language to encourage the student to pursue more information on the process and also to acknowledge that the student has the correct answer. On the other end, a high-achieving student may question the teacher’s feedback to better understand the process (Cuellar & Rahming, 2009). Therefore, the teacher should provide the high-achieving student with the opportunity to dialogue back and forth because the student is already motivated to pursue more information.

Written feedback in a mathematics classroom can take many forms. According to Voerman, Meijer, Korthagen, and Simons (2012), written feedback can be considered either progress feedback or discrepancy feedback, depending on the teacher’s intentions for the students. For example, a teacher may decide it is important to stress what progress the students have made toward the goal or objective, and he or she should write feedback about that. In addition, a teacher may decide that he or she wants to emphasize what has not yet been completed by writing feedback comments about the discrepancy between where the students are currently performing and where they should be (Voerman et al., 2012). Both forms are written feedback, and both forms are nonevaluative in terms of giving a grade, but each one sends a different message to students about how the teacher views where they are currently performing in their pursuit of accomplishing the goal or objective.

Voerman et al. (2012) also discuss the range of written feedback between degrees of positive and negative, as well as type, such as nonspecific, specific, or developmental feedback.
As mentioned above, tone is important when a teacher delivers written feedback. Therefore, looking at only positive degrees of written feedback, students could receive limited one- or two-word responses under nonspecific feedback or receive specific feedback that goes into great detail about all the positive things the students have done. However, Voerman et al.’s research suggests more positive developmental feedback, which acknowledges what the students have already accomplished and focuses also on what they need to do next to close the gap between their current performance and the goal or the objective of the class. In other words, the teacher should provide the students with feedback that promotes the concept of self-efficacy, thereby helping them progress toward accomplishing the goal or objective of the class.

In Cohen’s (1987) study on students’ writing, it was found that teachers tend to bring their own bias, both positive and negative, to the written feedback they give students. For example, Cohen found that teachers gave varied written feedback to students based on their academic status. Advanced students received more macro-feedback focused on organizational framework and global concepts, as compared to weaker students who received micro-feedback on grammar and mechanics.

Although Cohen’s (1987) study is reflective of teachers providing feedback to students about their writing rather than mathematics problems, the research about teacher bias in feedback can also be applied to mathematics classes. Whether positive or negative, the feedback was influenced by the teachers’ perceptions of the students’ academic strengths in their classes. This example can be found in any mathematics class, particularly when a teacher is providing students with corrective feedback.
According to Kaput (2000), algebra is considered to be a gatekeeper to advancing in mathematics, and if students struggle in it, then they tend to disengage from it and usually do not move on in mathematics. This could indicate that feedback could play a vital role in the success students have in learning algebra. The purpose of feedback in any discipline of study is to provide students with an awareness of what they need to be successful. Unlike English, mathematics tends to have only one correct answer to each problem. Mathematics teachers should provide feedback to help students determine how to obtain the correct answer. Therefore, one type of written feedback found in mathematics is corrective feedback.

Corrective feedback can be broken into specific types. For example, Ellis (2009) discusses five types of written corrective feedback that can be applied to mathematics classrooms: direct, indirect, metalinguistic, focused, and unfocused feedback. According to Ellis (2009), direct written feedback provides the students with a correct answer when they have one that is wrong. According to a study done by Schoen and Kreye (1974), direct corrective feedback can give the students just the correct answer when they have one that is wrong, or it could give them the correct answer and provide them with a reason for why it is correct. Boye (2015) points out that feedback should be tailored based on the type of assignment. Clearly, direct written feedback provides students with a solution to an incorrect answer. As mentioned earlier, for some students, receiving just the correct answer may be all they want to pursue. But some students may want to know why an answer is correct so that they can expand their learning. Regardless of the teacher’s choice of what to include with direct feedback beyond the correct answer, the sole purpose is to give students the knowledge of what is correct and incorrect.
Direct written feedback can also be quite specific as an order. For example, it could be provided in the form of regulatory instructions, advisory comments, or direct criticism (Office of Learning and Teaching, n.d.). In these forms, students are told exactly what is wrong and what the right answer is and how to fix it. The teacher has to determine what type of written feedback students need to be successful in learning the goal or objective. Sometimes, direct criticism might be too strong for certain students to handle, or sometimes, students need regulation to hold them to a certain point. Ellis (2009) states that direct feedback requires minimal processing and effort on the part of the students, and therefore, it may not contribute to long-term learning, and the students may not learn as much or sustain what they have learned because the correct answers were given to them with no effort on their part.

According to Ellis (2009), indirect written feedback indicates to the students that an error exists but no correct answer is provided. Ellis further explains that indirect written feedback can be provided with a clue or hint of what may be specifically wrong or can be provided with just an indication that the students have an incorrect answer. Boye’s (2015) point that feedback needs to be tailored to the assignment is relevant with indirect written feedback as well. In addition, the teacher needs to determine what is likely to be the most beneficial feedback to the students at any given time. Some examples of ways in which indirect written feedback can be used include

- asking a closed question,
- asking an open question,
- finishing an open-ended sentence,
- asking for an explanation, and
• rewriting or remodeling an example.

All these examples of guided learning and problem-solving tend to lead to long-term learning (Ferris & Roberts, 2001; Lalande, 1982). Indirect written feedback requires students to internalize the feedback and try to devise solutions to the assigned problem. Therefore, this type of feedback can lead to a higher level of learning and can help students eventually to excel at a higher level than does direct written feedback.

Metalinguistic written feedback, which may be used more with writing assignments, can still be used with mathematics because it is given to the students by associating a symbol with an explicit comment for a specific error (Ellis, 2009). For example, a teacher might use a symbol on part of a mathematics problem that tells the students to try this problem again, or a symbol can tell the student that he/she has the correct answer. In other words, metalinguistic written feedback can combine both direct and indirect feedback with its use of symbols to signal what the teacher wants them to see. Therefore, metalinguistic written feedback can provide students with the advantages and disadvantages of both direct and indirect written feedback.

One major disadvantage of metalinguistic feedback is that it is quite time-consuming for teachers because it requires the teacher to provide students with various codes for each form of written feedback given (Ellis, 2009). The teacher has to spend time establishing what the codes mean and what the teacher’s expectations are for each code. This can be more or less work for the teacher, depending on how many codes he or she uses and how complex the feedback associated with each code is. For this reason, metalinguistic written feedback may be more effective overall for writing assignments versus mathematics problems.
Focused written feedback provides students with feedback on only one error (Ellis, 2009). In other words, a teacher focuses on giving students feedback on one error in their work, even if more than one error exists. This feedback may be more conducive to writing assignments than to mathematics problems because mathematics problems tend to have multiple parts. However, in mathematics, a teacher could give feedback on only one error that affects multiple aspects of an assignment. For example, a teacher may address an error relating to the core concept of applying a specific formula and choose not to address computational errors. According to Ellis (2009), students are more likely to develop a better understanding of the error they have made when the feedback is focused written feedback. Because mathematics is about building on concepts over a period of time, focused written feedback can be beneficial because in responding to the focused feedback, students would be working on one concept at a time without being overwhelmed with too much feedback.

An obvious disadvantage of focused written feedback is that it focuses on only one type of error, even if students have multiple errors to correct. The students may have more time to concentrate on one error at a time, but focused written feedback can also prevent them from being exposed to additional material they need to learn. Therefore, it is possible that if a teacher uses only focused written feedback with his or her students, he or she may be limiting their overall learning.

Unfocused written feedback is the opposite of focused written feedback because it addresses multiple errors (Ellis, 2009). Students are given feedback on all of their errors at one time. This provides students with a comprehensive look at where they are in their progress toward the objective or goal. This may be beneficial to students because they can assess their
learning as a whole and they may be able to determine the areas in which they need more help or assistance.

Because unfocused written feedback gives students feedback on multiple errors at one time, it can be overwhelming. Students may not know what they should focus on first. In addition, because the feedback focuses on multiple errors, students may not receive a great amount of feedback on each error. Beyond Ellis’s (2009) expertise, there appears to be no research on whether unfocused written feedback is more effective with a certain amount of errors.

In summary, there does not appear to be any specific research on a certain type of written feedback that has been used successfully in mathematics classrooms. Therefore, several types of written feedback were reviewed that do not provide a grade yet give the students an idea of where they are in their progress. The feedback can be direct or indirect, with a positive or negative tone. The feedback can be focused by addressing one error that relates to a significant concept. The feedback can also be unfocused by addressing multiple errors and providing the students with a range of items to review. Regardless of the written feedback used, it is important that the teacher and the students have an opportunity to dialogue back and forth so learning takes on a dual responsibility and both the students and the teacher understand what needs to be learned or accomplished for the goal or the objective to be met.
Feedback in Classrooms

General

Randall and Zundel (2012) believe that letting students learn from their mistakes is a good pedagogical practice. To further investigate their belief, they conducted an in-depth qualitative study to investigate students’ perceptions about the effectiveness of oral and written feedback and, more importantly, the opportunity to use it for another assignment. Randall and Zundel worked with a small group of undergraduate students who were given multiple channels of feedback with a rubric for four assignments that did not have a grade attached to them. Upon completion of the assignments, the students were interviewed by an independent researcher about their experiences receiving feedback on assignments.

The responses from the students were quite positive about the personal detailed feedback they received and the opportunity to use it. However, the key to this study was the decision to provide students feedback without grades. Therefore, it is possible the students may have been more apt to utilize feedback to help improve their assignments because they were focused on only the feedback and were not distracted by a grade.

Butler (1987) also conducted a study regarding the effect of grades and feedback with 200 fifth- and sixth-grade students of high and low achievement. Butler found that providing students with written personal detailed feedback and a grade for an assignment had a negative effect, as the students seemed to be concerned with the grade they received rather than the feedback. In addition, she found that students who received personal detailed feedback without a grade showed more interest in the assignment because they internalized the feedback and
performed better than the students who received grades. Butler believes that grades force students to compare themselves to others. Butler alludes that such comparisons can lead to lower self-esteem, thus defeating the purpose of feedback.

In a similar study done a year later, Butler (1988) took 132 random fifth- and sixth-grade students and divided them into three groups: those who received written personal comments, those who received grades, and those who received grades with written personal comments. She again found that students responded with an increased interest for learning when receiving only written personal detailed comments from their teacher on an assessment. Butler mentions that the groups who received only grades and those who received written personal comments and grades immediately looked at the grades and, consequently, did not try to use the written comments to make improvements. In addition, Sendzuik (2010) makes the point that when grades or points are not assigned to assessments, the students are more likely to review the feedback.

Both of Butler’s (1987, 1988) studies have a larger sample than Randall and Zundel’s (2012) study, and both showed similar findings, despite a few differences. For example, Butler did not have a way to follow up on the students’ comments. Insight from the students would have been extremely helpful in understanding the students’ reactions to receiving feedback. In addition, Butler’s studies are older than Randall and Zundel’s (2012) and are limited to one age group. However, her studies are often referenced in other literature.

Ackerman and Gross (2010) conducted a study that was slightly different from Butler’s (1987, 1988) studies because it implemented another variable. The university-level marketing students in Ackerman and Gross’s study were told they were going to be given back a graded
assignment they had already hypothetically completed for graduation with (a) a grade with no feedback, (b) a grade with very little personal feedback, or (c) a grade with a lot of personal feedback. The purpose of their study was to explore the effect of written feedback on students’ perceptions. Ackerman and Gross gave the students a set of reflection questions to answer and found that the students preferred to receive a grade with less feedback than a grade with a lot of feedback or a grade with no feedback. Furthermore, they found that students who received a grade with no feedback reacted in much the same way as the students who received a grade with a great deal of feedback.

Ackerman and Gross’s (2010) study certainly challenges Randall and Zundel’s (2012) study by suggesting that less feedback is better than a great deal of feedback. However, Randall and Zundel, as well as Butler (1987, 1988), indicate that grades with feedback were not received positively as opposed to receiving only feedback. Ackerman and Gross do not mention the power or influence of grades on the students’ perceptions, regardless of the amount of feedback given with it. In addition, Ackerman and Gross did not provide the students with an opportunity to utilize the feedback. Therefore, critical variables are missing in this study that would need to be further reviewed before any generalizations could be made.

McGrath, Taylor, and Pychyl’s (2011) study did not focus on grades and the amount of feedback students received, as did Ackerman and Gross’s (2010) study. McGrath et al. divided students randomly into two groups and gave them two writing assignments with a rubric, just as in Randall and Zundel’s (2012) study. After the first assignment was turned in, one group was given written detailed feedback that followed the rubric and the other group received underdeveloped personal feedback that did not follow the rubric. The situation was reversed
on the second assignment. McGrath et al. found that students who received the developed and detailed written feedback on the first assignment thought that the written developed feedback was more helpful and fairer than the undeveloped written feedback they received on the second assignment. However, the students who received written developed feedback on the second assignment did not think it was any more helpful than the written undeveloped feedback.

Unlike Randall and Zundel’s (2012) study, the McGrath et al. (2011) study did not provide the students with an opportunity to utilize the feedback they were given. McGrath et al. note this lack of opportunity in their findings and believe that the reason the group did not find the developed written feedback on the second assignment useful was because there was no motivation for its use. Therefore, the lack of opportunity for the students to use feedback on future assignments was a major limitation to this study as well.

Similarly, Ellery (2008) assigned second-year undergraduate students an essay-style test and gave the entire class oral feedback without a grade. The students had to use the oral feedback to determine how well they thought they did on the test because they were given a choice to take a second test in place of the first test or they could accept whatever grade they had received on the first test. Most students took the option to take the second test and performed much better on it than on the first test. Ellery (2008) believes that the students probably engaged in the material more after receiving advice on the first test. Ellery (2008) found, through open-ended questions, that the students commented mostly that they learned basic test expectations and how to structure an essay. It would appear that the students may have benefited from the feedback because they were not aware of test expectations and the feedback they received may have been more like a rubric than feedback.
Huxham (2007) conducted a study with 150 biological science students, divided into three groups, over a period of two years. This study is similar to the McGrath et al. (2011) study because it is based on providing students with model feedback. However, it takes the research to another level by comparing students’ performances on a single assignment with detailed feedback versus less detailed feedback.

After the students had time to review the feedback on their assignment, their responses clearly favored receiving less detailed feedback. However, despite their preference, students performed better on assignments that provided them with model detailed feedback as compared to assignments that gave them less detailed feedback. The positive response toward less feedback is not consistent with the findings of Randall and Zundel (2012). However, Huxham (2007) points out that student perceptions may not always be aligned with what works best for them because of emotional ties to something. In other words, student perceptions toward feedback may not necessarily meet their learning needs. Therefore, it would appear that more research should be done to see if there is a correlation between students’ perceptions of feedback and their actual performance with various types of feedback.

Kramarski and Zeichner’s (2001) study removed the teacher variable from the feedback process by suggesting that not enough attention has been given to various types of computerized feedback for mathematics achievement and reasoning. Their study involved almost 200 11th-grade students from Israel. The students were randomly chosen to work on two identical mathematics computerized programs, with the only difference being that one group received
metacognitive feedback and the other received result feedback. On a pretest, the students given result feedback outperformed the students who were given metacognitive feedback. After a posttest was given to the students, those who received metacognitive feedback performed much better than the students who received result feedback. One possible reason for this could be that metacognitive feedback provided the students with more specific feedback to the problems they were encountering in comparison to result feedback that provided only general feedback.

Although Kramarski and Zeichner’s (2001) study did not seek out students’ perceptions of feedback, it certainly could be used to support Randall and Zundel’s (2012), study, which suggests that detailed feedback is preferred by students because the students clearly performed much better with more detailed feedback than less. Because Kramarski and Zeichner’s study used computers to provide feedback, the researchers identified the need to explore more about learning in which feedback is automated by a computer and not by a teacher. Therefore, there is a need to study how students respond to feedback from teachers versus computers.

Rakoczy, Harks, Klieme, Blum, and Hochweber (2013) investigated the effects of process-oriented feedback on student performance in mathematics as opposed to social-comparative feedback. They defined process-oriented feedback as helping students learn more about their performance and how to proceed when dealing with challenging problems. Rakoczy et al. define social-comparative feedback as the mere giving of grades to students. In their study, they found that the students perceived process-oriented feedback as more useful than the social-comparative feedback. However, Rakoczy et al.’s study did not show any conclusive results regarding achievement. It should be noted that they believe the lack of a control group in their study may have had an impact on the results.
According to Askew (2012), if mathematics students are to experience learning with an emphasis on learning the process to understand the big picture concepts, then they need to be active players in attaining knowledge and not just recipients of correct and incorrect answers. An emphasis on just finding the correct answer to an Algebra I problem is detrimental to students’ development versus focusing on the process and justification for the correct answer because it can lead to limited development of algebraic reasoning (Warren, 2002). Requiring students to learn how to process and explain the steps to solve an Algebra I problem correctly forces them to learn and comprehend how Algebra I problems are solved. In other words, there is more involved in achieving success in Algebra I than just arriving at the correct answer. In addition, over 80% of mathematics instruction in school is spent working on the process to arrive at the correct answer (Hiebert et al., 2003). Mathematics problems can have a series of necessary steps to solve them and can require corrections and justification in solving them. Mathematics problems with multiple tasks tend to lend themselves to feedback to improve justification for the correct answer (Santos & Pinto, 2011). Therefore, it appears that feedback would be a helpful intervention to meet the needs of students in mathematics classrooms.

Formative Assessments

Definition

As mentioned earlier, there is a great deal of information on what formative assessments are and on what makes up formative assessments. With that said, there are many definitions and opinions about what formative assessments are and what they are not. According to Sadler
(1998), the results of formative assessments can provide teacher feedback on students’ performance to improve learning. Formative assessments can provide teachers with a description of their students’ strengths and weaknesses in relation to the material the teachers have taught. “It is not the instrument that is formative; it is the use of the information gathered, by whatever means, to adjust teaching and learning that merits the formative label” (Chappuis, 2009, pp. 4-5). Therefore, one distinct description of formative assessments is that they can provide information that a teacher can use to adjust his or her own teaching to improve learning.

Formative assessments should not be confused with summative assessments because although summative assessments are used to determine what students have learned at a given time, they are also for communicating achievement to others (Chappuis, 2009). According to Chappuis (2009), achievement is usually described in the form of a letter grade or number to compare whether students have met a standard. In addition, whether the students are given a letter grade or they have been deemed proficient in a standard is also usually communicated to their parents. Therefore, summative assessments tend to be more conclusive about the students’ learning, and they can be related to accomplishment or failure. In other words, a summative assessment can be used as a final determination of learning, without the option for the teacher to reteach content that was not mastered.

Chappuis (2009) agrees with Popham (2008) that the assessments students are given are irrelevant in and of themselves, but it is what the teacher does with the results of the assessments that determines if they can be defined as formative. Gallagher and Turley (2012) point out that some assessments might just be mini-summative assessments because they are designed to help students improve their scores on future summative assessments. In other words, if the students
take the assessments over and over, eventually they will see what they need to know to do well on the summative assessment. Therefore, the concept of re-teaching for improving learning is not the objective of the mini-summative assessments but rather to improve overall scores on future summative assessments.

According to Johnston (1997), when a teacher changes his or her instruction based on information he or she has received from assessments, the assessments are truly formative assessments. However, if the information from the assessments is not used for improving instruction and learning, it leaves both the teacher and students with no opportunity to make changes for improvement.

Although formative assessments could be assigned a grade to provide students with a way to measure their performance, grades tend to be less effective (Bloom, 1969). Students tend to compare themselves to each other, and they may think about what the grade represents about them. In other words, if students receive a poor grade or low score, they may lose their confidence to try to improve and learn the material to do well eventually on summative assessments. Bloom (1969) agrees that an assessment is formative when the information derived from it results in instructional change that would not have otherwise happened without it. Again, the idea of a grade or some form of evaluation is not as positively associated with formative assessment as is improving instruction for learning.

Even though the concept of improving student learning is associated with formative assessments, it is not deemed to be solely the teacher’s responsibility. For example, although Chappuis (2009), Popham (2008), and Bloom (1969) agree that what a teacher does with the results of assessments determines whether it is summative or formative, it is not entirely the
teacher who makes the assessments formative. Students have a role in assessing themselves and improving their own learning (National Council of Teachers of Mathematics [NCTM], 2013). The students have to take the feedback they receive from the formative assessments and make adjustments or seek other learning opportunities. In other words, students must use the results of the formative assessments to monitor their own learning to determine how well they understand the content that was assessed. Students have to determine what they need to devote more time and effort to and whether they need to change their learning approach (Phelan, Choi, Vendlinski, Baker, & Herman, 2011). Just as a teacher may adjust his or her instruction, students must adjust their efforts and possibly their ways of learning the content taught by the teacher.

According to Phelen et al. (2011), formative assessments must provide students with high-quality feedback in a timely fashion to offer them an opportunity to learn from it to improve their own learning. However, to provide quality feedback and to provide students with opportunities to improve their learning, a teacher must be flexible enough to be able to adjust his or her own instruction (NCTM, 2013). Therefore, if a teacher uses formative assessments as an instructional tool, the teacher must expect to allow flexibility in the pacing of instruction to plan time to meet the learning needs of students.

According to Leahy, Lyon, Thompson, and Wiliam (2005), independent class work, group work, participation in class, assigned projects, and homework can be viewed as formative assessments. The students’ participation in class can be a formative assessment as well because the teacher is able to see what the students know by their answers as well as by the questions the students ask in class. Questions that are not asked in class could imply that the class already knows those concepts. On the other hand, it could also imply that the students may not be aware
of what they do not know to ask questions to improve their learning. Therefore, the teacher has to provide ways for the students to show what they understand and what they need to learn.

Although formative assessments can be given in various forms, the common denominator for all these examples is that they provide a teacher with information about his or her students. The teacher has to be able to decide what approach he or she must use to increase learning gains. Therefore, formative assessments must be given with the idea that both the teacher and students will be making adjustments to increase overall learning toward a final goal.

Research on Formative Assessment

In 2008, the National Mathematics Advisory Panel cited research that supported the use of formative assessment in mathematics classrooms and its direct correlation with improvement in student learning (NCTM, 2013). In addition, in 2013, the National Council of Supervisors of Mathematics (NCSM) and the Association of Mathematics Teacher Educators (AMTE) affirmed their support of the research on formative assessments. Even more decidedly, these organizations made clear that formative assessments are a key to improving mathematics proficiency in all classrooms. However, documents of these organizations came long after other reports of research on formative assessment.

From an analysis of 29 studies, Bangert-Drowns, Kulik, and Kulik (1991) found that if a teacher gave his or her students at least one formative assessment in a 15-week period, he or she saw significant gains in student achievement, and the effect was even greater when used more frequently. In addition, Fuchs and Fuchs (1986) report that they found significant improvements in student achievement when a teacher gave his or her students two formative tests per week.
They report that the gains were the equivalent of 30 points on a standardized test. These studies exposed the potential of formative assessments. However, it was the results of a nine-year meta-analysis on classroom interventions done by Black and Wiliam (1998) that transformed the research on formative assessments.

Black and Wiliam (1998) found that the use of formative assessments had a consistent impact on improving student learning. They found evidence of significant learning gains for all students in classrooms in which teachers used formative assessments. In addition, they found significant learning gains for low-achieving students in comparison to other students. Their research is referenced in many articles on formative assessment, thus establishing the significant role formative assessment can have on student learning.

In additional research, Ehrenberg, Brewer, Gamoran, and Williams (2001) conducted a meta-analysis on interventions and found that formative assessments do increase student learning. They reported that formative assessments had a four- to five-times greater effect on student achievement than the effect of reducing class size. Ross, Hogaboam, and Rolheiser (2002) conducted a study with 500 fifth- and sixth-grade students, using a type of formative assessment on mathematics problem-solving called self-assessment. The results of their study show that those students who used self-assessment regularly outperformed those who did not use self-assessment on a regular basis. The research mentioned above provides a foundation for a suggestion that formative assessments can improve student learning, which leads to achievement gains on summative tests. Therefore, it appears that formative assessments, regardless of their form, should be considered by teachers as a significant instructional strategy to improve student learning and, ultimately, student achievement.
Exit Slips

Definition

According to Marzano (2012), effective lessons end each day with some type of activity in which students reflect on what they have learned from that lesson. One way to accomplish such reflection is through using exit slips. As mentioned earlier, Leigh (2012) defines exit slips as small slips of paper on which students write reflections about what they know and what they are trying to learn. Exit slips are a fast and simple way for a teacher to assess their students’ understanding of the current class lesson or previously taught concepts. Exit slips can contain questions or statements, depending on the teacher’s intentions and the age group of the students (Leigh, 2012). “Teachers summarize many times in a class period for students, but students themselves sum up their learning only infrequently” reports Buehl (as cited in Bafile, 2004, p. 1). Dewey (1904) makes the point that students reflect on their work if they believe they have an opportunity to do so in a meaningful activity. “Exit slips are ideal for capturing individual bursts of thinking; just when students think they cannot be heard or have nothing to share, exit slip writing can capture their ideas as they occur” (Leigh, 2012, p. 190).

Exit slips are usually passed out toward the end of a class period, with the expectation that students will fill them out and turn them in before they leave class for that day (Leigh, 2012). Teachers usually leave the last 5-10 minutes of class for students to fill them out (Bafile, 2004). Therefore, the students are given adequate time to think about what they learned or did not learn from the lesson. The exit slip provides the teacher with a snapshot of what needs to be reinforced and what specific adaptations he or she may have to add to future lessons to help
students be successful. In addition, it also helps the teacher see what he or she may need to do differently, from a pedagogical perspective, when presenting the content to students next time.

Alber (2013) explains that the use of exit slips is an effective strategy to check for student understanding. However, there are multiple types of exit slips from which a teacher can choose. Therefore, a teacher must select carefully which type of exit slip best assesses his or her students’ level of understanding. Marzano (2012) describes at least four types of prompts that can be used with exit slips: formative assessment, student self-analysis, instructional strategies, and communication with the teacher. Marzano further explains that the type of prompt selected should be based on what the teacher wants to assess.

The formative assessment prompt is all about obtaining formative assessment data on the students (Marzano, 2012). For this prompt, the teacher looks to see how well the students understood the content of the lesson and what changes he or she needs to make to future instruction. Exit slips may also require students to show some type of work to demonstrate their level of understanding. In other words, this type of prompt would not focus on students’ reflection but on students’ understanding of the concepts previously taught.

Student self-analysis is all about students’ self-reflection (Marzano, 2012). In this prompt, the teacher might put out an exit slip that asks students to rate or evaluate their level of effort. This prompt does not focus on what the students learned or lessons for which they need more guidance or instruction. The goal is for the teacher to learn more about students’ attitudes toward the class. If the students are not engaged, the teacher may have to look at ways in which to stimulate student interest and/or to spark a commitment to learn. In addition to students’ attitudes and perceptions of the class, the teacher can use this exit slip to gauge the energy level
of the class, as that may change from time to time, depending on what else may be going on outside of class (Marzano, 2012). Therefore, this type of exit slip informs a teacher about the readiness of his or her students to learn.

According to Marzano (2012), instructional strategy prompts help a teacher learn about students’ perceptions and beliefs about a certain strategy. For example, a teacher may ask the students what they think about cooperative groups. The students are expected to give their opinions about the strategy to help the teacher determine if it was effective or if he or she needs to make adjustments. Although this prompt asks the students to reflect, it is specific to a strategy that helped or did not help them learn. The students are not asked to comment on anything else.

Marzano (2012) points out that communication with the teacher is the least commonly used prompt. Despite many reasons for this, the main reason is that it asks the teacher to take a risk. This prompt gives the students a chance to provide constructive criticism to their teacher, or it can be an opportunity for students to express their complaints. Therefore, this prompt could be quite beneficial for both the teacher and students if used in a positive and productive manner. However, it could also be quite negative and possibly hurtful to the teacher. Nevertheless, Marzano (2012) claims that the potential rewards gained from this prompt are quite powerful because it can send the message to students that everyone is a learner, including their teacher.

Although many exit slips include prompts that can be used in any discipline of study, they can also be created to include prompts that address certain situations or help students learn specific subjects. Admit/Exit Slip Examples (2017) provides examples of ways in which exit slips can include general prompts for use in any discipline of study. Some of these examples include
• What did you learn today?
• What are some questions you have about today’s lesson?
• What would you like me to review in class tomorrow and why?
• What was the most difficult or confusing idea we learned today and why? (p. 1)

Admit/Exit Slip Examples (2017) also provides examples of ways in which subject-specific prompts can be used in mathematics classes. Some of these examples include

• How could this mathematics formula be applied to a real-life situation?
• Pick a mathematics problem on page 4 and write down in words how you solved it.
• How can you tell whether two sets of data vary, and how can you tell if the lines on the graph are a direct variation?
• What do you think is true about the rate of change for a horizontal line? (p. 1)

All of the prompts listed above require students to be active in their learning process, whether they are solving a problem or self-reflecting. One of the purposes of exit slips is to promote the learning process to help students meet the goal or objective of the class. Therefore, the type of exit slip used by a teacher should be based on the goal or objective of the class.

Research on Exit Slips

Unlike formative assessment, research on exit slips is limited. Leigh (2012) conducted a research study utilizing 608 exit slips from 44 undergraduate and graduate students from a public university in the midwestern part of the United States. Leigh found that exit slips provided students with an opportunity to reflect on their current practices and their future learning applications. In addition, the exit slips provided Leigh (2012) with information about what
content needed to be reviewed again in the next class and what supports the students still needed. The exit slips served as a source of information for both the students and the teacher.

In another study, conducted by Sterrett and Fiddner (2007), with fourth-grade mathematics students, teachers gave the students exit slips to answer in class every day. The exit slips took the form of a mathematics problem based on a strand in a unit of study. The students were expected to answer the mathematics problem on the exit slip and turn it in to the teacher. Each teacher then graded each exit slip and kept track of the results on a chart for all of his or her students. Sterrett et al. (2010) found a high correlation between the results of the exit slips and the results of the end-of-the-year assessment. Furthermore, they found that the formative assessments the teachers gave the students, in addition to the exit slips, also had a high correlation with the end-of-the-year assessment.

Although limited, the research on exit slips appears to parallel that of formative assessments. As mentioned above, exit slips appear to be able to provide teachers with vital information about their students’ learning without the need for extensive assessment. It appears that exit slips, although considered small pieces of paper, are a highly valuable tool to determine how to help students progress in their learning. Teachers can also gain insight into students’ thoughts and emotions if the exit slips ask for self-reflection.
Brookhart (2008) points out that students who lack self-regulation and self-efficacy do not have the confidence or self-discipline to face or deal with constructive feedback. Self-efficacy is about students’ beliefs that through their actions they can be successful and can overcome challenges (Bandura, 1977). Brookhart’s claim implies that if students do not have the confidence to make changes and grow from feedback that is given to them, then that feedback is useless to them. For example, if the classroom environment is one where learning from mistakes is not safe, then feedback is something students can reject because they may fear learning that they are wrong.

According to Schunk (1991), mathematics self-efficacy refers to students’ convictions that they can be successful in mathematics and can learn whatever concepts are taught to them. This would seem to imply that students who lack self-efficacy would not gain much from exit slips, and therefore, it would defeat the purpose of using exit slips to deliver feedback to them with the expectation they would learn from it. It would appear that students have to have self-efficacy to reflect on feedback that is given to them. In other words, students must believe that, by utilizing feedback, they can make changes that can help them grow and improve from where they are currently. Therefore, self-regulation theory is the core premise of feedback because feedback is only effective if it is utilized.

This claim about feedback is also supported by Zimmerman (2000), who believes that learning is a personal choice that students decide to pursue actively rather than passively. In other words, students make a choice to proactively learn and try to grow from feedback. If they
are passive, they will not learn and grow from feedback. Students must be engaged and willing to take risks to benefit from feedback on their progress. This is further supported by Berger and Karabenick (2011), who reported in a study of 306 ninth-graders that students’ self-confidence in mathematics is the best predictor of their use of learning strategies, concluding that students’ self-efficacy for mathematics rather than their motivation for the class determines their desire to use strategies to succeed.

Contrary to Berger and Karabenick’s (2011) study, Pintrich and Zusho (2002) and Zimmerman (2000) state that students who value a task are more likely to utilize strategies to learn. Lens, Simons, and Dewitte (2002) support this point by stating that students who take a class for its relevance toward their future are more likely to use learning strategies than are students who are taking a class merely for credit. In other words, students who are motivated to learn a subject are more likely to utilize learning strategies to help them learn, regardless of their level of confidence in the subject matter.

According to Tang (2013), self-regulation for students is the ability to exhibit control over learning contexts to maximize their academic success. Tang compared students’ use of self-regulation and found that high-achieving students in a pre-university lower-level mathematics class used more self-regulated strategies than did high-achieving students in a higher-level mathematics class. Tang questioned why high-achieving students in the higher-level mathematics class did not use as many self-regulation strategies as high-achieving students in the lower level mathematics class. Because he found no possible explanation, it is possible that further research is needed to address this finding.
In addition, there appears to be little to no research about whether the type of learning strategies offered to students affects their desire to utilize feedback. In other words, could it be possible that feedback could provide students with both self-efficacy and motivation because they believe the strategy is helpful to them? In conclusion, there appears to be a need for more research on students’ desire to use learning strategies and what might contribute to that desire in learning a subject.
CHAPTER 3
METHODOLOGY

Introduction

In this study, the researcher examined the feedback provided on the exit slips used in high school pre-calculus classes. Three classes that participated in the study received verbal feedback on their exit slips. However, one class also received process feedback, and the second class also received task feedback. The third class received only verbal feedback on their exit slips.

In this study, the researcher used a mixed-methods design to investigate ways in which various levels of written feedback influenced student achievement, students’ use of exit slips, and teacher preparation in a pre-calculus class. Pretests and posttests, along with a Likert-scale survey, were used to collect the quantitative data. Qualitative data were collected through three separate interviews with the high school mathematics teacher who examined her use of exit slips and her beliefs about the process.

The purpose of this study was to examine whether a certain level of written feedback on exit slips influenced student learning, student studying, and a teacher’s instructional approach. In this chapter, the researcher presents the research questions, research design, study context, teacher participant, intervention, instrumentation, timeline, data analysis, and summary.
Research Questions

The following research questions were used to measure the impact of student growth using various levels of feedback, written and verbal, on exit slips and the students’ use of the feedback in their preparation for the posttest. In addition, the following research questions measured the teacher’s utilization of exit slips with various levels of feedback. This study was guided by the following research questions:

1. Does providing students in a pre-calculus mathematics course with process feedback on their exit slips result in a higher average of growth from their pretest to their posttest than for students who received task feedback on their exit slips or students who receive only verbal feedback on their exit slips?

2. Do students who receive process feedback on their exit slips refer more to their exit slips as part of their independent study and preparation for a posttest than do students who receive task feedback or students who received only verbal feedback on their exit slips?

3. How does a high school mathematics teacher utilize exit slips, using both process and task feedback?

   3a. What can a high school mathematics teacher learn from the process of using exit slips over time?

   3b. How does the use of exit slips inform his/her subsequent instruction?
Research Design

The goal of this study was to determine if a certain level of feedback on exit slips helped increase student learning, as evidenced in growth scores through the combination of instructional and individual efforts to learn. The teacher’s role included instruction, and the students’ role included their participation on the pretests/posttests and their use of the exit slips. To attain this goal, a mixed-methods approach was used that consisted of acquiring both quantitative and qualitative data.

Quantitative research is defined as the collection of numerical data to analyze and explain some type of occurrence (Muijs, 2004). It aims to answer questions about how certain variables are related to each other (Leedy & Ormrod, 2001). Quantitative research is often associated with positivist viewpoints that perceive research as the determination of a cause and its effect (Muijs, 2004). However, positivists rely on what can be observed and do not consider nonobservable behaviors (Mertens, 2015). Quantitative research is significant to this study because it measured ways in which various types of written feedback on exit slips impacted student growth.

The core of qualitative research is a focus on what is observed, heard, and/or read (McEwan & McEwan, 2003). According to McEwan and McEwan, qualitative researchers ask questions about how and why things work. Therefore, as Charmaz (2014) notes, qualitative research often utilizes informational investigative interview strategies to gather information. Three interviews with the high school mathematics teacher gathered data based on her experiences utilizing exit slips to deliver task and process feedback. Because the interviews were conducted in a mostly intensive approach, with some informational strategies, intensive open-ended questions achieved the objective of obtaining detailed responses (Charmaz, 2014).
This style of interviewing helped capture the teacher’s detailed experiences. The researcher used this information to analyze how, if at all, she adjusted her instruction based on the results of the exit slips. The three sets of teacher interview questions can be found in Appendices A, B, and C.

Context of Study

The participants in this study were from a public high school in the suburbs of a large city in the midwest United States. The population of this high school was approximately 2,020 students. Approximately 85.0% were Caucasian students, 0.5% were African American, 6.5% were Hispanic, 5.5% were Asian, 1.0% were American Indian, and 1.5% were two or more races. Approximately 14.9% were from low-income households. The school’s overall attendance rate was 95%, with a 96% graduation rate in four years. In addition, approximately 87% of the students were likely to attend either a community college or a four-year college upon graduation.

The researcher chose this high school for many reasons. This high school had high expectations for all students as large number of students pursued post-secondary opportunities upon graduation (Illinois Interactive Report Card [IIRC], 2014). The math teacher who participated in this study expressed to the researcher that the teachers in this high school were open to trying new interventions without fear of failure. They tended to see their attempts to try new interventions as a way for them to grow as teachers, based on what they learned from the students’ responses to interventions and the ways in which they grew academically. In other words, even if an intervention did not have the effect the teachers were looking for, they could find reasons for why it did not work and make adjustments based on the students’ needs. The
high school principal expressed to the researcher that he supported the math teacher’s efforts, which helped create the environment for exploration of interventions. The principal completed the School Administrator Form for Research (see Appendix D).

Teacher Participant

Jen (pseudonym) was a licensed, tenured teacher of high school mathematics, with seven years of experience and a master’s degree. Currently, she taught two classes of Algebra II and three classes of pre-calculus. Previously, she had taught Algebra I and had seven years of experience teaching Algebra II. This was her third year teaching pre-calculus.

Reasons for Selecting This Teacher

Initially, the researcher put a flyer in the teacher’s lounge, looking for a potential teacher to participate in the study (see Appendix E); however, the researcher ultimately decided to ask one specific teacher, Jen, to participate in the study for the following reasons. First, Jen had begun to research the idea of using exit slips in her classes in the previous academic year, with the idea of implementing them in her current classes during the school year in which the study took place. Second, she had a strong interest in learning about her students’ perceptions of her and how they viewed her class. As such, Jen had a strong desire to continue to grow as a teacher to be able to meet the range of students’ needs. Third, Jen was chosen because she had three classes of pre-calculus. Given this teaching load, one class received written process feedback on the exit slips, which provided specific information about the students’ answers and ways to improve as well as verbal feedback in class. Another class received task feedback on their exit
slips, which would indicate to the students only whether they arrived at the right or wrong answer, as well as verbal feedback in class. The third class served as the control class. This class completed exit slips, but the students received only verbal feedback the next day when Jen reviewed the problems on the board. No feedback was provided on their exit slips. A fourth and final reason for choosing Jen was that she was an experienced teacher who was able to ensure that each class received the consistent assigned level of written feedback on their exit slips over the same units of study. The consistent delivery of the assigned written level of feedback to each class contributed to gathering reliable data.

As mentioned before, Jen agreed to participate in this study to explore various ways to help her students learn and increase their skills in pre-calculus. She also agreed to provide various levels of written feedback on student exit slips to determine which level of feedback helped students attain the greatest level of growth. Therefore, her willingness to participate and to make a commitment to providing various levels of written feedback on exit slips made her an ideal fit for this study. Finally, Jen signed an Internal Review Board (IRB)-approved consent form agreeing to participate in three taped interviews (see Appendix F).

**Teacher Preparation**

To ensure that Jen was prepared and aligned with the expectations of the research study, the researcher asked her to read literature on process- and task-level feedback. Additionally, she was specifically asked to read about the delivery of feedback and how feedback could be utilized in mathematics classes. In the first interview, Jen was asked what she thought was the most significant thing she learned from the reading. She said,
As I was reading, I was actively reflecting on, what have I done? Have my past practices benefited my students? Have they potentially not helped my students at all in the past, and what can I continue doing after reading that to try and fine-tune my approach for my students in the classroom? (Interview, November 7, 2016)

It appeared that the literature Jen read caused her to reflect on her own practices and think about how she could help her students. Jen was also asked what she knew about process and task feedback prior to reading the literature. She said,

Again, just the recognition. I’ve known that feedback, of course, comes in different forms. I haven’t necessarily heard, off the top of my head, heard of task and process Feedback, specifically, and what those both entail. Process feedback, I think it’s kind of self-explanatory, but as far as a clean dividing line of how the two are different, I really didn’t know much about them at all. (Interview, November 7, 2016)

It appeared that the literature was a learning experience for Jen both for self-reflection and by adding to her overall knowledge base. Jen was asked to describe what she thought when it came to exit slips in a pre-calculus class. She responded by saying, “If they think they understand something and, in reality, they don’t, that’s an issue that we need to address” (Interview, November 7, 2016). In other words, it seemed that Jen saw exit slips as an opportunity to learn how to think about her students before the study even started.

Then the researcher met with Jen to discuss the use of exit slips and how to align them to the pretests and posttests for the two different units of study. The last component of the teacher preparation was verification that Jen was delivering process and task feedback, as deemed appropriate for students in a pre-calculus class. The verification was performed by another veteran, tenured, pre-calculus teacher known as John, who was experienced with and knowledgeable about process and task feedback, as defined by Hattie and Timperley (2007). The researcher met with the other veteran teacher to make sure he understood the expectations of
the study, so the other veteran teacher could ensure that the students were receiving the correct type of feedback designated for their classes.

Classes in the Study

The sample consisted of students in three class sections of pre-calculus, all taught by Jen. The sample in this study included 42 students, both male and female, ranging from 14 to 18 years of age. Therefore, the students in the pre-calculus courses were from Grades 10 to 12. Some students were seniors or advanced sophomores because the sample was made up of the class sections that were available in the high school (Mertens, 2015). A convenience sample method was used to avoid identifying only a specific subgroup to create a larger sample size, which was more likely to decrease the standard error for measurement (Gravetter & Wallnau, 2014).

All three classes were considered to be the same academic math level, and no one class was perceived as advanced or below the others. Each class studied the same material at the same time. In addition, each class section was assessed at the same time for the pretests, exit slips, and posttests, so the amount of instruction and homework given to the students was the same for each class. All three pre-calculus classes received identical instruction. The school in which the study was conducted has a nine-period day, and Jen taught pre-calculus during Periods 2, 4, and 8. Therefore, Jen chose which class received which level of feedback randomly as they were all quite similar. Factors such as when the students had lunch were not considered at the time Jen chose the classes.
Recruitment and Consent

All the students enrolled in Jen’s three pre-calculus classes were invited to participate in the study, and appropriate protocols for IRB approval were completed. Jen told the students that she was looking at ways to help them learn mathematics content with a deeper level of understanding. To do this, she told the students, she would like to see if certain interventions would help them grow more in their learning and grades compared to other interventions. Jen explained to the students that the interventions were all intended to help the students with their learning, and some might be more effective than others. In addition, the students were told by the researcher that at no time would the teacher alter the curriculum they were learning and no class would be given an advantage or an award for their participation in the study.

The researcher explained to the students that at no time would their names be revealed to anyone but their teacher. The students were told by the researcher that only their test scores, without their names, would be revealed to him. The researcher asked the teacher for only the results of the pretests and posttests the students took to assess growth. The students were also told that participation in the study was their choice, and their parents’ choice, and that they could withdraw from the study at any time without any consequences to them or their grades.

Because most of the students were under the age of 18, the researcher needed to get both consent and assent from the students and their parents. The researcher provided a hard copy of the consent form for students to take home for their parents/guardians to sign and to return (see Appendix G). In addition, the researcher distributed the assent form to all of the students in class and asked them to sign the form if they were interested in participating in the study (see Appendix H). Students who were 18 or over were given a consent form to sign.
Veteran Teacher Verifier

John (pseudonym name) was a 15-year tenured veteran teacher of high school mathematics, all at the same high school, with a master’s degree, and he was licensed in the state in which he taught. Although John did not currently teach pre-calculus, he had taught that content for five years. John believed that exit slips could provide students with a tremendous benefit, and he was interested in how various levels of feedback provided on exit slips could impact student achievement. John had known Jen for the seven years she had taught at the high school, and they often traded ideas and thoughts on mathematical pedagogy. Therefore, John, with a background in pre-calculus and interest in levels of written feedback on exit slips, was an ideal candidate to review Jen’s exit slips to meet the requirements of the study. As mentioned earlier, the researcher met with John to make sure that he understood the expectations of the levels of feedback Jen was to provide the students on their exit slips. John reviewed some exit slips Jen gave her students and was able to verify that she was providing the students with task and process feedback as it was described by Hattie and Timperley (2007). John, like Jen, also agreed to sign an IRB-approved consent form to participate as the veteran teacher verifier (see Appendix F).

Researcher’s Role

The researcher played a significant role prior to the study when he met with Jen to make sure that she understood fully the various levels of written feedback and the purpose behind each one. Prior to their meeting, the researcher provided Jen with literature on the various levels of written feedback. The researcher worked with Jen to understand what the exit slips should
include. In other words, the researcher and Jen determined how many problems would appear on each exit slip and how often she would provide them to students. The researcher presented the consent and assent forms to all three pre-calculus classes to ensure they all received the same message and to answer any of their questions and address any concerns they had. The researcher interviewed Jen on three separate occasions and met with her periodically to gather data throughout the study.

Prior to the study, the researcher also met with John to make sure he understood fully the various levels of written feedback and the purpose behind them. As with Jen, the researcher provided John with specific literature on the various levels of written feedback prior to their meeting. At the beginning of the study, the researcher and John reviewed some of the exit slips that Jen had given the students to ensure that she was providing appropriate exit slips for students in a pre-calculus class and that they matched the written levels of feedback discussed prior to the study.

Intervention

Overview

This study included two levels of written feedback given to students on their exit slips, with one class receiving process feedback and the other class receiving task feedback. The third class, as the control group, did not receive any written feedback. All three classes received verbal feedback when Jen went over the exit slips in class the next day. Jen gave the students exit slips twice a week to complete during the last 5 to 10 minutes of class. The exit slips had to
be turned in at the end of class whether the students had finished them or not (a sample exit slip is provided in Appendix I). The results of the exit slips did not factor into the students’ grades in any way. Jen was expected to be consistent with her delivery of feedback to each class (see Table 1 for how each intervention was linked to the research questions.

Because this study was based on the feedback given on exit slips, the cycle of frequent feedback was no earlier or later than 24 hours (Quinn, 2012). Feedback that is given frequently or sometimes considered timely or immediate is about providing students with an opportunity to make necessary corrections to move forward in the learning process (Mason & Bruning, 2001). Frequent feedback should also help students by preventing them from repeating mistakes because they learn about mistakes immediately (Chappuis, 2012). Therefore, this study provided consistent feedback to students on their exit slips no more than 24 hours after they submitted them.

Levels of Feedback Provided

As mentioned earlier, one class received written process feedback, which Hattie and Timperley (2007) describe as providing specific information about the students’ response and ways to improve. Jen provided the students with brief comments about why they were correct or incorrect specific to their answers. The students had the opportunity to review these exit slips to pinpoint areas for growth.

Another class received written task feedback, which Hattie and Timperley (2007) describe as indicating only whether the students had the answer right or wrong. Jen did
Table 1

Research Question Alignment

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>Research Question 1</strong>&lt;br&gt;Does providing students in a pre-calculus mathematics course with written process feedback on their exit slips result in a higher average percentage of growth from their pretest to their posttest than providing students with written task feedback on their exit slips or providing only verbal feedback on their exit slips?</td>
<td>X</td>
<td>X</td>
<td></td>
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</tr>
<tr>
<td><strong>Research Question 2</strong>&lt;br&gt;Do students who receive written process feedback on their exit slips refer more to their exit slips as part of their independent study and preparation for a posttest than students who receive written task feedback or students who receive only verbal feedback on their exit slips?</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>Research Question 3</strong>&lt;br&gt;How does a high school mathematics teacher utilize exit slips, using both process and task feedback?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>3a. How can a high school mathematics teacher learn from the process of using exit slips over time?</td>
<td></td>
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<tr>
<td>3b. How does the use of exit slips inform his/her subsequent instruction?</td>
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</tbody>
</table>
not provide any comments. The students had to seek out more information to understand the reasons for their right or wrong answers.

The third class served as the control class. This class completed exit slips, but the students received verbal feedback only the next day when Jen reviewed the problems on the board. No feedback was given on their exit slips. This class had to self-evaluate their exit slips for correctness based on Jen’s review on the board.

Verification

As mentioned earlier the researcher met with John to develop an understanding of what defines the different written levels of feedback and whether the exit slips given by Jen were appropriate for a pre-calculus class. (For examples of exit slips with process and task feedback, see Appendix J.) It is important that there is consistency in the level of written feedback delivered to each class to measure its impact on the students. In addition, it is also important to ensure that the exit slips are asking the students types of questions appropriate for a pre-calculus class. Again, John and the researcher developed an understanding of the various levels of written feedback and appropriate types of questions for a pre-calculus class using exit slips. Any discrepancies were communicated to Jen and worked out in a meeting with the researcher.
Instrumentation

Overview

To answer Research Question 1, the researcher used a quantitative method called a one-way analysis of variance (ANOVA) to determine growth differences among the three classes participating in the study. In addition, effect size was conducted on the growth scores to determine the level of effectiveness of the different levels of feedback on growth. To answer Research Question 2, the researcher used a quantitative survey method, presented in a Likert-scale format at the end of each posttest, to examine the students’ use of exit slips. The researcher also gathered the mean of student responses to the Likert-scale questions for each class. Finally, the researcher used qualitative interviews to examine how the high school mathematics teacher utilized exit slips in her classes.

Data were collected using three instruments. First, student growth was measured with a nonstandardized pretest and posttest created by Jen, based on the unit she was teaching at that time. Second, the students were asked three survey questions at the end of each posttest regarding their use of the exit slips for their preparation for the posttest. Third, three teacher interviews took place, one each at the beginning, middle, and end of the study (see Table 2 for timeline of implementation of the entire research process).
### Table 2

#### Study Task Timeline

<table>
<thead>
<tr>
<th>Date</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>07/16</td>
<td>Ask Principal for approval to pursue study in high school</td>
</tr>
<tr>
<td>08/16</td>
<td>Recruitment of teachers for study</td>
</tr>
<tr>
<td>09/16</td>
<td>Literature provided to teachers on exit slips and feedback</td>
</tr>
<tr>
<td>10/16</td>
<td>Proposal made to Dissertation Committee</td>
</tr>
<tr>
<td>10/16</td>
<td>Application made to IRB for approval</td>
</tr>
<tr>
<td>11/16</td>
<td>Researcher and teacher meet to discuss and agree on exit slips and levels of written feedback.</td>
</tr>
<tr>
<td>11/16</td>
<td>Researcher meets with students to explain consent/assent</td>
</tr>
<tr>
<td>11/16</td>
<td>Researcher meets with teacher to do interview 1</td>
</tr>
<tr>
<td>11/16</td>
<td>Teacher administers Pretest for Unit 4 to all students</td>
</tr>
<tr>
<td>11/16</td>
<td>Teacher administers exit slips to students twice a week over the next three weeks with one class receiving process feedback, one class receiving task feedback and one class only receiving verbal feedback</td>
</tr>
<tr>
<td>11/16</td>
<td>Teacher administers posttest to all students</td>
</tr>
<tr>
<td>11/16</td>
<td>All students take survey on posttest</td>
</tr>
<tr>
<td>12/16</td>
<td>Researcher meets with teacher to do interview 2</td>
</tr>
<tr>
<td>12/16</td>
<td>Teacher administers Pretest for Unit 5 to all students</td>
</tr>
<tr>
<td>12/16</td>
<td>Teacher administers exit slips to students twice a week over the next three weeks with one class receiving process feedback, one class receiving task feedback and one class only receiving verbal feedback</td>
</tr>
<tr>
<td>1/17</td>
<td>Teacher administers posttest to all students</td>
</tr>
<tr>
<td>1/17</td>
<td>All students take survey on posttest</td>
</tr>
<tr>
<td>1/17</td>
<td>Researcher meets with teacher to do interview 3</td>
</tr>
</tbody>
</table>
Pretest

According to Sanders and Horn (1995), there is probably no assessment that can appraise the students’ total classroom experience. Nonstandardized tests are usually made by a teacher, and in this study, the teacher created the pretest and the posttest (Mertens, 2015; Office of Planning and Institutional Assessment, 2006). According to Sanders and Horn (1995), a nonstandardized test allows the teacher to individualize the assessment to the learning of her students. Because the teacher was a veteran, she was fully aware of what the students were expected to know by the end of the unit, as set by the district’s curriculum. In other words, the teacher was able to ensure that the tests evaluated only what the students were taught and expected to learn in the unit. Therefore, the students were given a pretest at the beginning of each unit and a posttest at the end of each unit.

Pretests helped determine differences among groups that were being compared. In addition, pretests eliminated error variance and systematic bias that would help in the data analysis process because the students were not exposed to the material before the pretest on which they would later take a posttest (Dimitrov & Rumrill, 2003). In other words, the pretests provided the researcher with baseline data to compare the three classes from the beginning to the end of the units to see which intervention most impacted student growth (Ary, Jacobs, Razavieh, & Sorensen, 2006). By using a pretest, the researcher could assess the students’ current skills or the knowledge base of the unit of study prior to any delivery of feedback from the teacher to the students (Gouldthorpe & Israel, 2013). The pretests can be found in Appendix K.
**Posttest**

The posttest had the same set of problems as the pretest, but the problems were arranged in a different format. The data collected from the posttest were calculated and measured against the data collected from the pretests, based on the various deliveries of feedback given to the students in the three classes (Pratt, McGuigan, & Katzev, 2000). The posttests were an adequate indicator of the growth the students made because the pretests were aligned to the objectives of the unit, which could show the level of student mastery of the objectives (Sacks, 1999). In addition, the posttest used by the teacher was quite similar to other tests used by other pre-calculus teachers in the school. Therefore, the posttests reflected the common expectations for all students enrolled in pre-calculus in the participating high school. The posttests can be found in Appendix L.

**Survey**

Likert-type items indicate the extent to which people agree or disagree with something. They do not measure exact numbers (Patten, 2001). For this study, the students’ recollection of their use of exit slips may not be exact. However, Likert-type items provided a way to measure the students’ use of exit slips in the three different pre-calculus classes because they can have as many as six choices, which helps eliminate students from responding with false distinctions and providing the researcher with a more accurate reflection of the students’ viewpoints (Patten, 2001). Therefore, the researcher designed a survey that was used twice after the two posttests with all three pre-calculus classes.
The students participated in this survey at the end of each unit, and it asked them three questions about their usage of the exit slips in their preparation for the unit posttest. The survey was stapled to each posttest to ensure the students answered the questions before they turned them in with their posttest. The three questions on the survey gave the students six choices for each question. Each question on the survey had a different rating scale response, based on the research question purpose. Although the survey had never been used before, the researcher was able to distinguish the students’ responses to quantify their thoughts and feelings about each question.

The data from the survey provided the researcher with information to see if the students’ use of the feedback in their preparation for the unit posttest was in any way correlated to student growth and a specific type of feedback. In addition, the survey provided the researcher with information on whether the students found the exit slips helpful and if they would like their teacher to continue to use them. The survey questions can be found in Appendix M.

**Teacher Interviews**

The teacher interviews provided insight into Jen’s perceptions of the use of exit slips and the level feedback she provided. For example, three interviews were held with Jen: at the beginning, in the middle, and at the end of the study. Each interview provided the researcher with information about Jen’s perceptions of the exit slips and whether she thought they were a viable tool to use with students. The same point was made for the various levels of written feedback. Because the interviews took place at the beginning, middle, and end of the study, the researcher was able to see if Jen’s perceptions changed about the use of exit slips and the various
levels of feedback and what she planned to do beyond the study. In addition, the researcher was able to see if Jen made changes to her delivery of instruction based on the use of exit slips with various levels of feedback.

The first interview provided the researcher with Jen’s mindset about her class and the use of exit slips with various levels of feedback. The second interview asked questions based on Jen’s experiences in the classroom and how she had responded to that point in the study. The third and final interview was when Jen reflected on and determined ways in which she would utilize what she had learned in her classes for the remainder of the school year and beyond.

Data Analysis

Inferential and descriptive statistics were used to analyze the quantitative data in this study. Inferential statistics allow a researcher to draw general conclusions about the findings from just the sample used in the study (Gravetter & Wallnau, 2014). In addition, inferential statistics help a researcher determine if sample scores differ significantly from each other and from general population values (Mertens, 2015). Descriptive statistics are used to describe the characteristics of a body of data, and in this study, the mean and standard deviation were reported. Growth scores were calculated by subtracting the pretest scores from the posttest scores. The pretests and posttests were exactly the same assessment with the exception that Jen changed the order of the questions; as mentioned earlier, they can be seen in Appendices K and L.

Although some students appeared to have gained more from one type of feedback than another, the students at no time were at a disadvantage because the teacher still delivered the
curriculum in equitable fashion among all three classes. In other words, the students still had the same opportunities to learn and be successful in the class, regardless of what form of feedback they received on the exit slips the day after they completed them. All the students were given verbal feedback with their exit slips. In addition, it was possible that the delivery of feedback with the lowest mean average may not necessarily be inferior to the other forms of feedback because there could be other factors with that class that may have influenced the growth for those students (Dimitrov & Rumrill, 2003). The researcher has taken this into account as a possible limitation of the study.

The student surveys were based on a Likert-scale, so the data were based on the extent to which students agreed or disagreed with something. It was not an exact measurement but merely a description of how often students believe they referred to their exit slips, what they thought of the exit slips, and if they would like their teacher to continue to provide them to their class. These data were analyzed quantitatively by connecting the mean averages for each survey question for each class. The data collected from this part of the study were designed to answer Research Question 2 and were analyzed from a perspective of how useful the students perceived the exit slips to be by how often they referred to them. In other words, the researcher connected the frequency with which the students referred to the exit slips to the value students gave the exit slips in their learning. As with all research, the researcher understands that the results of the survey should be analyzed through a lens that acknowledges that other factors could have influenced how often students referred to them outside of how valuable they perceived them. For example, it should be noted that the students had received 12 exit slips when they took the Unit 5 posttest and the survey that followed, compared to six exit slips when they took the Unit 4
posttest and the survey that followed. Therefore, the analysis of the survey results was done with an understanding that more time beyond two units of study was probably necessary to learn about the students’ use of the exit slips in their preparation for the posttests.

The teacher interviews were analyzed qualitatively. The qualitative method helped the researcher gather information on the use of exit slips and various levels of feedback from Jen’s perspective. The interviews captured intangibles such as Jen’s perception of students’ responses to taking the exit slips twice a week and their reactions to them when they were reviewed the next day. In addition, the interviews captured whether the teacher perceived that the exit slips and the various levels of written feedback were assisting the students’ learning and what, if anything, she should change in her instruction based on that information. All data were explored and reviewed to find connective themes in the data (Mertens, 2015). Content analysis was used to code and categorize Jen’s responses (Charmaz, 2014). The coded responses were then summarized for tabulation to determine significant findings or features as they related to Research Question 3 (Charmaz, 2014). In addition, a comparison of what the various codes meant was reviewed to answer Research Question 3 (Charmaz, 2014). Therefore, the use of three in-depth interviews helped the researcher examine Jen’s perceptions of the use of exit slips with various written levels of feedback and reviewed any changes in her pedagogical approach as a result of her participation in the study.

As mentioned earlier, the three teacher interviews were coded; however, they were based on the ways in which they addressed Research Question 3. Interview 1 provided information as it related to the teacher’s perceptions prior to the study and her thoughts about feedback after
reading some literature that was provided to her by the researcher. Interviews 2 and 3 were used to answer Research Question 3.

The three parts of Research Question 3 were separated into three themes: Learn from the Process, Inform Instruction, and Utilization of Process and Task feedback. All the interview questions and responses that appeared to address Research Question 3 were pulled from the interview transcripts and were grouped together. Each group of interview questions and responses were color-coded to distinguish the different information that each one provided (see Figure 1). The colors are grouped together to answer the three different research questions. Each research question is highlighted in green. The answers from the three interviews are grouped together by colors based on the information they provided and how they addressed the three research questions.

Summary

The mixed-methods study used pretests and posttests to compare the effect of different levels of written feedback on student achievement. In addition, a short survey was administered after the students completed the posttests; this survey asked students how often they referred to the exits slips in preparation for the posttest. In addition, the students were asked how helpful they believed the exit slips were in reviewing the math concepts on the posttest and whether they believed the teacher should continue using weekly exit slips. Finally, three separate interviews with Jen gained insight into her perceptions of the use of exit slips with the various levels of written feedback on them and how it impacted her teaching practices.
What can a high school mathematics teacher learn from the process of using exit slips over time?

<table>
<thead>
<tr>
<th>What have you learned so far about your pre-calculus students? (Interview #2)</th>
<th>Motivated students see value in it. Nonmotivated students do not see value in anything. Motivated students see it as a tool of preparation with nothing to lose.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you sense a trend with each class, such as if they became reliant on a style of feedback?</td>
<td>I think I would have noticed more of a, if they were crying out saying, “Yesterday you gave me so much detail, and today you didn’t.” I think that would be a noticeable difference, but because it wasn’t changing from day to day, it was more consistent.</td>
</tr>
<tr>
<td>In your view, did process feedback make a difference in how the students performed on their daily work?</td>
<td>On a day-to-day basis, no. I don’t know how much time students spent looking at exit slips outside of the classroom after they were reviewed. I look at all those components of their performance of daily work, and I wouldn’t say that process feedback made a substantial difference, but I also know that there are other differences in the classes regarding time of day and proximity to the lunch hour, which also play into their daily work performance as well.</td>
</tr>
<tr>
<td>What is working and what is not working? (Interview #2)</td>
<td>Which one of the three in theory helps them the most? What’s going to benefit them the most? I think I’m realizing there’s so much more behind that. I look at the homework grades for the classes, and that’s just, I guess I have more of an overall perspective of what’s really going into this learning process, something that I’ve known, but it’s really kind of making it more clear to me. I don’t know. I would say, like, for the class that’s receiving process feedback, I believe, I don’t have hard numbers in my head, but I believe they have the lowest homework average. And that low, I’m giving them the most descriptive feedback and I’m also noticing that they have lower quiz scores.</td>
</tr>
<tr>
<td>Does the task or verbal have . . . which one has better homework?</td>
<td>Verbal has the highest homework completion and the highest test scores.</td>
</tr>
<tr>
<td>Is there something from this experience that stands out to you that you will always remember, and if you could follow up with why was this important to you?</td>
<td>I don’t know if it’s enough to say if it’s right or it’s wrong. I want students to know, these are the parts of the process that you have include for it to be right. There are certain characteristics or certain components, especially looking at a math problem, certain components that kind of have to be there to go from the start to the finish. It’s a matter of what to do with that feedback. Whether they’re actually keeping their exit slips, I know I had a lot of students say that yes, they refer back to them. They use them as a study tool, but I also can think of a handful of students that leave them on their desk or they throw them away immediately.</td>
</tr>
<tr>
<td>What advice would you give a colleague who was interested in using exit slips in his or her math class?</td>
<td>I would also encourage them to think about why they’re using exit slips. Some teachers use it as just a way to fill a couple extra minutes, but what’s the goal? What are you hoping to accomplish with it? Is it a matter of getting feedback? Is it a matter of just formative assessment? You’re using it for your own benefit. I know for me, it’s much more letting the students know where they’re at on this continuum, but I would encourage teachers to think about what that looks like for them and their students, and that’s, of course, something that might change from day to day or from unit to unit, too, or class to class, or student to student. So there’s a lot of variations with that.</td>
</tr>
<tr>
<td>Question</td>
<td>Response</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Is there anything you believe that I should know that I did not ask you?</td>
<td>Student ownership of the exit slips. The teacher shouldn't do all the work.</td>
</tr>
<tr>
<td>Could you describe the most important thing you learned from this experience?</td>
<td>I think that getting them in the habit of knowing that feedback is coming and being able as a teacher to model how to properly use the feedback, I think all of these are skills, and like I said, I . . . being able, if I were to go back and say maybe one day I would use task, one day I would use process, one day I would use verbal, in all the classes. I think maybe by switching it up, that might actually encourage them to think even more and say how getting them to start thinking about how do these processes compare and do I benefit from one of them? They might not be able to sit there and say, “This is task, and this process,” but how, in a way, how vague is the teacher being? Is she spelling it out for us where maybe they don’t have to put in a lot of effort at the front end, or do I have to work a little bit harder for it? But I think overall, it’s just, it’s getting students used to using, to getting the feedback and using it.</td>
</tr>
<tr>
<td>How does the use of exit slips inform her subsequent instruction?</td>
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</tr>
<tr>
<td>How have you adjusted your instructional preparation for your pre-calculus classes? (Interview #2)</td>
<td>You have to leave time at the end of class to give them and you have to leave time at the beginning of class to go over them. It has allowed me to see common mistakes and use that to focus on in future lessons.</td>
</tr>
<tr>
<td>How have you adjusted your pedagogy---in other words, your style of teaching---based on the feedback you’re receiving from the students on their exit slips? So in terms of your . . . you’ve talked about your instructional preparation, but now, what you know about your students, have you adjusted how you approach presenting the information?</td>
<td>Provided ways to give more personalized one-on-one learning because of the focus of each individual.</td>
</tr>
<tr>
<td>How have you adjusted your instructional preparation for your pre-calculus classes because of using exit slips, based on what you have learned from working with students who received process feedback on exit slips? (Interview #3)</td>
<td>One of the major benefits was having a source for students to look back at. By giving them specific things to focus on as far as making corrections or making improvements or knowing what they did right and what they did wrong, they had something to look back at that, even in the classroom, we were able to use as a guide. So instead of starting from scratch each time, we were able to kind of go back and say, “Here’s this connection. Here’s the missing piece between what you’ve done and what you needed to do,” taking it one step further. With task feedback, there wasn’t as much of that support in mind. Without having that guide, we’d spend a lot of time saying, “Okay, let’s try that again. Let’s maybe look at it in a slightly different context.” Students with verbal feedback, as far as having kind of like a reference using that as a resource in the class, unless they were taking notes when we went through it as a group,</td>
</tr>
<tr>
<td>Is there anything you would change about your teaching style or pedagogy duty or participation in this study?</td>
<td>To get them thinking about their mistakes and how to correct them rather than relying on somebody else to do it for them. So, more emphasis on kind of the metacognition about what they’re doing.</td>
</tr>
</tbody>
</table>
### How does a high school mathematics teacher utilize exit slips, using both process and task feedback?

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select an exit slip on which you gave the student task feedback and one on which you gave the student process feedback. Would you please describe each student’s work and why you decided on what you wrote in the feedback? (Interview #2)</td>
<td>Task feedback is limited and students can get something right and not know how they got there. Process can help students see where their mistakes are. However, I don't know if the students will refer back to the feedback to learn from it.</td>
</tr>
<tr>
<td>How about with the verbal? Just the verbal? Do you sense anything their challenge?</td>
<td>I think I see students taking more notes and making more corrections on their exit slips for the verbal feedback group than either of the task or process. I don’t know if they actually look back at it or not, but they do more on their end to have some resource to look back at later on than the other two groups.</td>
</tr>
<tr>
<td>Have you sensed any difference in the responses between the classes? So if you compared task and process, do you notice how the students responded to their exit slips?</td>
<td>Once student receive process feedback, they would come to expect it. Therefore, if you all of the sudden took away process feedback and gave the students task, they would notice. However, internal motivation determines their use and value of the feedback.</td>
</tr>
<tr>
<td>What are your most significant challenges in the different uses of exit slips in the three classes? (Interview #2)</td>
<td>Frustrated with task feedback because I want to tell them this is wrong because.</td>
</tr>
<tr>
<td>And how about with the process? How does that make you feel?</td>
<td>In a perfect world, if you do it wrong once, you’re going to correct it, and I feel like I’m doing more to contribute to that by providing them with the process feedback.</td>
</tr>
<tr>
<td>How has your approach to using the exit slips changed over time? What motivated this change? (Interview #3)</td>
<td>I think I would stick to a system where maybe I’m able to kind of, somewhere in between process and task, where I’m not going to correct it for them. I still want them to be able to make that connection and to be able to think through it but also identify specifically where it went wrong. So they have at least something to direct their attention to. With the task feedback, I was looking at the task overall, saying, “Yes or no. You got it or you didn’t get it,” and I think that’s a skill that a lot of students work really hard to achieve to say . . . They don’t know where they made their mistake. They don’t know that they started correct. They don’t know where they went wrong, and that’s a very grey area.</td>
</tr>
<tr>
<td>What do you think was most significant about what you read, in preparation for this study? (Interview #1)</td>
<td>As I was reading, I was actively reflecting on what have I done? Have my past practices benefited my students? Have they potentially not helped my students at all in the past, and what can I continue doing after reading that to try and fine-tune my approach for my students in the classroom?</td>
</tr>
<tr>
<td>What did you know about task and process feedback prior to reading about it for the purpose of this study? (Interview #1)</td>
<td>Again, just the recognition. I’ve known that feedback, of course, comes in different forms. I haven’t necessarily heard, off the top of my head, heard of task and process feedback, specifically, and what those both entail. Process feedback, I think it’s kind of self-explanatory, but as far as a clean dividing line of how the two are different, I really didn’t know much about them at all.</td>
</tr>
<tr>
<td>What do you think about when it comes to using exit slips with your pre-calculus classes? (Interview #1)</td>
<td>If they think they understand something and, in reality, they don’t, that’s an issue that we need to address.</td>
</tr>
</tbody>
</table>

*Figure 1. Color-Coded Responses*
CHAPTER 4

RESULTS

Introduction

Presented in this chapter are the findings with respect to student assessment scores from three separate high school pre-calculus classes, using two pretests from two different units of study as benchmarks to compare growth from each class on two corresponding posttests. Each class was given exit slips twice a week and received verbal feedback as the teacher went over them at the beginning of the next class. Based on the research protocol, one class received only the verbal feedback that the teacher gave to all three classes when she went over the exit slips at the beginning of class. In contrast, the second class also received process feedback written on their exit slips, and the third class also received task feedback written on their exit slips. As mentioned in Chapter 3, a total of 42 students participated in the study (Process Feedback = 14, Task Feedback = 17, Verbal Only = 11).

This chapter also presents findings from the three pre-calculus classes on students’ use of the exit slips in their preparation for the posttests as well as the students’ perceptions about exit slips. Finally, this chapter examines how the teacher utilized exit slips by providing students with various levels of feedback. Findings are related to each of the research questions addressed in the study:
1. Does providing students in a pre-calculus mathematics course with process feedback on their exit slips result in a higher average of growth from their pretest to their posttest than for students who received task feedback on their exit slips or students who receive only verbal feedback on their exit slips?

2. Do students who receive process feedback on their exit slips refer more to their exit slips as part of their independent study and preparation for a posttest than do students who receive task feedback or students who received only verbal feedback on their exit slips?

3. How does a high school mathematics teacher utilize exit slips, using both process and task feedback?

   3a. What can a high school mathematics teacher learn from the process of using exit slips over time?

   3b. How does the use of exit slips inform his/her subsequent instruction?

Analysis of Quantitative Data

Quantitative data were collected using pretest and posttest performance measures to answer Research Question 1. In addition, quantitative data were collected through surveys with Likert scales to measure usage of exit slips by students in their preparation for their post-tests to answer Research Question 2. The findings in this study should be treated with caution given the sample size and the length of the time of it.
Research Question 1

To answer Research Question 1, a one-way ANOVA was conducted on the growth scores to determine if there were differences in test performance among the three classes. The results from the ANOVA showed no differences among the classes for both units of study. For Unit 4, the growth scores were $F(2, 49) = 2.74$, $p = .077$, and for Unit 5, the growth scores were $F(2, 37) = 0.95$, $p = .40$.

In addition, effect size was measured for both of the classes that received process and task feedback. Hattie, (2008) states that any intervention with an effect size above .40 would indicate a better-than-average growth in one school year. For example, an intervention with an effect size of .40 would indicate, according to Hattie (2008), students growing at a learning rate that keeps them on par for their grade level. Anything above .40 would indicate that students were learning at a faster rate than their expected grade level in one year of school (Hattie, 2008). Cohen (1992) states that effect sizes should be measured according to values of small, medium, and large. In addition, Cohen states that effect sizes that are small would be considered .20 and below, those that are medium would be .50, and those that are large would be .80 and higher.

The class that received process feedback had an effect size of (.05) for Unit 4 and the class that received task feedback had an effect size of .70. Although the ANOVA showed no significant differences of growth scores among the three groups, the effect size of the difference between the task feedback and verbal feedback groups was of medium size (ES = .70). The results of the growth scores can be seen in Table 3.
The results of the growth scores from Unit 5 were similar to the results from Unit 4. As noted in Table 4, the class that received process feedback had an effect size of .10, and the class that received task feedback had an effect size of .48. As mentioned earlier, the overall differences among the three classes was not statistically significant. The class that received task feedback was slightly below medium size (ES = .48), according to Cohen (1992), but better than average, according to Hattie (2008).

Table 3
Unit 4 Results

<table>
<thead>
<tr>
<th>Type of Feedback</th>
<th>N</th>
<th>Unit 4 Pretest (out of 14)</th>
<th>Unit 4 Posttest (out of 14)</th>
<th>MG</th>
<th>SDG</th>
<th>ES</th>
<th>Growth Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal only</td>
<td>14</td>
<td>4.42</td>
<td>1.94</td>
<td>9.57</td>
<td>1.76</td>
<td>5.14</td>
<td>2.41</td>
</tr>
<tr>
<td>Task</td>
<td>17</td>
<td>3.47</td>
<td>1.81</td>
<td>10.29</td>
<td>1.26</td>
<td>6.82</td>
<td>1.91</td>
</tr>
<tr>
<td>Process</td>
<td>11</td>
<td>4.27</td>
<td>1.95</td>
<td>9.55</td>
<td>1.29</td>
<td>5.27</td>
<td>2.37</td>
</tr>
</tbody>
</table>

Note: M = mean (average of each class period’s pre/posttest scores); SD = standard deviation (of each classes’ pre/post test scores); MG = mean growth (average growth from pretest to posttest); SDG = standard deviation growth (between pretest and posttest); ES = effect size (magnitude of the difference between the verbal-only group and the other two groups).

Table 4
Unit 5 Results

<table>
<thead>
<tr>
<th>Type of Feedback</th>
<th>N</th>
<th>Unit 5 Pretest (out of 10)</th>
<th>Unit 5 Posttest (out of 10)</th>
<th>MG</th>
<th>SDG</th>
<th>ES</th>
<th>Growth Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal only</td>
<td>14</td>
<td>2.93</td>
<td>1.44</td>
<td>6.64</td>
<td>1.55</td>
<td>3.71</td>
<td>1.73</td>
</tr>
<tr>
<td>Task</td>
<td>15</td>
<td>2.46</td>
<td>1.19</td>
<td>7.00</td>
<td>1.93</td>
<td>4.54</td>
<td>2.45</td>
</tr>
<tr>
<td>Process</td>
<td>11</td>
<td>2.83</td>
<td>1.25</td>
<td>6.36</td>
<td>1.29</td>
<td>3.54</td>
<td>1.64</td>
</tr>
</tbody>
</table>

Note: M = mean (average of each class period’s pre/posttest scores); SD = standard deviation (of each classes’ pre/post test scores); MG = mean growth (average growth from pretest to posttest); SDG = standard deviation growth (between pretest and posttest); ES = effect size (magnitude of the difference between the verbal-only group and the other two groups).
The results from this portion of the study seem to indicate that process feedback provided to students on their exit slips did not appear to give them an advantage over students who received task feedback. Given the minimal differences in growth among the three classes, more research over a longer period of time may be needed. Additional research may help provide more clarity on whether or not a certain level of feedback provided to students may give them an advantage over students who receive a different level of feedback.

**Research Question 2**

As mentioned earlier, the students in all three pre-calculus classes were given a three-question survey to complete after they had finished their posttests for both Units 4 and 5. The students were asked to respond to each survey question using a Likert scale that had six different response options. The first question of the survey was written with the intent to answer Research Question 2. The other two survey questions were written to provide the researcher with information on the students’ perceptions regarding the value of exit slips in their learning.

The first survey question asked the students how often they referred to their exit slips when they prepared for the posttest. The range of responses included a 1, which indicated never, and a 6, which indicated very frequently. All the responses between 1 and 6 indicated the frequency based on its proximity to either 1 or 6. Table 5 shows that the students who received task feedback on their exit slips had a higher mean (Task Feedback = 2.71) than did the students who received process feedback (Process Feedback = 2.55) and those who received only verbal feedback (Verbal Feedback = 2.62). Regardless of the differences of
means, just as in Research Question 1, the overall differences were not statistically significant.

<table>
<thead>
<tr>
<th>Survey after Unit 4 Posttest</th>
<th>N</th>
<th>Survey Question 1</th>
<th>Survey Question 2</th>
<th>Survey Question 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Task Feedback</td>
<td>17</td>
<td>2.71</td>
<td>1.36</td>
<td>4.29</td>
</tr>
<tr>
<td>Verbal Feedback</td>
<td>13</td>
<td>2.62</td>
<td>.77</td>
<td>4.31</td>
</tr>
<tr>
<td>Process Feedback</td>
<td>11</td>
<td>2.55</td>
<td>1.37</td>
<td>3.73</td>
</tr>
</tbody>
</table>

(1 = Never, 6 = Very Frequently)

The results of the survey taken after the Unit 5 posttest provided slightly more differences than did the results from the survey after the Unit 4 posttest. As seen in Table 6, the students who received process feedback on their exit slips referred to their exit slips on average almost 1 point more often (Process Feedback = 3.64) than did the students who received task feedback (Task Feedback = 2.69) and just over 1 point more than the students who received only verbal feedback (Verbal Only Feedback = 2.50). Table 6 also indicates more of a difference between the students who received task feedback and the students who received just verbal feedback in comparison to their reference to the exit slips for the posttest in Unit 5 than found in Unit 4. Again, the differences in means was not statistically significant.
Table 6
Survey, Unit 4

<table>
<thead>
<tr>
<th>Survey after Unit 5 Posttest</th>
<th>N</th>
<th>Survey Question 1</th>
<th></th>
<th>Survey Question 2</th>
<th></th>
<th>Survey Question 3</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Task Feedback</td>
<td>16</td>
<td>2.69</td>
<td>1.45</td>
<td>4.19</td>
<td>1.38</td>
<td>4.75</td>
<td>1.24</td>
</tr>
<tr>
<td>Verbal Feedback</td>
<td>14</td>
<td>2.50</td>
<td>1.35</td>
<td>3.93</td>
<td>1.07</td>
<td>4.07</td>
<td>1.21</td>
</tr>
<tr>
<td>Process Feedback</td>
<td>11</td>
<td>3.64</td>
<td>1.29</td>
<td>4.45</td>
<td>.82</td>
<td>4.27</td>
<td>.91</td>
</tr>
</tbody>
</table>

(1 = Never, 6 = Very Frequently)

Additional Survey Data

Questions 2 and 3 of the surveys that followed Units 4 and 5 were not aligned with any research questions for this study; however, they do provide more information regarding the students’ perceptions about the use of exit slips in their classes. For example, Survey Question 2 asked the students how helpful the exit slips were in learning the mathematics concepts for the test. Survey Question 3 asked the students if they believed their teacher should continue to give weekly exit slips. Survey Questions 2 and 3 also used the same Likert scale that had six different response options. The range of responses included a 1, which indicated never, and a 6, which indicated very frequently.

As seen in Tables 5 and 6, there were no significant statistical difference among the three classes for either survey question. However, as seen in the results from Survey Question 1, the class that received process feedback had the lowest mean for Survey Questions 2 and 3 after the Unit 4 posttest but had the highest mean for Survey Question 2 after the Unit 5 posttest. The class that received process feedback had a higher mean for Survey Question 3 than did the class that received only verbal feedback but a lower mean than the class that received task feedback for Unit 5.
Analysis of Qualitative Data

Three separate teacher interviews at different points in the study were conducted by the researcher to gain the teacher’s insight and perspective on the use of exit slips in her three different classes and on the use of various levels of feedback she provided on the exit slips. The qualitative analysis is organized according to three themes that align with Research Question 3. The three themes are (1) What can a high school mathematics teacher learn from the process of using exit slips over time?, (2) How does the use of exit slips inform her subsequent instruction?, and (3) How does a high school mathematics teacher utilize exit slips, using both process and task feedback? These data provided findings to answer Research Question 3.

Learn from the Process

In the third interview, Jen indicated that she had determined that the students’ level of motivation played a major role in their use of the exit slips. She said, “Motivated students see value in it. Nonmotivated students do not see value in anything. Motivated students see it as a tool of preparation with nothing to lose” (Interview, December 14, 2016). Jen indicated that the students who were not motivated probably would not have seen value in anything she would have provided them, and as a teacher, she would never know if an intervention worked because of their resistance to working in the class.

Jen did not sense that any of the three classes became reliant on the level of feedback provided to them because it was the same for each class for both units. However, she indicated that had she changed the level of feedback she provided them from week to week or
exit slip to exit slip, a class may have shown a preference for one level of feedback. Because Jen kept the level of feedback the same for each class throughout the study, the students never noticed or experienced a change in the level of feedback they received. For example, she said,

I think I would have noticed more complaining, if they were crying out saying, “Yesterday you gave me so much detail, and today you did not.” I think that would be a noticeable difference, but because it wasn’t changing from day to day, it was more consistent. (Interview, January 13, 2017)

Therefore, Jen indicated that the students who received process feedback may have made comments to her about the level of feedback they were receiving if she had, one week, given them task feedback and another week just given them verbal feedback. She believed the students would have complained about how much feedback they were getting in comparison to a previous exit slip they had received with process feedback.

Jen indicated that she did not believe that providing process feedback on the exit slips gave students a distinct advantage over the students who received task feedback on their exit slips or the students who only received verbal feedback. She said,

Based on what I see from my class with these students and looking at their test scores and their homework scores, I look at all those components of their performance of daily work, and I wouldn’t say that process feedback made a substantial difference. (Interview, January 13, 2017)

Therefore, she believed other factors may have had a similar or equal influence on student performance. For example, she talked about the time of day the students had her class and that its proximity to lunch may have affected their attitude and performance in her class. She also spoke about the various classes’ homework average and what effect that had on the students’ overall performance by saying,
I look at the homework grades for the classes, and that’s just, I guess I have more of an overall perspective of what’s really going into this learning process, something that I’ve known, but it’s really kind of making it more clear to me. I don’t know. I would say, like, for the class that’s receiving process feedback, I believe, I don’t have hard numbers in my head, but I believe they have the lowest homework average. And that low, I’m giving them the most descriptive feedback, and I’m also noticing that they have lower quiz scores. (December 14, 2016)

She pointed out that the students who received process feedback on their exit slips had the lowest homework completion average as well as the lowest mean posttest scores for both units of the three classes. Therefore, as mentioned earlier, Jen pointed out that student motivation may have been a factor in the overall student achievement and could have been a factor in homework completion.

Although Jen did not believe that providing students with process feedback on exit slips gave them a distinct advantage over receiving other levels of feedback, she did believe that providing the students with process feedback is important because certain characteristics and components make up a math problem. She stated,

I don’t know if it’s enough to say if it’s right or it’s wrong. I want students to know, these are the parts of the process that you have to include for it to be right. There are certain characteristics or certain components, especially looking at a math problem, certain components that kind of have to be there to go from the start to the finish. (Interview, January 13, 2017)

She believed that from the start to the finish, students need to connect various steps that are part of solving a math problem. Jen believed that students need to know more than if a problem is right or wrong, as is provided through task feedback. In addition, she believed that students need something from the teacher to refer to later, which would not be provided with verbal feedback. However, she pointed out that it is a matter of what the students do with that feedback. In other words, do the students keep their exit slips and refer to them as a study
tool, or do they throw them away immediately after they receive them? The value of the feedback is lost if the students do not utilize the feedback on the exit slip as a study tool as part of their learning process.

With that said, she believed that the students need to take ownership of the exit slips. To do that, Jen said, they need to possess the necessary skills on how to use feedback on the exit slips. She mentioned that teachers should first model how to use feedback on exit slips with their classes so the students have an example to refer to and can maximize their value in their learning. This point, made by Jen, is supported by Sadler (1998), who believes that students should be taught ways in which to use feedback and that it should not be assumed that they know what to do with feedback when they receive it. Perhaps the most critical thing that Jen learned from this process was that teachers should first establish the reasons for using exit slips in their classes. Jen cautioned teachers by saying,

I would encourage them to think about why they’re using exit slips. Some teachers use it as just a way to fill a couple extra minutes, but what’s the goal? What are you hoping to accomplish with it? Is it a matter of getting feedback? Is it a matter of just formative assessment? (Interview, January 13, 2017)

Additionally, she pointed out that teachers need to leave time at the end of class to administer exit slips and time at the beginning of class the next day to go over them. If it is to be used as a formative assessment, teachers should determine if they want to provide the students feedback, or if they want feedback from the students for themselves, or both. For Jen, it was about letting the students know where they were at on the continuum. She also acknowledged that the purpose of the exit slips could change from unit to unit or day to day, but she believed
that a consistent purpose would provide more benefit to the students because they would know what to expect.

When students know what to expect and how to utilize the exit slips, Jen believed that teachers should pick and choose situations in which they may give a certain level of feedback on exit slips to encourage the students to invest more effort into them. Again, although she believed that process feedback, when utilized to its capacity, is most beneficial to students in math, she also believes that students can become reliant on process feedback and expect teachers to always provide them with that amount of feedback. Jen believed that sometimes students should have to put in the time and effort to determine what additional feedback they need to pursue to understand a concept. Therefore, Jen stated that if students understand how to utilize the other forms of feedback, they will be able to maximize the feedback they receive from exit slips regardless of the level.

Inform Instruction

Jen stated that the exit slips provided her with a great deal of information. For example, the exit slips allowed her to see common mistakes made by the students that she could address in future lessons. “Instead of starting from scratch each time, we were able to kind of go back and say, this is the connection. Here is the missing piece between what you have done and what you needed to do, taking it one step further” (Interview, January 13, 2017). She was able to address specific issues as they related to each class’s needs. This allowed her to make the most of her lessons because she was targeting student learning needs as opposed to just staying on pace with the syllabus, for which it could be two or three weeks
before she had a truly good idea of the students’ level of understanding of the content that was taught. In other words, each class received specific instruction rather than all of them getting the same instruction. This had been her common practice in the past because all three classes were at the same level.

Giving students process feedback on their exit slips gave her a chance to provide personalized instruction for each individual student because she could write specific comments on what he/she needed to do improve and learn. However, with task feedback Jen pointed out,

There wasn’t as much of that support in mind. Without having that guide, we’d spend a lot of time saying, okay, let’s try that again. Let’s maybe look at it in a slightly different context. Students with verbal feedback, as far as having kind of like a reference using that as a resource in the class, unless they were taking notes when we went through it as a group. (Interview, January 13, 2017)

The students who received process feedback on their exit slips could refer to them and draw connections to things they had learned previously. Jen believed that, regardless of the level of feedback the students received on their exit slips, the exit slips gave the students something to look back at and something she could consistently remind them of in every lesson she taught.

Jen believed that one thing she would do differently in the future would be sometimes to use part of her independent practice time as a time for students to look at the individual errors on their exit slips and correct them on their own, regardless of what level of feedback she had given them and instead of just time to work on their homework. In other words, she would expect the students to utilize the task or process feedback they had on their exit slips and to develop their understanding of the concept assessed on the exit slip. She said that she would not give them any verbal feedback when she would do this. Jen believed this method
would help develop metacognition skills because students would have to work purely with the feedback they had on their exit slips, without additional verbal feedback to add to it.

**Utilization of Process and Task Feedback**

Until this point, the information related to Jen’s experience dealt with students receiving feedback for problems that they answered incorrectly on their exit slips. Jen reiterated in the interviews that feedback was provided to students on their exit slips for problems that they also answered correctly. For example, one concern that Jen had about the use of task feedback was a student who had an answer correct but did not really comprehend how he or she had arrived at that correct answer. However, the class that received process feedback always received feedback on what they did correctly in a problem. Therefore, those students could review their exit slips later as examples of how those particular problems should be solved.

In addition, Jen expressed that she was frustrated with providing one class with only task feedback because, she said, “I want to tell them why they are wrong” (December 14, 2016). She believed that not telling them why something was wrong could be detrimental to some students’ development in learning the math material on the exit slips. She mentioned that some of those students did not know what steps they should take to learn about what they did wrong. However, she said that she believed that the students she gave process feedback could learn from their mistakes because the specific feedback they received showed them what they needed to do differently to answer the questions correctly. In other words, Jen believed that the students were not only able to learn from their mistakes on the exit slips with
the process feedback but that they were more likely not to make those same mistakes again. She did not believe this was the case with the students who received task feedback. However, the data from the study does not support Jen’s opinion about students learning from their mistakes because the class that received process feedback had shown the lowest or second lowest growth among the three classes.

According to Jen, the class that received only verbal feedback appeared to take more notes on their exit slips when she went over them at the beginning of class than the classes that also received either process or task feedback. She said,

I believe I saw students taking more notes and making more corrections on their exit slips from the verbal feedback group than either of the task or process. I do not know if they actually looked back them or not, but they did do more on their end to have some resource to look back at later on than the other two groups. (Interview, January 13, 2017)

Jen believed that the class that only received verbal feedback appeared more invested in their exit slips because of the additional work they would have to do by writing the feedback down to refer to it later. Jen mentioned that, in a perfect world, the students would take notes on their exit slips as they did for verbal feedback, regardless of the type of feedback they received on their exit slip. In other words, the students who received task feedback would want to have an explanation for the correct or incorrect way to solve a problem, and the students who received process feedback would seek more information about how to implement the feedback they received on their exit slip.

Jen believed ultimately that the best level of feedback to provide students on an exit slip would be a hybrid of task and process feedback. In other words, she would tell them if their answer was right or wrong, but instead of providing specific feedback on how they could
correct their answers, she would provide them with feedback that pointed out what they did right or wrong within the problem. She believed that this would help the students draw a connection to where they made a mistake within the problem. For example, the students may have correctly answered the first steps to a problem but somewhere missed a subsequent step, thereby resulting in an incorrect answer. This would help the students determine where they went wrong as they tried to solve the problem on the exit slip. Therefore, this hybrid level of feedback would prevent the teacher from just saying to the students that they were right or wrong on the exit-slip question or, more specifically, how to correct the problem. Instead, it would provide the students with enough information to know they still had work to do to correct their answers. However, the students would know where they went wrong and how they could correct it in the future. Jen believed that a hybrid approach of both task and process feedback would probably cause the students some discomfort in the beginning, but eventually, like any other practice or routine in class, the students would adjust to the expectations and maximize the feedback provided on their exit slips. She again reiterated the importance of the teacher modeling ways in which to use feedback on exit slips to maximize their value.

As mentioned above, Jen indicated that she believed that a hybrid of process and task feedback would be the best level of feedback to provide to students. However, after the researcher reviewed the process exit slips she gave students, he found that she may have inadvertently provided the students with a hybrid version of process and task feedback, rather than the strictly process feedback as defined by Hattie and Timperley (2007). For example, as shown in Figure 2, Jen provided the student with task feedback in the form of checkmarks
indicating “correct.” She also provided process feedback, in describing what needed to be done to answer the questions correctly. However, the student was still responsible for applying the feedback to correct the problem. Figure 3 shows that Jen provided only task feedback in the form of checks and x’s, indicating “correct” and “incorrect.” Therefore, the feedback in Figure 2 has more detail in it than the feedback found in Figure 3.

In addition, the feedback in Figure 2 does not specifically explain how to use “trig ratios” to find side lengths. Had Jen provided the student with an explanation of how to use “trig ratios,” it would appear to align more with Hattie and Timperley’s (2007) definition of process feedback. With that said, as shown in Figure 2, Jen may have believed that informing a student to use “trig ratios” would not require an explanation and that her comment itself was
providing the student with process feedback because the student would understand how to proceed with no further explanation. Further research is needed to establish more clearly what a hybrid level of feedback would look like in mathematics classes.

Figure 3. Exit Slip with Task Feedback

Summary

As mentioned earlier, Jen believed that student motivation might play a major role in the success of students’ use of exit slips. Ultimately, the exit slips provided the students with information about their learning at a specific point in the unit they are studying. Jen pointed out that the students must utilize the exit slips to gain any benefit from them other than just being exposed to them. She suggested that when students took ownership of their exit slips, they were more likely to refer to them and use them to learn. She mentioned that teachers
need to model how students can utilize feedback provided on an exit slip to maximize their value.

Jen expressed frustration when providing only task feedback for one class because she could not elaborate in any detail why students had an answer correct or incorrect. Jen thought that she was helping the students learn and grow when she was able to provide process feedback, but she also did not want to do all the work for them. Therefore, she mentioned that she thought a hybrid of task and process feedback would be the best form of feedback. However, as explained previously, Jen may have provided the students with a hybrid version of feedback when attempting to provide process feedback on the exit slips.

Although the students who received process feedback had the lowest mean for both posttests, the value of process feedback cannot be underestimated, based on Jen’s comments and the data from Survey Question 2 from Unit 5. For example, the students who received process feedback appeared to see that the exit slips had value to them, as demonstrated by how likely they were to refer to them in preparation for the Unit 5 posttest. All the quantitative data should be viewed with caution because of the small sample of students in the study and the number of opportunities to assess the students. Therefore, the next chapter discusses what the data mean and how they relate to literature on the use of feedback and exit slips.
CHAPTER 5

DISCUSSION

Introduction

The purpose of this study was to examine whether providing process feedback on exit slips for students in a pre-calculus class would help increase their learning growth in comparison to students receiving task feedback or just verbal feedback. The study used two pretests from two different units of study as benchmarks to compare growth from each class on two corresponding posttests. In addition, the study examined how frequently students referred to their exit slips in preparation for the posttests they took. Finally, this study examined the perceptions of the teacher of the pre-calculus classes regarding the use of exit slips and the ways in which she utilized them to inform her instruction when providing students with various levels of feedback.

A mixed-methods approach was used to collect quantitative and qualitative data. The data were analyzed to answer the three research questions. This chapter presents observations generated by the integration of the quantitative and qualitative portions of the study to provide insights as they relate to each research question. Therefore, this chapter presents the integration of mixed methods, important findings, factors that may have influenced the results, recommendations for future research, relationship to past literature, recommendations to mathematics teachers, and final thoughts from the researcher.
Integration of Mixed-Methods Data

The first research question addressed in this study was prompted by a need to determine whether a certain level of feedback provided to students on exit slips would have the potential to increase learning more than another level of feedback. Results were generated by comparing the growth from the students’ pretest and posttest scores. It was decided that at least two units of study would be used to compare the various levels of feedback given to the three pre-calculus classes. The units of study were each approximately three weeks long, and the teacher provided the students with exit slips twice a week. It was important for the teacher to provide each class one consistently designated level of feedback for both units of study.

The second research question was prompted by the need to determine how frequently students would refer to their exit slips in their preparation for the posttests. In addition, this was prompted by the need to determine if students referred to exit slips with a certain level feedback on them more often than to those of other levels. The survey was stapled to the students’ posttests to gather their thoughts as they had just finished them. The rationale for stapling the survey to the posttests was that it was more likely that the students would have studied for the posttests fairly recently, so their memory of what they used in their preparation would be fresh in their minds. A Likert scale was used to quantify a class mean based on the students’ perceptions of the level of feedback on exit slips. Although the remaining two questions on the Likert-scale survey did not relate directly to the second research question, they did ask the students about their perceptions of the use of exit slips, and the data can supplement the first survey question.
The third research question was prompted by the need to understand the teacher’s perspective. Because she provided various levels of feedback on the exit slips, it was critical to gain insight into her thoughts and opinions on the use of exit slips and the various levels of feedback she provided on them. In other words, the teacher’s opinions could hold the most weight because she represented a perspective that went beyond the test scores and means of growth. Her thoughts and opinions represent the practicality of the use of exit slips in a classroom and whether a certain level of feedback was perceived to be more helpful to students than others. With such information, teachers may deem the findings to be something worth trying in their classes. Therefore, the teacher’s thoughts and opinions from three separate interviews provided details beyond what the quantitative data could provide.

Data should be taken at face value as pure numbers can be deceiving because, ultimately, circumstances that may have had some influence on the data collected are not reflected. The teacher’s thoughts and opinions provided insight into student behavior that could have had an influence on the data. For example, as mentioned in Chapter 4, the teacher believed that student motivation and homework completion played a major role in student success. She mentioned that the class that received process feedback had the lowest level of homework completion and they had the lowest posttest mean scores. Such information can provide more insight and understanding about the numbers behind the data and what should be considered when reviewing it.
Important Findings

As mentioned previously in Chapter 4, the data from this study should be treated with caution due to the number of participants and the length of the study. Statistically there were no significant differences found among the three classes when assessing growth scores. However, the effect size of the difference between the task feedback and verbal feedback groups was of medium size (ES = .70). Again, small sample sizes could account for nonsignificant results in the ANOVA, but interpreting effect size is of some practical value. It is possible that with larger sample sizes in a future study, significant group differences might emerge.

The importance of these results is that the class that received task feedback was told only whether their answers for a problem on an exit slip were correct or wrong. Otherwise, they received no other feedback on their exit slips. They also, similar to the students in the other classes, received verbal feedback, so they could have had a slight advantage over the class that received only verbal feedback because their exit slips were not marked with any feedback. However, the students who received process feedback were given details about the way they answered the problems on the exit slips, so they could have insight into what they did well and what they needed to correct. It would appear that the students who received process feedback would have an advantage over the students who received task feedback because of the amount of detail provided to them on their exit slips.

As mentioned in Chapter 4, the results are very similar for Unit 5. It is also important to point out that the students who received process feedback did not emerge on the Unit 5 posttest with the most growth, despite having been able to take advantage of previous
experience with process feedback on exit slips with Unit 4. In other words, it may be possible to explain that because the students did not have prior experience with process feedback in Unit 4, they might not have known how to maximize it. However, prior to the start of Unit 5, they had already experienced process feedback on exit slips on six different occasions and had a posttest. In addition, the students had received 12 exit slips when they took the Unit 5 posttest and the survey that followed the posttest. In other words, the students had more time to work with exit slips to see how they could use them after Unit 5 than when they took the survey after Unit 4. Therefore, the students who had received process feedback on their exit slips had some experience with process feedback from Unit 4 to learn from for Unit 5 and still had a lower effect size (.10) than the students who received task feedback (.48).

In the second interview (December 14, 2016), Jen stated her opinions about student motivation and the ways in which students’ motivational level may affect their view of feedback on exit slips. The theoretical framework presented in Chapter 2 discussed self-regulation and Brookhart’s (2008) opinion that self-regulation plays a role in the students’ control of their learning. In other words, Brookhart (2008) points out that through self-regulation, students determine if they want accept help such as feedback on an exit slip.

Tang (2013) also states that self-regulation is the students’ ability to exhibit control over learning contexts to maximize their academic success. Because exit slips are a resource and not an assignment that has points assigned to it, students must determine if they are willing to put in the time to review them to learn and maximize their purpose. Brookhart (2008) found that students who lack self-regulation do not have the confidence or self-discipline to face or deal with constructive feedback. Again, this point is reinforced by
Schunk’s (1991) belief that students’ mathematics self-efficacy can determine the confidence level of their ability to learn what is taught to them in mathematics. In other words, student motivation and self-efficacy can possibly have an important influence over whether students choose to value the feedback provided to them on exit slips. Berger and Karabenick (2011) support this point, as noted in Chapter 2, through their study of 306 ninth-graders, in which they concluded that students’ self-confidence in mathematics is the best predictor of their use of learning strategies. Therefore, as Jen stated in the second interview (Interview, December 14, 2016), she believed that nonmotivated students do not see value in anything that could help them in the learning process and will not utilize help provided to them.

In Chapter 2, it was mentioned that Pintrich and Zusho (2002) and Zimmerman (2000) state that students who value a task are more likely to utilize strategies to learn. Again, Jen pointed out in the second interview (December 14, 2016) that, in her opinion, motivated students found a value in using the exit slips to learn from. Jen also stated,

I don’t know how much time students spent looking at exit slips outside of the classroom after they were reviewed. Whether they are actually keeping their exit slips, I know I had a lot of students say that yes, they refer back to them. They use them as a study tool, but I also can think of a handful of students that leave them on their desk or they throw them away immediately. (Interview, January 13, 2017)

Although student motivation was not measured in this study, the students were asked a survey question about how often they referred to their exit slips to get some insight on their use of them. As noted earlier, Zimmerman (2000) believes that learning is a personal choice that students decide. Ultimately, the students’ use of the exit slips could be possibly related to their value of them, which reinforces the point made by the studies referenced earlier in Chapter 2 and by Jen on student motivation. Therefore, more research is needed on students’
desire and self-confidence to use learning strategies and what factors might contribute to that desire and self-confidence in learning a subject.

The Likert survey, which had three questions on it, was administered to the students immediately after they took the posttest for both units. The first question, which was directly related to Research Question 2, asked the students how often they referred to their exit slips when they prepared for the posttest. Again, the class that received process feedback had the lowest mean of the three classes for Unit 4 for Survey Question 1. It seems that the additional details the students received on their exit slips would incentivize them to refer to them more than the other two classes who received little or no feedback from their teacher on their exit slips.

In Unit 5, unlike the pretest-to-posttest growth in Unit 4, the class that received process feedback had the highest mean of the three classes for Survey Question 1. It is possible that the students who received process feedback on their exit slips saw that the exit slips provided more value to them in their learning after they had previous experience with them in Unit 4. Although their reference to them did not translate into having more growth, they did refer to them more than did the other classes who again had received less or no feedback on their exit slips. This would seem to support the rationale of providing students with process feedback over other levels of feedback because of their reference to them. As noted earlier, the change in means is not statistically significant in comparison to the other two classes. Therefore, the results of Survey Question 1 leaves an inconclusive answer to Research Question 2.
The teacher’s perspective was a major part of this study because her insight provided the practicality of the use of feedback on exit slips in a math class. Jen brought up that she believed that students need to be taught how to use feedback on exit slips before they are given them. She believed that the students need to see how they can utilize the feedback to help them in their learning. Jen said, “I think that getting them in the habit of knowing that feedback is coming and being able as a teacher to model how to properly use the feedback is crucial” (Interview, December 14, 2016). This is significant because any intervention is only effective if the students can maximize the benefit from it. This point made by Jen may be the reason the students who received process feedback referred more to their exit slips in Unit 5 than in Unit 4; they may have seen the value of the feedback on the exit slips for their learning experiences in Unit 4. In other words, because this study did not require the teacher to show the students how to utilize the exit slips before she gave them to them, they were able to learn how to utilize them only after having had experience with them.

Jen mentioned that she believed that she would like her students to have more feedback on their exit slips than the task feedback provided. However, she also said that she did not always believe that students should get all the details on their exit slips that process feedback gave. In other words, Jen preferred a hybrid of some sort of feedback, consisting of task feedback with the correct or incorrect marking, along with some process feedback that would point the students in the right direction. She believed that she should not provide too much detail on students’ exit slips so they would have to work at determining ways in which to reach the correct answer instead of it being provided to them.
Jen stated that she believed that students would take more ownership of their learning when they had to seek out additional help to better understand the feedback that was provided to them. She said, “The teacher should not do all of the work; the students should have to own their learning” (Interview, January 13, 2017). However, by providing more detail than task feedback, Jen believed that she was giving the students direction on how to proceed as opposed to no direction with just task feedback. For example, she mentioned,

“I still want them to be able to make that connection and to be able to have them think through it but also identify specifically where it went wrong. They have to have at least something to direct their attention to. With task feedback, I was looking at the task overall saying, yes or no, you got it or you did not get it, and I think that is a skill that a lot of students work really hard to achieve. The students do not know where they made their mistake. They do not know that they started correct, and they do not know where they went wrong, and that is a very grey area. (Interview, January 13, 2017)

This insight that Jen gathered through her experiences is significant because she is now able to look at altering her feedback level to help students learn but also to engage them in the process. As mentioned in Chapter 4, Jen may have provided her students with what she described as “hybrid feedback,” instead of what Hattie and Timperley (2007) would have considered to be process feedback.

Jen pointed out that the feedback she received from the exit slips helped her adjust her instruction and personalize it to each class and student. For example, she mentioned that “I was able to provide ways to give more personalized one-on-one learning because of the focus on each individual” (Interview, December 14, 2016). In other words, she could see patterns in the classes as a whole and was able to provide individual students with specific information as
it related to their learning. This is significant to teachers as they attempt to plan their lessons to deliver their required curriculum as they also address specific student needs.

Factors that May Have Influenced Results

The results in this study may have been influenced by factors that were beyond the control of the researcher. For example, more units in which to run the study could have provided more data to analyze and to compare when attempting to answer all three research questions. The researcher was able to secure the teacher’s involvement in the study for only two units of study. Because Unit 4 was the students’ first experience in receiving one level of feedback consistently on exit slips, every unit following Unit 4 would more likely provide a better insight on how the students used and learned from the various levels of feedback because they would have had more experience with exit slips and the levels of feedback that they received on them. Therefore, the number of opportunities to compare the various of levels of feedback was limited to two pretests and posttests, with 12 exit slips per student in between.

As mentioned previously, each class was considered to be at the same ability level, with the only differences being the period of the day they had the class and the number of participants from each class who agreed to participate in the study. Again, because the level of feedback provided to each class was randomly selected by Jen, the period of the day was not considered or thought of as one class having an advantage over the other. The researcher had no control over when the teacher’s classes were offered. As mentioned previously, Jen brought up that the time of day when a class meets could influence its quality of learning; she
stated, “Proximity to the lunch hour could have played into the students’ daily work performance” (Interview, January 13, 2017). In other words, students who have had lunch already may or may not have been as attentive in class as compared to students who had the class at the beginning or the end of the day, when lunch is not likely to be a factor. Again, any given period of the school day can be more conducive for some students to learn over other periods of the day and could have influenced the results.

The size of the study was limited to 42 participants based on the total number of students in the teacher’s pre-calculus classes and the number of students who returned parent permission slips to participate. As mentioned previously, the class sizes were not equal, with the class that received process feedback having 11 students, the class that received task feedback having 17 students, and the class that received only verbal feedback having 14 students. An even number of students in all three classes might have provided an equal comparison in terms of numbers being calculated in the data, and more participants would have provided a deeper sample with which to compare results. Therefore, these factors may have also influenced the calculated means that were presented in the data.

Recommendations for Future Research

The results of the study and the teacher’s perceptions and experiences of the study present the need to pursue additional data based on the number of participants and units used in the study. It would be useful to have several units to compare data from each class receiving task, process, and only verbal feedback. This could provide insight into how each class responded to and utilized the exit slips with the various levels of feedback. The
additional units would also provide more time, which could provide more information on which the teacher could reflect in possible interviews. Finally, it would be useful to have the students’ perceptions of exit slips and feedback in general prior to them receiving anything to compare with their responses to the survey given after the posttests.

Another area that would be useful to research would be the students’ reflection on the feedback they receive. In this study, the students were asked only about the frequency with which they referred to the exit slips in their preparation for the posttests. Perhaps a study that explored students’ perceptions on the value of the feedback they received on the exit slips would provide more insight into which level of feedback they found more helpful to them in their learning and the reasons for these perceptions. A comparison of the students’ perceptions of the various levels of feedback to be compared between their pretest and posttest scores could provide great insight on whether a certain level of feedback could be possibly correlated to student learning and growth.

Based on the results of this study, a future study that is dedicated solely to teacher benefits from using exit slips would be useful for teachers, in order to better understand how feedback on exit slips could inform their instruction. When teachers use this information to improve feedback and instruction, they can see benefits in student learning and growth. Further research could also help show teachers the benefits they can gain from the use of exit slips, an intervention that is simple to implement.
Relationship of the Study to Past Literature

As mentioned earlier, Jen utilized the data she gathered from the students’ exit slips to make adjustments to her instruction to meet each class’s needs, and she used the data to provide individual students with specific feedback as it related to their specific learning needs. Sterrett et al. (2010) stress the importance of math exit slips because they provide teachers and students with data they can use to improve their learning. In other words, Sterrett et al. point out that teachers can use the data they gather from the exit slips to make adjustments to their instruction. This point is supported by Leigh (2012) because she believes that information collected from exit slips should be reviewed so the teacher can determine what supports students still need in subsequent lessons. She believes that the exit slips serve as a source of information for both the students and the teacher. Therefore, Jen’s practice of the utilization of the feedback she received from the students’ exit slips supports Leigh’s (2012) and Sterrett et al.’s previously researched practice on the utilization of data from exit slips to inform subsequent instruction.

Another area of literature that could be compared to the study involves the timing of the feedback. Jen always gave the students feedback on their exit slips the very next class after she administered it to them. Regardless of the level of feedback the students received in this study, they always had an opportunity to review and reflect immediately on their exit slips from the day before. Mason and Bruning (2001) and Chappuis (2012) stress the importance of students receiving feedback quickly to avoid having students go in the wrong direction. This practice is also advocated by Brookhart (2012) and Wiggins (2012), as they both promote the idea that students should have the opportunity to reflect on and utilize
feedback on future assessments to maximize its relevance and value to them. By providing feedback to students on their exit slips the day after they solved them, Jen was also supporting the research on the timing of feedback as she was committed to giving the students feedback on their exit slips as soon as she was able.

As mentioned in Chapter 2, Hattie (2008) conducted a synthesis of over 800 studies involving various interventions and found feedback to have a .73 effect size on student learning. As mentioned in Chapter 4, Hattie (2008) determined that any intervention with an effect size above .40 would be considered better than average in its ability to influence student growth. However, Hattie’s research does not pinpoint which level or levels of feedback were used to create an effect size of .73 for feedback. Therefore, there is no way to determine without more research on which level of feedback might influence student growth more than any other one.

Besides some similar practices to other studies, the researcher was unable to find other studies that matched all three research questions in this study. In addition, the researcher was unable to find any studies on feedback in mathematics classrooms at the high school level except for Berger and Karabenick (2011) and Kramarski and Zeichner’s (2001). Kramarski and Zeichner’s (2001) study involved 11th-graders from Israel who received one of two different types of computerized mathematics feedback.

This study is probably the most similar to the current study because the students in Kramarski and Zeichner’s (2001) study received either result-oriented feedback or metacognitive feedback. According to Kramarski and Zeichner (2001), result feedback provides students with general feedback, and metacognitive feedback provides students more
specific feedback. In Kramarski and Zeichner’s study, it would appear that result feedback would possibly resemble task feedback and metacognitive feedback would resemble process feedback, even though both types of feedback were computerized. The results of Kramarski and Zeichner’s study show that the students who received metacognitive feedback performed better on the posttest, which would not be supported by the current study, in which the class that received task feedback both performed better on the posttests and showed the most growth from the pretests.

Although this researcher was unaware of any studies that would match the current study, it is clear that there are aspects of various studies to which it can be compared. However, given the sample size and the length of time of the current study, it does not appear to be accurate to compare the results of this study in a way that could either support or refute the findings of other studies with a high degree of confidence. The current study has created a need for more research that would not only follow up on the reported results but also on how it would compare to similar studies to better report more conclusive results.

Recommendations for High School Mathematics Teachers

This study provided several opportunities for Jen to learn and grow as a teacher from the various experiences of providing various levels of exit slips to students for two units of study. These recommendations are a summary of all the key points that Jen learned through her experiences, which were stated previously. To begin, teachers should first establish their reasons for using exit slips in their classes. Jen said,
Some teachers use it as just a way to fill a couple extra minutes, but what’s the goal? What are you hoping to accomplish with it? Is it a matter of getting feedback? Is it a matter of just formative assessment? You’re using it for your own benefit. I know for me, it’s much more letting the students know where they’re at on this continuum, but I would encourage teachers to think about what that looks like for them and their students, and that’s, of course, something that might change from day to day or from unit to unit, too, or class to class, or student to student. So there’s a lot of variations with that. (Interview, January 13, 2017)

Teachers need to leave time at the end of class to administer exit slips and time at the beginning of class the next day to review them. If it is to be used as a formative assessment, teachers should determine whether they want to provide the students feedback, want feedback from the students for themselves, or both. Teachers should have a consistent purpose for their use of exit slips as this would provide more benefit to the students because they would know what to expect from them.

Teachers should first model ways in which to use feedback on exit slips for their classes so that the students have an example to refer to and can maximize their value in their learning. Sadler (1998) supports this point by writing that teachers should not assume that students know how to use feedback and should teach students how to use it. More specifically, Sadler states that students should be taught how to make connections between the feedback and class content so that they can apply the feedback to future learning. In other words, if students understand the feedback they have received, they can apply it immediately to their learning. Therefore, by understanding how to use exit slips, students can have the necessary skills to be able to utilize the feedback provided to them to help them in their learning.
The value of the feedback is lost if the students do not know how to utilize the feedback on the exit slip as a study tool as part of their learning process. Jen believed that when students know what to expect and how to utilize the exit slips, teachers should pick and choose situations in which they may give a certain level of feedback on exit slips to encourage the students to invest more effort in them. With that said, she believed that students need to take ownership of the exit slips. Sometimes students should have to put in the time and effort to determine what additional feedback they need to pursue to understand a concept. When students take more ownership of their exit slips, they have to seek out additional help to better understand the feedback that is provided to them.

Finally, the most important recommendation from this study was that Jen utilized the information she received from the exit slips to adapt and change her instruction based on each class’s needs. The information from the exit slips helped her to personalize each class based on those learning needs so that she was better able to address gaps or issues as opposed to providing them all the same exact lesson as she may have done in the past. In addition, the exit slips helped Jen know more quickly when students did not understand a key concept and be able to reteach the concept before moving on to subsequent content. In that way, she utilized her instruction time more efficiently. In the past, she might have found out halfway through the next lesson, or even a day or two after a lesson, that her students did not understand a key concept. Because, in mathematics, each concept builds upon the previous concepts, it is imperative that students fully grasp current content before moving on to the next.
In addition, one specific system in which exit slips could benefit teachers is a standards-based grading evaluation system. Standards-based grading is often associated with academic expectations that indicate mastery of material (Hamilton, Stecher, & Yuan, 2008). In essence, students must demonstrate what they have learned on summative assessments in order to progress to the next level of curriculum. Therefore, individual practice, such as homework, is no longer relevant in the assessment of students, because they are evaluated only by their ability to demonstrate mastery of an objective. In standards-based grading, homework does not count in students’ final grades (Abud, 2013). Therefore, if a teacher is in a system of standards-based grading, he/she determines student grades solely on mastery of objectives. Teachers in this type of system would benefit from using exit slips because they provide a simple and quick way to provide students with formative feedback and then tailor instruction to help the students gain mastery of the objectives.

Final Thoughts

Two very important points have been mentioned previously in this study, but the researcher believes that they deserve to be acknowledged again because they could be used as a foundation for future research. To begin with, Jen mentioned that she was not comfortable providing the students with task feedback because it did not explain to them what was wrong or right on their problem. However, she also believed that sometimes providing students with process feedback might give them too much feedback and did not ask them to work as hard as she believes they need to work in the learning process. Therefore, she believed that a hybrid of task and process feedback---one that provided the students with
feedback that consisted of more than merely whether the student answered the problem correctly or incorrectly but less than what they did wrong and the exact steps they need to do to correct the problem---would be more beneficial. In other words, she believed in providing the students with feedback that told them what they did right, where they may have gone wrong, and how they could go about learning to correct their mistakes on any given mathematics problem. Jen believed that giving students that level of feedback would both inform them and encourage them to take ownership of their learning. Therefore, the students would believe that they had a sense of direction and that they were empowered in their personal learning. As noted previously, Jen appeared to provide her students with something that more closely resembled what she called "hybrid feedback," as opposed to what Hattie and Timperley (2007) refer to as "process feedback." This concept of hybrid feedback requires more research to determine the ways in which it differs from Hattie and Timperley’s definition of process feedback and the ways in which the provision of hybrid, process, and task feedback affects student learning.

The other very important point from this study was seeing that the students who received process feedback showed that they referred to their exit slips in preparation for the posttest more often than did the other two classes on the survey after the Unit 5 posttest, despite having the lowest mean of the three classes on Survey Question 1 after the Unit 4 posttest. The important point that could be a basis for further research is that the students who received process feedback may have discovered the value of the feedback they were receiving and chose to refer to it more often because they saw its purpose for them. In other words, this point could be related to Jen’s point of ensuring that students understand how to utilize exit
slips before they are given them. Although the class that received process feedback did not show more growth than the class that received task feedback, it is possible, over a longer period of time, that the students might have grown more and surpassed the class who received task feedback because they were utilizing the feedback they received more often in their learning. Again, more research would be required to investigate this point to see if it is something teachers should consider when providing their students feedback on exit slips.

The premise of this study was based on the need to find successful interventions that can be applied in high school. High school teachers, unlike their counterparts at the lower grade levels, often have more students over less time in a day, due to the number of periods in a typical school day. Teachers are often faced with the challenge to find interventions that are practical enough that they can be utilized in one class period for an entire class of students. The quest to find successful interventions is a never-ending process for teachers. Teachers at all levels in high school face the daily challenges of finding ways to help their students learn and reach their fullest potential. What may work for one student may not always work for another student. Therefore, this study was about trying to provide some insight into potential interventions that are practical enough to be used at the high school level.

One of the challenges of this study was that the researcher could not find any studies done on the use of feedback using exit slips in higher-level math classes in a high school classroom. In fact, there have been few studies done on the use exit slips at all. With that said, there were not really any models or example studies to follow up on to try to replicate for this study. Therefore, this study can provide some insight on the concept of utilizing feedback on exit slips for high school math teachers and teachers of other disciplines as well.
Although there are many factors that could have influenced the results of this study, as were discussed earlier; also, significant findings were presented as well. As with any research study, there is always a need to follow-up to learn more, and this study was no exception to that, but it did provide some insight that can be used by high school teachers in the future. For example, research on formative assessment has stated that one of the advantages of formative assessment is that it provides both the student and teacher information on the learning process. This study further supported that point as Jen used the information she gathered from the exit slips to adjust her instruction for each class. In addition, the students could see how well they were doing by taking exit slips twice a week. The major difference in this study was, of course, the level of feedback they received on the exit slips. However, Jen discovered a new level of feedback from her experiences. She found a level that was not process feedback nor was it task feedback but a mixture or hybrid of the two. This discovery could be something for teachers to explore and contemplate in their classes if they choose to use exit slips or some other type of formative assessment when they provide feedback to their students.

Teachers are not hired to be magicians, but they are charged with the task of helping their students learn, even when that task seems insurmountable. Many factors play a part in how students learn. However, this study could be used as a baseline to explore further the use of various levels of feedback on exit slips, and it could provide insight into some of the variables that may have influenced the results. For example, before teachers use exit slips, they may choose to teach students how to utilize exit slips for their maximum value. This
could help students potentially benefit from exit slips immediately upon the implementation of them.

Students bring variables that are part of their daily lives that effect their learning capacity. Although teachers cannot control all the variables in their students’ lives, they can be aware of and sensitive to students’ levels of motivation and try to address them with the interventions they use. Although this study did not find a magic intervention, it did provide insight not only about ways to help students learn but also about exposed factors that may need to be considered when choosing an intervention option. Often, interventions are explained and described to teachers for what they could potentially accomplish, but they are rarely explained by emphasizing factors that should be considered prior to using them. Therefore, this study is one that can be used not only as a baseline for future studies but as a practical one that high school teachers can review and utilize without having to have certain materials or professional development to try. In other words, this study is a practical one that all high school teachers can review as an implement with their students immediately after reading about it. This researcher can state, as an educator of over 20 years, that practical interventions are often the only ones that are actually used beyond a study and in a classroom to help students learn.
REFERENCES


APPENDICES
APPENDIX A

TEACHER INTERVIEW 1: QUESTIONS
1. Please briefly describe your philosophy of teaching mathematics.

2. What do you think was most significant about what you read, in preparation for this study?
   
   2a. Why was this important to you?

3. What did you know about task and process feedback, prior to reading about it for the purpose of this study?

4. What are your expectations for the students in your pre-calculus classes?
   
   4a. How will you know if they have met them?

5. What do you think about when it comes to using exit slips with your pre-calculus classes?
   
   5a. What do you anticipate being the benefits to your students?

6. What challenges do you see in implementing exit slips for this study?

7. How do you determine success in your classroom?

8. How do you motivate students in mathematics class?

9. How do you differentiate instruction in your classroom?
APPENDIX B

TEACHER INTERVIEW 2: QUESTIONS
1. How have you prepared the students to utilize the feedback you have given them on their exit slips?

2. What have learned so far about your pre-calculus students?

3. How have you adjusted your instructional preparation for your pre-calculus classes?

4. How have you adjusted your pedagogy based on the feedback you have received from the students on their exit slips?

5. Select an exit slip on which you gave the student task feedback and one on which you gave the student process feedback. Would you please describe each student’s work and why you decided on what you wrote in the feedback?

6. What are your most significant challenges in the various uses of exit slips in the three classes?

7. What is working and what is not working?
APPENDIX C

TEACHER INTERVIEW 3: QUESTIONS
1. How have you adjusted your instructional preparation for your pre-calculus classes because of using exit slips based on what you have learned from working with students who received process feedback on exit slips?

   **1a. Based on what you have learned from working with students who received task feedback?**

   **1B. Based on what you have learned from working with students who received verbal feedback?**

2. How has your approach to using the exit slips changed over time?

   **2a. What motivated this change?**

3. In your view, did process feedback make a difference on how the students performed on their daily work?

4. Could you describe the most important thing you learned from this experience?

5. Is there anything you will change about your teaching style or pedagogy due to your participation in this study?

6. Is there something from this experience that stands out to you, that you will always remember?

   **6a. Why was this important to you?**

7. What advice would you give a colleague who is interested in using exit slips in his or her math class?

8. Is there anything you believe that I should know that I did not ask you?
APPENDIX D

SCHOOL ADMINISTRATOR FORM FOR RESEARCH
School Administrator Permission Form for Research

As principal of __________ High School, and on behalf of _______ School District #____, I have given Mitch Berenson permission to conduct the research study described below, and I fully support this opportunity for our high school students.

I understand that __________ High School students will have the opportunity to participate in the research project titled *Levels of Feedback in High School Pre-Calculus*, being conducted by Mitch Berenson, a doctoral student at Northern Illinois University, under the supervision of Faculty Advisor Dr. Stephen Tonks. I have been informed that the purpose of the study is to determine which level of feedback is most helpful for students in a high school pre-calculus class.

I understand that students participating in this study will be asked to complete exit slips and utilize various levels of teacher feedback on those exit slips as a learning strategy. I understand that students will also be asked to complete brief questionnaires about how they utilized the exit slips and teacher feedback as a learning strategy. I also understand that the duration of the study will last for three units in their Fall 2016 pre-calculus class at __________ High School.

I understand that the intended benefits of this study include improving the overall learning and academic achievement for pre-calculus students who participate in this study. I understand that all information gathered during this study will be kept confidential, with respect to maintaining the anonymity of individual student scores, grades, and opinions.

I understand that I can contact Mitch Berenson at [phone number], at any time, if I have any additional questions concerning this study. I also understand that parents/guardians will also be required to give consent for permission for their children/wards to participate in this research study and that participation is voluntary. Their decision whether or not to allow their children/wards to participate will not negatively affect them or their children/wards. Parents and students are also free to withdraw from participation at any time without penalty or prejudice.

I agree to allow __________ High School students to participate in this research study and acknowledge that I have received a copy of this permission form.

Print _________________________________________________________________________
____________________________________________________________________________
__________________________________________________________
Signature of School Principal                     Date
APPENDIX E

TEACHER PARTICIPANT RECRUITMENT FLYER
Levels of Feedback Research Study
Calling Interested Pre-Calculus Teachers

__________ High School students have the opportunity to participate in a research study being conducted by Mitch Berenson, doctoral student at Northern Illinois University, titled:

Levels of Feedback in High School Pre-Calculus

Looking for a pre-calculus teacher willing to participate in this study by offering various levels of feedback to their students through the use of exit slips, for three units of their 2016 Fall Pre-Calculus classes at _________ High School.

The purpose of the study is to determine which level of feedback is most helpful for students in a high school pre-calculus class. The intended benefits of this study include improving the overall learning and academic achievement for pre-calculus students that participate in this study.

Students participating in this study will:

- Take a pretest and posttest for each unit and allow the researcher to view their scores, in order to explore how the various levels of feedback assisted their learning.
- Complete exit slips and utilize various levels of teacher feedback on the exit slips as a learning strategy.
- Complete brief survey questions about how they utilized the exit slips and teacher feedback as a learning strategy.

The teacher participating in this study will:

- Receive training about study related topics and instructional strategies.
- Participate in three interviews with the researcher.
- Administer a pretest and posttest for each unit included in the study.
- Administer exit slips to the students, twice weekly.
- Provide various levels of feedback to students on their exit slip responses.
- Include brief survey questions for students on unit assessments.

All information gathered during this study will be kept confidential, with respect to maintaining the anonymity of the teacher and the individual student scores, grades, and opinions.

Contact Mitch Berenson at [phone number] or [email address] if interested in participating in this research study.
APPENDIX F

TEACHER PARTICIPANT CONSENT FORM
I agree to participate in the research project, *Levels of Feedback*, being conducted by Mitch Berenson, a doctoral student from Northern Illinois University. I have been informed that the purpose of the study is to determine which level of feedback is most helpful to students in a high school pre-calculus class.

I understand that if I agree to participate in this study, I will be asked to complete the following tasks. I will administer exit slips to each of my three pre-calculus classes twice a week, for approximately eight weeks. For all three classes, I will go over the correct answers to the exit slips, the day after they are administered. For one class, I will provide process-level feedback on the students’ exit slips. For another class, I will provide task-level feedback on the students’ exit slips. For the third class, the students will have to refer to the verbal feedback I provide to the whole class while going over the correct answers to the exit slips on the board. In addition, I will participate in three audiotaped interviews with the researcher at the school I teach for approximately 30 minutes each, a few days before the study, another one four weeks into the study and one last one at the end of the approximate eight week study. I understand that the interviews serve to explore what I learn through the process and how the exit slips inform my instruction, based on using various levels of feedback.

I am aware that my participation is voluntary and may be withdrawn at any time, without penalty or prejudice. I understand that if I have any additional questions concerning this study, I may contact Mitch Berenson at [phone number] or Dr. Stephen Tonks at (815) 753-5497. I also understand that if I would like further information regarding my rights as a research subject, I may contact the Office of Research Compliance at Northern Illinois University at (815) 753-8588.

I understand that the intended benefits of this study include the opportunity for me to learn how different levels of feedback can assist in student learning. I am also aware that this study may contribute to the body of research on different levels of feedback given to students by teachers.

In addition, I understand that the information gathered in this study will be kept confidential by the researcher and at no time will any students’ identities be exposed. I understand that as the teacher of the classes, I will have access to the students’ scores on the pretests and posttests, their exit slip responses, and their responses to the survey questions. In addition, I know that my identity will not be revealed, from the interviews in which I participate.

I understand that my consent to participate in the research project does not constitute a waiver of any legal rights or redress I might have as a result of my participation, and I acknowledge that I have received a copy of this consent form. I am aware that each interview will be audiotaped.

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**Signature & Date for consent to audiotape each interview**

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**Signature & Date for consent to participate in the study**
PERMISSION FORM FOR PARENTS/GUARDIANS OF MINORS

We would like to invite your student to participate in a research study entitled *Levels of Feedback in Secondary Mathematics*, being conducted by Mr. Mitch Berenson, doctoral student in the College of Education at Northern Illinois University. The following paragraphs outline the basic information about the study, and we would like to inform you that all identifying information about your student will be kept strictly confidential.

**Purpose**
The purpose of the study is to explore how various levels of feedback on students’ exit slips assist in their learning. This research project will also explore how often students refer to their exit slips in preparation for summative assessments.

**Procedure**
At the beginning of a math unit, your student will be given a pretest to assess his or her knowledge of the math concepts about to be taught in class over the next few weeks. Your student’s math teacher will record those scores from the pretest and share them with the researcher, for the sole purpose of later comparison to the posttest that your student will take at the end of the math unit. At no time will the level of instruction or type of instruction be different for your student, as the pretests and posttests are part of the current math curriculum. In addition, as part of the current math curriculum, your student will be given exit slips that review currently taught math concepts. The exit slips are a way to provide the students and teacher with feedback on their level of understanding of the current math concepts. The teacher will go over the answers to the exit slips in class on the day after they have been administered. The teacher will provide various levels of feedback to classes, in an attempt to see how the various levels assist in student learning. Your student will be asked to answer three survey multiple-choice style questions at the end of two unit assessments, regarding his or her use of the exit slips in preparation for the unit assessment. To ensure confidentiality, only the researcher and your student’s math teacher will have access to your student’s pretest and posttest scores, his or her completed exit slips, and his or her responses to the survey.

**Risks and Benefits**
There are benefits for the school community where the study will take place. Results will help the teacher in her reflection on various ways to assist with student learning. In addition, the study may influence other teachers’ practices to assist with student learning. Results will not include any identifying data of student participants.

As mentioned above, the level or type of instruction will not be changed. Various levels of feedback will be used by the teacher, in order to see how they assist students in their learning.
Use of Information
Information obtained during this study will be used in the final dissertation, but any information which could identify your student will be kept strictly confidential.

Voluntary Nature of the Study
Participation in this study is voluntary. Your decision whether or not to allow your student to participate, as well as his or her willingness to participate, will not have a negative effect on you or your student. The teacher will still evaluate all of your student's work, and his or her grade will not be affected. Your student will be free to withdraw from participation at any time without penalty or prejudice.

Contact Information and Questions
Any questions about the study should be addressed to Mr. Mitch Berenson by phone at [phone number] or by email at [email address]. If you wish further information regarding your rights or your child's rights as a research subject, you may contact the Office of Research Compliance at Northern Illinois University at (815) 753-8588.

I agree to allow my student to participate in this research study and for school personnel to release my student's pretest and posttest scores, completed exit slips, and responses to the survey to the main researcher, Mitch Berenson. Also, I acknowledge that I have received a copy of this form.

____________________________________________________
I agree to allow my student to participate in this research study and for school personnel to release my student's pretest and posttest scores, completed exit slips, and responses to the survey to the main researcher, Mitch Berenson. Also, I acknowledge that I have received a copy of this form.

Student's Name _______________________________ Parent/Guardian Name _______________________________

Signature of Parent/Guardian _______________________________ Date _______________________________

*Please sign and return one copy of this form to your student's teacher, and keep the other copy for your records. Thank you!
APPENDIX H

STUDENT ASSENT/CONSENT FORM
Levels of Feedback Research Study
(Assent Form for those students under 18 & Consent Form for those students 18 or older)

Hello,

My name is Mr. Berenson, and I am a doctoral student at Northern Illinois University. I am trying to learn how various levels of feedback on your exit slips assist with your learning of math concepts. In addition, I would like to learn how often students refer to their exit slips, in preparation for unit assessments. In order to determine how various levels of feedback assist your learning, I need to be able to view your completed exit slips and compare your unit pretest and posttest scores. I would also greatly appreciate your willingness to answer my survey questions at the end of your units and allow me to view your responses. You will be asked to answer three survey multiple-choice style questions at the end of two unit assessments, regarding your use of the exit slips for your preparation for the unit assessment you completed and how helpful you found them. The survey should take you no more than two minutes to answer.

If you decide to help me out, your exit slips, pretest and posttest scores, and your responses to the survey questions will be compiled as data, for only your teacher and me to review. Other people will not know how you did on the pretests, posttests, and exit slips, or how you answered the survey questions. When I tell other people about my findings, I will not use your name, so no one can tell who I am talking about. All grading will be done by your teacher, and whether you decide to participate or not participate it will not affect your grade.

Your parents or guardians have agreed for you to participate in my study. Now, you may choose if you want to do it. If you don’t want to be in the study, no one will be mad at you. If you want to be in the study now and change your mind later, that’s okay. You can stop at any time.

My telephone number is [phone number], and my e-mail address is [email address]. My dissertation chair, Dr. Stephen Tonks, can be reached at (815) 753-5497 and stonks@niu.edu. You or your parents can call me, if you have questions about the study or if you decide you don’t want to participate anymore. If you wish further information regarding your rights as a research subject, you may contact the Office of Research Compliance at Northern Illinois University at (815) 753-8588.

I will give you a copy of this form, in case you want to ask questions later.

Agreement

I have decided to participate in the study as it is described above, even though I know that I don’t have to. Mr. Berenson and my teacher have answered all of my questions.

______________________________  ______________________________
Name of Study Participant Date

______________________________  ______________________________
Signature of Study Participant Date
APPENDIX I

SAMPLE EXIT SLIPS
Unit 4 Day 1
Exit Slip

a. Convert $110^\circ$ to radians

b. Convert $\frac{3\pi}{7}$ to degrees.

c. Find a positive and a negative co-terminal angle for $207^\circ$.

Name: ____________________
APPENDIX J

EXIT SLIP FEEDBACK SAMPLES
Figure 4. Sample of Process Feedback, Unit 4, Day 8

Figure 5. Sample of Task Feedback, Unit 4, Day 8
Unit 5 Day 5-6 Exit Slip

1. Solve triangle DEF

2. Determine how many triangles exist for the triangle described by $\angle A = 30^\circ$, $a = 7$, and $b = 16$. Then, solve for the triangle(s).

Figure 6. Sample of Process Feedback, Unit 5, Day 5-6

Unit 5 Day 5-6 Exit Slip

1. Solve triangle DEF

2. Determine how many triangles exist for the triangle described by $\angle A = 30^\circ$, $a = 7$, and $b = 16$. Then, solve for the triangle(s).

Figure 7. Sample of Task Feedback, Unit 5, Day 5-6
At the carnival, a Ferris wheel has a radius of 14 m, and it completes one revolution every 16 seconds. The bottom of the Ferris Wheel rests at 1.5 m above ground level. Considering a rider is at the top of the wheel when the stop watch starts, write a sinusoidal function to represent the movement and determine how high above the ground a person will be after a minute and 7 seconds.

Figure 8. Sample of Process Feedback, Unit 4, Day 13
Unit 5 Day 0-1 Exit Slip

#1- Solve the right triangle, if $m \angle C = 90^\circ$, $m \angle B = 37^\circ$, and $AC = 12$. Round all values to the nearest thousandth. Draw a picture to help you!

A telephone pole casts a shadow that is 37 feet long. Find the height of the pole if a bird perched at the top is looking down at an angle of depression of $23^\circ$.

Figure 10. Sample of Process Feedback, Unit 5, Day 1

Unit 5 Day 0-1 Exit Slip

#1- Solve the right triangle, if $m \angle C = 90^\circ$, $m \angle B = 37^\circ$, and $AC = 12$. Round all values to the nearest thousandth. Draw a picture to help you!

A telephone pole casts a shadow that is 37 feet long. Find the height of the pole if a bird perched at the top is looking down at an angle of depression of $23^\circ$.

Figure 11. Sample of Task Feedback, Unit 5, Day 1
APPENDIX K

PRETESTS
7) Identify the period for \( y = 2 \tan \left( \frac{3\pi}{4} x \right) \) \( (4.1.10) \)
   a. \( \frac{3}{4} \)
   b. \( \frac{8}{3} \)
   c. \( \frac{4}{3} \)
   d. \( \frac{2}{3} \)
   e. I do not know how to solve this problem.

8) Antonio's toy boat is bobbing in the water under a dock. The vertical distance (in cm) between the dock and the top of the boat after \( t \) seconds is modeled by \( H(t) = 5 \cos \left( \frac{2\pi}{3} t \right) - 35.5 \) \( (4.1.12) \)

   Find the minimum and maximum heights of the boat.
   a. Min. = 30.5 feet; Max. = 40.5 feet
   b. Min. = 40.5 feet; Max. = 30.5 feet
   c. Min. = 30.5 feet; Max. = 40.5 feet
   d. Min. = 30.5 feet; Max. = 30.5 feet
   e. I do not know how to solve this problem.

9) Which cosine equation is represented below? \( (4.1.11) \)

   ![Graph of a cosine function]

   a. \( y = 3 + 2 \cos \left( \frac{2\pi}{5} x \right) \)
   b. \( y = 3 - 2 \cos \left( \frac{5\pi}{2} x \right) \)
   c. \( y = 2 + 3 \cos \left( \frac{2\pi}{5} x \right) \)
   d. \( y = 3 - 2 \cos \left( \frac{2\pi}{5} x \right) \)
   e. I do not know how to solve this problem.

10) Evaluate \( \tan^{-1}(-\sqrt{3}) \). \( (4.1.14) \)

   a. \( \frac{11\pi}{6} \)
   b. \( \frac{5\pi}{3} \)
   c. \( \frac{-\pi}{3} \)
   d. \( \frac{-\pi}{6} \)
   e. I do not know how to solve this problem.

11) Convert 155° to radians. \( (4.1.1) \)

   a. \( \frac{11\pi}{18} \)
   b. \( \frac{31\pi}{36} \)
   c. \( \frac{-3\pi}{3} \)
   d. \( \frac{31\pi}{72} \)
   e. I do not know how to solve this problem.

12) Convert \( \frac{12\pi}{15} \) to degrees \( (4.1.1) \)

   a. 112°
   b. 168°
   c. 144°
   d. 36°
   e. I do not know how to solve this problem.
13) State the coordinate that corresponds with $\frac{5\pi}{3}$ on the unit circle. (4.1.4)

- a. \( \left( \frac{1}{2}, \frac{\sqrt{3}}{2} \right) \)
- b. \( \left( \frac{1}{2}, -\frac{\sqrt{3}}{2} \right) \)
- c. \( \left( \frac{\sqrt{3}}{2}, \frac{1}{2} \right) \)
- d. \( \left( \frac{\sqrt{3}}{2}, -\frac{1}{2} \right) \)
- e. I do not know how to solve this problem.

14) Evaluate \( \sin \left( 5\cos^{-1} \frac{\sqrt{3}}{2} + 2\sin^{-1}(-1) \right) \) (4.1.15)

- a. \( -\frac{1}{2} \)
- b. \( -\frac{\sqrt{3}}{2} \)
- c. 1
- d. 0
- e. I do not know how to solve this problem.
Unit 5 Pre-Assessment

This pre-test is used to determine your prior knowledge on this topic. Please answer each question to the best of your ability. If you do not know how to solve the problem please select e.

1) Given a point in Quadrant III, which of the following trigonometric ratios (sine, cosine, tangent) will have a positive value? (Target 5.1)
   a. Sine and Cosine
   b. Cosine and Tangent
   c. Tangent and Sine
   d. Tangent Only
   e. I do not know how to solve this problem.

2) Given sec $\theta = \frac{-13}{12}$ with terminal side of $\theta$ lies in Quadrant II, find $\tan \theta$. (Target 5.1)
   a. $\tan \theta = \frac{-5}{12}$
   b. $\tan \theta = \frac{5}{12}$
   c. $\tan \theta = \frac{-12}{5}$
   d. $\tan \theta = \frac{-5}{13}$
   e. I do not know how to solve this problem.

3) Using the triangle to the right, find the value of cos $\theta$. (Target 5.1)
   a. $\cos \theta = \frac{24}{25}$
   b. $\cos \theta = \frac{7}{25}$
   c. $\cos \theta = \frac{25}{24}$
   d. $\cos \theta = \frac{24}{7}$
   e. I do not know how to solve this problem.

4) A 40-foot cable is stretched from the bottom of a tree to the top of a roof. The angle of elevation between the ground and the cable is 35°. Find the height of the roof. (Target 5.2)
   a. height = 69.74 ft
   b. height = 22.94 ft
   c. height = 17.13 ft
   d. height = 36.17 ft
   e. I do not know how to solve this problem.

5) Evaluate $\sin \left( \cos^{-1} \frac{12}{5} \right)$. (Target 5.4)
   a. $\frac{5}{12}$
   b. $\frac{13}{5}$
   c. $\frac{5}{13}$
   d. $\frac{12}{13}$
   e. I do not know how to solve this problem.

6) Solve for side $a$ in triangle ABC, given $A = 35^\circ$, $B = 67^\circ$ and $c = 22$. (Target 5.6)
   a. $a = 6.45$ units
   b. $a = 12.90$ units
   c. $a = 25.2$ units
   d. $a = 37.52$ units
   e. I do not know how to solve this problem.
7) Solve for side $c$ in triangle $ABC$, given $a = 15$, $b = 45$ and $C = 140^\circ$. (Target 5.9)
   a. $c = 57.3$ units
   b. $c = 34.89$ units
   c. $c = 55.84$ units
   d. $c = 33.08$ units
   e. I do not know how to solve this problem.

8) Solve for the measure of $\angle C$ in triangle $ABC$, if given $a = 17$, $b = 13$ and $c = 7$. (Target 5.9)
   a. $m < C = 22.28^\circ$
   b. $m < C = 157.72^\circ$
   c. $m < C = 19.29^\circ$
   d. $m < C = 69.22^\circ$
   e. I do not know how to solve this problem.

9) Find the area of triangle $ABC$, given $a = 17$, $b = 13$ and $c = 7$. (Target 5.10)
   a. area $= 1755.19u^2$
   b. area $= 729.93u^2$
   c. area $= 41.89u^2$
   d. area $= 364.97u^2$
   e. I do not know how to solve this problem.

10) Two ships leave port at 4 p.m. One is headed at a bearing of N 38 E and is traveling at 11.5 miles per hour. The other is traveling 13 miles per hour at a bearing of S 47 E. How far apart are they when dinner is served at 6 p.m.? (Target 5.11)
    a. 13.55 miles
    b. 16.90 miles
    c. 33.18 miles
    d. 36.18 miles
    e. I do not know how to solve this problem.
APPENDIX L

POSTTESTS
7) Identify the equation that has a horizontal shift of $\frac{\pi}{2}$ units to the left. \(\text{\textcolor{#20008b}{(4.1.10)}}\)

- a. \(y = -4\cos(4x - 2\pi) + 3\)
- b. \(y = 5\sin(2x - 2\pi)\)
- c. \(y = 3\cos(2x + \pi) - 4\)
- d. \(y = -6\sin(x + 2\pi)\)

8) Identify the equation of a cosine function that has a vertical shift of 5 units up and a period of $\frac{\pi}{3}$. \(\text{\textcolor{#20008b}{(4.1.10)}}\)

- a. \(y = 5 + \cos(3x + \pi)\)
- b. \(y = 3 + \cos(5x + \pi)\)
- c. \(y = 5 + \cos(6x - 4\pi)\)
- d. \(y = 3 + \cos(5x)\)

9) State the coordinate that corresponds with $\frac{5\pi}{3}$ on the unit circle. \(\text{\textcolor{#20008b}{(4.1.4)}}\)

- a. \(\left(\frac{1}{2}, \frac{\sqrt{3}}{2}\right)\)
- b. \(\left(-\frac{1}{2}, \frac{\sqrt{3}}{2}\right)\)
- c. \(\left(\frac{\sqrt{3}}{2}, -\frac{1}{2}\right)\)
- d. \(\left(-\frac{\sqrt{3}}{2}, -\frac{1}{2}\right)\)

10) Identify the period for \(y = 2\tan\left(\frac{3x}{4}\right)\). \(\text{\textcolor{#20008b}{(4.1.10)}}\)

- a. \(\frac{3}{4}\)
- b. \(\frac{8}{3}\)
- c. \(\frac{4}{3}\)
- d. \(\frac{2}{3}\)

11) Evaluate $\tan^{-1}(-\sqrt{3})$. \(\text{\textcolor{#20008b}{(4.1.4)}}\)

- a. \(\frac{11\pi}{6}\)
- b. \(\frac{5\pi}{3}\)
- c. \(\frac{-\pi}{3}\)
- d. \(\frac{-\pi}{6}\)

12) Antonio’s toy boat is bobbing in the water under a dock. The vertical distance (in cm) between the dock and the top of the boat after \(t\) seconds is modeled by \(H(t) = 5\cos\left(\frac{2\pi}{3}t\right) - 35.5\). \(\text{\textcolor{#20008b}{(4.1.12)}}\)

Find the minimum and maximum heights of the boat.

- a. Min. = -30.5 feet; Max. = -40.5 feet
- b. Min. = -40.5 feet; Max. = -30.5 feet
- c. Min. = 30.5 feet; Max. = 40.5 feet
- d. Min. = -30.5 feet; Max. = 40.5 feet
13) Which cosine equation is represented below:

\[ y = 3 + 2 \cos \left( \frac{2\pi}{3} x \right) \]

a. \[ y = 3 + 2 \cos \left( \frac{2\pi}{3} x \right) \]

b. \[ y = 3 - 2 \cos \left( \frac{5\pi}{2} x \right) \]

c. \[ y = 2 + 3 \cos \left( \frac{2\pi}{5} x \right) \]

d. \[ y = 3 - 2 \cos \left( \frac{2\pi}{3} x \right) \]

14) Evaluate

\[ \sin \left( \frac{\sin^{-1} \left( \frac{\sqrt{3}}{2} \right)}{2} + 2\sin^{-1}(-1) \right) \]

a. \( \frac{1}{2} \)

b. \( \frac{\sqrt{3}}{2} \)

c. 1

d. 0
Unit 5 Post-Assessment

This pre-test is used to determine your prior knowledge on this topic. Please answer each question to the best of your ability.

1) Using the triangle to the right, find the value of \( \cos \theta \). \((\text{Target 5.1})\)

- a. \( \cos \theta = \frac{24}{25} \)
- b. \( \cos \theta = \frac{7}{25} \)
- c. \( \cos \theta = \frac{25}{24} \)
- d. \( \cos \theta = \frac{24}{7} \)

2) Given \( \sec \theta = \frac{13}{12} \) with terminal side of \( \theta \) lies in Quadrant II, find \( \tan \theta \). \((\text{Target 5.1})\)

- a. \( \tan \theta = -\frac{5}{12} \)
- b. \( \tan \theta = \frac{5}{12} \)
- c. \( \tan \theta = -\frac{12}{5} \)
- d. \( \tan \theta = -\frac{5}{13} \)

3) Evaluate \( \sin \left( \cos^{-1} \frac{12}{5} \right) \). \((\text{Target 5.4})\)

- a. \( \frac{5}{12} \)
- b. \( \frac{13}{5} \)
- c. \( \frac{5}{13} \)
- d. \( \frac{12}{13} \)

4) Given a point in Quadrant III, which of the following trigonometric ratios ( sine, cosine, tangent) will have a positive value? \((\text{Target 5.1})\)

- a. Sine and Cosine
- b. Cosine and Tangent
- c. Tangent and Sine
- d. Tangent Only

5) A 40-foot cable is stretched from the bottom of a tree to the top of a roof. The angle of elevation between the ground and the cable is 35°. Find the height of the roof. \((\text{Target 5.2})\)

- a. height = 69.74 ft
- b. height = 22.94 ft
- c. height = 17.13 ft
- d. height = 36.17 ft

6) Solve for side \( a \) in triangle ABC, given \( A = 35^\circ \), \( B = 65^\circ \), and \( c = 22 \). \((\text{Target 5.6})\)

- a. \( a = 6.45 \text{ units} \)
- b. \( a = 12.90 \text{ units} \)
- c. \( a = 25.21 \text{ units} \)
- d. \( a = 37.52 \text{ units} \)
7) Solve for the measure of \( \angle C \) in triangle ABC, if given \( a = 17, b = 13 \) and \( c = 7 \). *(Target 5.9)*
   
   a. \( m \angle C = 22.28^\circ \)
   b. \( m \angle C = 157.72^\circ \)
   c. \( m \angle C = 19.29^\circ \)
   d. \( m \angle C = 69.22^\circ \)

8) Two ships leave port at 4 p.m. One is headed at a bearing of N 38 E and is traveling at 11.5 miles per hour. The other is traveling 13 miles per hour at a bearing of S 47 E. How far apart are they when dinner is served at 6 p.m.? *(Target 5.11)*
   
   a. 13.55 miles
   b. 16.90 miles
   c. 33.18 miles
   d. 36.18 miles

9) Solve for side \( c \) in triangle ABC, given \( a = 15, b = 45 \) and \( C = 140^\circ \). *(Target 5.9)*
   
   a. \( c = 57.31 \text{ units} \)
   b. \( c = 34.89 \text{ units} \)
   c. \( c = 55.84 \text{ units} \)
   d. \( c = 33.08 \text{ units} \)

10) Find the area of triangle ABC, given \( a = 17, b = 13 \) and \( c = 7 \). *(Target 5.10)*
    
    a. \( \text{area} = 1755.19 \text{ } \text{u}^2 \)
    b. \( \text{area} = 729.93 \text{ } \text{u}^2 \)
    c. \( \text{area} = 41.89 \text{ } \text{u}^2 \)
    d. \( \text{area} = 364.97 \text{ } \text{u}^2 \)
APPENDIX M

STUDENT SURVEY QUESTIONS
The following questions are not part of the test and will not affect your grade. Please answer them honestly.

Please circle only one number to each question.

1. How often did you refer to your exit slips when you prepared for this test?
   
   1. NEVER   2. 3. 4. 5. 6. VERY
   FREQUENTLY

2. How helpful were the exit slips in learning the mathematics concepts on this test?
   
   1. NOT AT ALL   2. 3. 4. 5. 6. VERY
   HELPFUL

3. I believe that my teacher should continue to give weekly exit slips.
   
   1. STRONGLY   2. 3. 4. 5. 6. STRONGLY
   DISAGREE

   AGREE