2018

# A Qualitative Case Study of Mathematics Teachers' Formative Assessment Feedback

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Abstract

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November 2018

## Abstract

Formative assessment is supported by research as a process to enhance student learning. A vital aspect in the process is the role of feedback which, based on its use, can support or hinder student learning. The problem addressed in this study was based on the concern of a high school administrator that teachers in the school were not using formative feedback in a manner that supported student learning. The purpose of this instrumental qualitative case study was to explore and understand the assessment and feedback practices of mathematics teachers in a private high school setting. The conceptual framework for this study was a model influenced by Black and Wiliam's theory of formative assessment and by Hattie and Timperley's model of feedback in which effective feedback is the supporting structure of the formative assessment process for promotion of student learning. The research questions were designed to explore the beliefs and practices of 3 mathematics teachers regarding the purpose of assessment and feedback. Qualitative data were collected from archival documents, observations, and a series of semistructured interviews. Data were analyzed by using multicycle descriptive coding and development of themes. Findings included teachers' beliefs, practices and misconceptions about the assessment and feedback cycle in relation to student learning in their classrooms. A recurring theme was that they lacked training in formative assessment practice. A 3-day professional development workshop that integrated and grounded formative assessment research into the daily practice of teachers was developed as a project. Teachers might bring about positive social change as their students develop self-regulatory learning strategies and transfer them into community life.

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# Dedication

I would like to dedicate this publication to my wife and three children. You are a true blessing, and without your love, encouragement, and patient support, this would not have been possible. Thank you for the many sacrifices you made during this process. I also dedicate this to my Lord Jesus Christ. Soli Deo Gloria!

Acknowledgments

I would like to express my gratitude to Dr. Richard Flor and Dr. Heather Pederson for your feedback, guidance, and assistance during this process. I would also like to thank my family, colleagues, and friends who have supported me during this journey.

Table of Contents

List of Tables ..... iv

List of Figures ..... v

Section 1: The Problem ..... 1

Introduction ..... 1

Definition of the Problem ..... 4

Rationale ..... 5

Evidence of the Problem at the Local Level ..... 6

Evidence of the Problem from the Professional Literature ..... 7

Definitions ..... 11

Significance ..... 11

Guiding/Research Question ..... 13

Review of the Literature ..... 14

Theoretical Framework ..... 14

Classroom Assessment ..... 25

Feedback ..... 36

Implications ..... 52

Summary ..... 52

Section 2: The Methodology ..... 54

Introduction ..... 54

Research Design and Approach ..... 55

Participants ..... 56

Data Collection ..... 60
Data Analysis ..... 63
Limitations ..... 64
Data Analysis Results ..... 65
Theme 1: How teachers communicate learning intentions for students ..... 65
Theme 2: How teachers design tasks to uncover evidence of student learning ..... 66
Theme 3: Feedback that teachers give students ..... 68
Theme 4: Teacher perceptions and beliefs about assessment and feedback ..... 70
Theme 5: Teacher training and support ..... 73
Discussion of Findings ..... 75
Summary ..... 80
Section 3: The Project ..... 81
Introduction ..... 81
Rationale ..... 81
Review of the Literature ..... 82
Purpose of Professional Development ..... 83
Elements of Effective Professional Development ..... 85
Connection of the Research and the Project Study ..... 89
Project Description ..... 90
Needed Resources and Existing Supports ..... 92
Potential Barriers and Solutions to Barriers ..... 92

Implementation and Responsibilities ..... 92
Project Evaluation Plan ..... 93
Project Implications ..... 94
Section 4: Reflections and Conclusions ..... 96
Project Strengths and Limitations ..... 96
Project Strengths ..... 96
Project Limitations ..... 97
Recommendations for Alternative Approaches ..... 98
Scholarship, Project Development and Evaluation, and Leadership and Change ..... 98
Reflection on Importance of the Work ..... 100
Implications, Applications, and Directions for Future Research ..... 100
Conclusion ..... 101
References ..... 103
Appendix A: Project ..... 121
Appendix B: Document Summary/Analysis Form ..... 197
Appendix C: Interview Protocol ..... 198
Appendix D: Observation Field Notes Form ..... 203

List of Tables

Table 1. Scores of Teachers' Knowledge of Error Analysis…..…….……..35

Table 2. Possible Responses to Feedback Interventions……..……..38

List of Figures

Figure 1. Aspects of formative assessment..... 17

Figure 2. A model of feedback to enhance learning ..... 22

Figure 3. Effective feedback: The structural support for formative assessment..... 25

Section 1: The Problem

## Introduction

For many years, education and the effectiveness of our nation's schools have been in the spotlight at the national, state, and local levels. Accountability measures such as the federal government's 2002 enacting of the No Child Left Behind Act sought to ensure that access to a high-quality education is available to all children in the country (NCLB, 2002). The law also looked to promote effective, research-based, instructional strategies and to improve teacher quality in order to improve our nation's schools (NCLB, 2002). Recent accountability legislation such as Race to the Top in 2009 and the Every Student Succeeds Act in December of 2015 have continued the dialogue about the most efficient method of improving the educational experience of students (ESSA, 2015).

The national attention brought to education in ensuring that all children receive a high quality education has also led to the construction of various academic standards including the Common Core State Standards (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). These standards aim to bring consistency and focus to teaching and learning across the country, regardless of where a student resides. Despite these efforts, there is still growing concern about the status of education in the nation. In reviewing the below average results of the United States on the 2015 Program for International Student Assessment (PISA), Carr, the Commissioner for the National Center for Educations Statistics, noted that while reading and science scores showed no measurable change, mathematics scores have declined since 2009 (National Center for Education Statistics, 2016).

The National Council of Teachers of Mathematics (NCTM) also identified that mathematics education needed improvement (2014). The NCTM stated that the quality of mathematics education is inconsistent across the educational landscape and that there is "no question that the effectiveness of mathematics education in the United States and Canada can be improved substantially" (NCTM, 2000, p. 5). NCTM has advocated mathematics education reform in order that all students have the opportunity to receive high quality mathematics education from the national down to the local level (NCTM, 2014).

From years of researching various educational methods, tools, and techniques, formative assessment has been revealed as a research-supported approach that has the capacity to increase student achievement (Black & Wiliam, 2009; Dorn, 2010; Hudesman et al., 2014; Killion & Roy, 2009; Wiliam, 2011b). Formative assessment is not constrained or confined to one particular developmental level or curricular domain, and the NCTM has promoted the use of formative assessment techniques (NCTM, 2013) to assist in realizing the vision of increasing mathematics achievement for all students at the highest possible level (NCTM, 2014).

Formative assessment does not have a singular widespread definition or set of practices (Bennett, 2011); however, it is typically meant as a continuous cyclical process that uses student assessment information to make instructional decisions while the learning is taking place. Making decisions during the learning cycle is a powerful process that responds to student needs, increases student learning, and promotes student self-regulation (Black & Wiliam, 2009; Clark, 2012; Sadler, 1989).

One of the foundational aspects of formative assessment is in the purpose and use of feedback that is given to students (Hattie & Timperley, 2007). In education, feedback is typically meant as the information provided to the learner about their performance with the intent of improving performance (Hattie & Gan, 2011). While feedback "has one of the highest effects on student learning" (Hattie, 2012, p. 18), it has a wide variability on its effectiveness and is dependent upon its use (Fyfe, Rittle-Johnson, & DeCaro, 2012; Hattie & Gan, 2011). The project study was guided by the amalgamation of Black and Wiliam's (2009) theory of formative assessment and Hattie and Timperley's (2007) model of feedback, which aligned with the principles of assessment that are advocated by the NCTM.

The purpose of this qualitative instrumental case study was to explore and understand the assessment and feedback practices of mathematics teachers in a private high school setting. Qualitative data was gathered from observations and voluntary interviews with teachers, and various documents made available by the school such as: curriculum documents, course syllabi, lesson plans, classroom artifacts, and professional development records. Multicycle descriptive coding was used to analyze the qualitative data to provide an awareness of specific issues in mathematics classroom that prohibit or hinder effective formative assessment and formative feedback implementation. These results may provide school administrators at the local level with information they need to address the gap in practice between current assessment and feedback practices and what research suggests to further promote increased mathematics achievement in their local context.

Here in Section 1, the problem will be defined at the local level as well as within the larger educational context. A rationale is included to justify research in exploring the use of formative assessment and feedback within mathematics education. Evidence of the local problem and from both scholarly and professional literature will be presented. Definitions of essential terms that relate to formative assessment and feedback will be presented. The significance of the issue and the questions guiding the research will be included as well as a critical literature review that addresses the theoretical framework and a historical context of the problem. The anticipated implications of the research will be provided. The methodology of this qualitative instrumental case study will be detailed in Section 2. The resulting project will be discussed in Section 3, while the reflections and conclusions of the project study will be addressed in Section 4.

## Definition of the Problem

Across the educational landscape, there is a gap between what literature suggests is good feedback and what is found in classrooms (Gamlem, 2015; Lee, Mak, & Burns, 2016; van den Bergh, Ros, & Beijaard, 2013; Voerman, Meijer, Korthhagen, & Simons, 2012). Many mathematics teachers "lack training or expertise in sound practices" (An & Wu, 2012, p. 720) and are typically unable to communicate the role of feedback in promoting student learning (Hattie & Gan, 2011). The problem in some mathematics classrooms at a Midwest private high school in the United States, as reported by the school principal, is that assessment and feedback practices may not align with what research suggests as effective practices that support student learning and that the teachers may not have received training in these practices (personal communication, May 5,

2017). The school's average ACT mathematics score in 2012 was 24.1 and trended downward over the course of the next couple years to a 23.5 in 2015 (ACT School Summary Statistics, 2016). The principal realized that a gap in practice between local practice and what research suggests is effective practice may mitigate the recent trend.

The NCTM stated that assessments should be conducted for student learning and the resulting information be used as feedback to increase student learning (NCTM, 2014). The school principal felt that this gap in formative assessment and feedback practice is possibly hindering student achievement in mathematics (personal communication, May 5, 2017), prompting the need to explore and understand the assessment and feedback strategies of the teachers and reduce this gap in practice.

## Rationale

Researchers have identified that sound assessment and feedback practice in education is a key factor in improving student learning (Black & Wiliam, 2009; Hattie & Timperley, 2007). However, simply giving feedback to students does not necessarily mean increased student learning (Sadler, 2010), and if not used properly it can negatively impact student learning (Fyfe & Rittle-Johnson, 2016; Hattie & Timperley, 2007; Havnes, Smith, Dysthe, & Ludvigsen, 2012). Hattie and Gan (2011) stated that many educators do not possess the capacity of how to use feedback's power effectively. Due to this gap in practice, it is vital that this study explore teacher assessment and feedback practices to align them with methods that support increased student learning (Lee, et al., 2016; van den Bergh, et al., 2013; Voerman, et al., 2012). In this section, the problem of

using assessment and feedback for learning is addressed at the local level and in the professional literature.

**Evidence of the Problem at the Local Level**

NCTM has identified that mathematics education in the United States and Canada needs to be improved and move toward a formative assessment process in daily mathematics instruction (NCTM, 2000, 2013, 2014). The local school's state teacher's union has also advocated for more formative assessment in mathematics education in order to inform daily instruction for increased student learning.

From 2012 to 2015, the composite mathematics ACT scores at the high school selected for this study have been declining from an average score of 24.1 in 2012 to an average of 23.5 in 2015 (ACT School Summary Statistics, 2016). The principal at the high school is concerned that assessment and feedback practices may not align with what research suggests as effective practices that support student learning and that the teachers may not have received training in these practices as advocated by the NCTM (personal communication, May 5, 2017).

The principal expressed that many of the mathematics classes are heavy with summative assessments and primarily give feedback to students in the form of grades (personal communication, May 5, 2017). This is a concern because when feedback is given as scores or grades it negatively impacts student learning (Chappuis, 2015; Dixon & Haigh, 2009; Gamlem, 2015; See Ling & Saw Lan, 2012; Wiliam, 2011b, 2012, 2016a). In order for students to improve their learning, it is imperative that assessment and feedback practices are effective, and that feedback clearly communicates the gap

between the student's current and desired level of knowledge (Chan, Konrad, Gonzalez, Peters, & Ressa, 2014; Gamlem, 2015; Goodwin & Miller, 2012; Jenkins, 2010).

It is important to investigate the feedback methods of the mathematics teachers in this particular school in order to understand how students' learning might be reinforced and promoted through more effective use of feedback within formative assessment. The findings of this study may be helpful in identifying the specific gap in knowledge and practice to assist the administration of the school in developing procedures and professional development to help its mathematics teachers deliver formative feedback effectively to students to promote increased learning.

**Evidence of the Problem from the Professional Literature**

The NCTM (2014) and the local state educator's union both advocate for mathematics instruction to feature more formative assessment techniques in daily instructional practice, and for good reason. The body of research on formative assessment and the use of feedback show that, when implemented appropriately, the impact on student learning can be powerful (Hattie & Gan, 2011; Hudesman et al., 2014; Wiliam, 2016a; Yang & Carless, 2013). However, despite the research that shows the potential of formative assessment and feedback in increasing student learning, it is not widespread in practice (Black & Wiliam, 1998a, 2009; Gamlem & Munthe, 2014; Hattie & Timperley, 2007; Lee et. al., 2016; Wiliam, 2016b) and the mathematics field needs more teachers that can implement formative assessment strategies (An & Wu, 2012; Gotwals, Philhower, Cisterna, & Bennett, 2015; Hodgen & Wiliam, 2006). This supports the need to study the problem in the local context.

**Formative assessment.** Black and Wiliam (1998b) state that raising standards at the national level has not made much impact at the local level because the "everyday practice of assessment in classrooms is beset with problems and shortcomings" (p. 5) and hinders effective learning interactions. Assessment practices by classrooms teachers in general are regarded by Black and Wiliam as "weak" (1998a, p. 17) and that formative assessment is not well understood or prevalent in classrooms despite the literature touting the benefits to student learning that formative assessment can bring.

Formative assessment has received a lot of attention in educational literature due it its reported benefits, but yet most practice in classrooms remains summative in nature (Chappuis, Stiggins, Chappuis, & Arter, 2012; Gamlem, 2015; Wylie & Lyon, 2015), and formative assessment has not become the prevailing process to assess student learning. One of the barriers of implementing a formative assessment system originates in the dominant historical practice of the summative grading practices that occur in classrooms (Black & Wiliam, 1998a; Chappuis, 2015; Chappuis et al., 2012; Hodgen & Wiliam, 2006; Wiggins, 2012; Wiliam, 2011b; Wiliam & Leahy, 2015) and is a feature in many mathematics classrooms (NCTM, 2014; Peshek, 2012). This historical practice which is deeply rooted in education and teacher comfort levels, including societal pressures, may inhibit a departure from the traditional grading practices (Black & Wiliam, 1998a; Dorn, 2010; Dueck, 2014; Kohn, 2011; Marzano & Heflebower, 2011; Vatterott, 2015; Westerberg, 2016).

Black and Wiliam (1998a) also argued that "it is not possible to introduce formative assessment without some radical change in classroom pedagogy" (p. 10). In

their research they saw teachers using assessments primarily in an evaluative summative function (Black & Wiliam, 1998a). In order for formative assessment to be effectively implemented, Black and Wiliam called for changes in "teachers' perception of their own role in relation to the students and classroom practice" (1998a, p. 20). This change in perception primarily deals with how assessments are used. In order for any assessment to function formatively, the teacher needs to use the assessment results as the basis to provide feedback to students in order to move their learning forward.

**Feedback.** Within the formative assessment process, feedback takes a pivotal role in moving student learning forward (Clark, 2012; Wiliam, 2016a, 2016b). While feedback's base function is to provide information to the student on their current progress within the learning process (Sadler, 1989), it does have the power to influence learning both positively and negatively, depending on the manner in which the giver uses it (Fyfe & Rittle-Johnson, 2016; Hattie & Gan, 2011; Hattie & Timperley, 2007; Havnes, et al., 2012).

One of the time-honored hallmarks of education is the use of grades in giving feedback to students (Dueck, 2014; Vatterott, 2015; Westerberg, 2016; Wiggins, 2012), but yet their traditional use does not support student learning within a formative assessment system (Chappius, 2015; Dukor & Holmberg, 2013; Gamlem, 2015; Nicol & Macfarlane-Dick, 2006; Wiliam, 2016b). The traditional use of grades provides students with a knowledge of results, but does not produce information that the student can use to move their learning forward and has been shown to decrease student engagement and hinder student learning (Dukor & Holmberg, 2013; Goodwin & Miller, 2012). The use of

grades is also a common feature in mathematics classrooms but is unproductive in improving student learning (NCTM, 2014; Wiliam, 2016b).

Additionally, feedback that is normative or directs student attention toward the self, such as praise, have been shown to impede student learning (Hattie & Timperley, 2007; Hargreaves, 2012; Kluger & DeNisi, 1996). This type of feedback is very common in classrooms, but yet has multiple problems in that it may subvert intrinsic motivation (Hargreaves, 2012), lead to self-handicapping and social comparison (Hattie & Gan, 2011; Hattie & Timperley, 2007), and does not give the student specific information on how to reduce the gap between the current performance and the desired goal (Fyfe & Rittle-Johnson, 2016; Hattie & Gan, 2011; Hattie & Timperley, 2007). Since feedback can function as a "double-edged sword" (Kluger & DeNisi, 1996, p. 275) for good or ill, and many of the detrimental practices are frequently found in classrooms, it is vital that teachers are aware of, and implement effective feedback strategies.

The purpose of this qualitative instrumental case study was to explore and understand the assessment and feedback practices of mathematics teachers in a high school mathematics setting. As a consequence of learning about the feedback practices of teachers and what teachers perceive to be effective feedback practices, the discrepancy between effective feedback strategies and common practice can be more clearly understood. This understanding will provide an opportunity to allow teachers and administrators at this high school to identify specific areas in need of further training and continuing education so that effective feedback practices may be implemented, resulting in improved student learning and the potential to positively impact teaching and learning.

## Definitions

*Feedback:* Feedback is defined as "information provided by an agent (e.g., teacher, peer, book, parent, and self/experience) regarding aspects of one's performance or understanding that reduces the discrepancy between what is understood and what is aimed to be understood" (Hattie & Gan, 2011, p. 258).

*Formative Assessment:* A formative assessment is "evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was solicited" (Black & Wiliam, 2009, p. 9).

*Formative Feedback:* Formative feedback is "information communicated to the learner that is intended to modify his or her thinking or behavior for the purpose of improving learning" (Shute, 2008, p. 154).

*Self-regulation:* Self-regulation "refers to the degree to which students can regulate aspects of their thinking, motivation, and behavior during learning" (Nicol & Macfarlane-Dick, 2006, p. 199)

## Significance

Despite the research that promotes the power of effective feedback within formative assessment, it is not consistently put into practice to support student learning (Gamlem & Munthe, 2014; Hattie & Gan, 2011). A number of researchers have suggested that feedback is not widely implemented in a manner that assists students in furthering their learning (Dorn, 2010; Kearney, Webb, Goldhorn, & Peters, 2013; Lee

et.al., 2016) and that feedback is "one of the most problematic aspects of the student experience" (Carless, Salter, Yang, & Lam, 2011, p. 395). To address this gap in practice, it is important to identify various aspects that might impede implementation.

There are several barriers that hinder effective formative feedback practice, including practical, structural, organizational, cultural, and political factors (Dorn, 2010; Yang & Carless, 2013). Despite the many variables that could be studied in relation to the problem of effective feedback, Lee (2011) suggested that research focus on teachers, who are of "paramount importance since they are the deliverers of feedback and agents of change in the classroom" (p. 2). In the case study of three science teachers, Box, Skoog, and Dabbs (2015) also emphasized the importance of studying the role of the teacher in regard to formative assessment practices.

As a consequence of learning about the assessment and feedback practices of teachers, what teachers perceive to be effective practices, and what factors influence their practices, a greater awareness can be achieved of the gap between assessment and feedback practices supported by research and current classroom practice. This understanding could provide an original contribution that will allow teachers and administrators at this high school to identify specific barriers that could be mitigated and investigate possible areas for increased training and education and construct a professional development plan that addresses this gap in practice. The result could be the potential to implement more effective feedback and formative assessment strategies which could lead to increased student learning and bringing about positive social change in how students interact within the educational process and develop life-long self-

regulatory strategies. This research also has the potential to impact how teachers view their assessment and feedback practices and promote an educational model that becomes more learning-centered and serves student needs.

## Guiding/Research Question

Feedback is "one of the most powerful influences on learning, too rarely occurs, and needs to be more fully researched by qualitatively and quantitatively investigating how feedback works in the classroom and learning process" (Hattie & Timperley, 2007, p. 104). This instrumental case study investigated aspects of assessment and formative feedback within mathematics classrooms in a private Midwest high school through archival documents, observations, and interviews to answer the following questions:

1. How do current practices of mathematics teachers align with the purpose and classroom application of both the Black and Wiliam (2009) assessment model and the Hattie and Timperley (2007) feedback model?
    1.1 In what ways do current practices identify the learning intentions for students?
    1.2 How do teachers design tasks to uncover evidence of student learning?
    1.3 What aspects and levels of feedback are present in current classroom practice?
2. What are mathematics teacher beliefs about the purpose of assessment and feedback?
3. What types of training have mathematics teachers received related to formative assessment and feedback?

These research questions connect to aspects of the Black and Wiliam (2009) theory of formative assessment and the Hattie and Timperley (2007) model of feedback.

Through these questions, I focused on the aspects of the theoretical framework that were influenced and controlled by the decisions or actions of the classroom teacher.

## Review of the Literature

In the educational process of effective instruction, formative assessment has emerged as a potentially powerful technique to enhance student learning (Black & Wiliam, 2009). A key facet of the formative assessment process is the use and intent of feedback teachers provide. The purpose of this qualitative instrumental case study was to explore and understand the assessment and feedback practices of mathematics teachers in a private high school setting.

In the literature review for this project study. I will explore the purpose and characteristics of formative assessment and the role that feedback occupies in supporting the goals and purpose of formative assessment. This section begins by my describing the theoretical framework of formative assessment and feedback and then current literature on formative assessment and feedback and how their use influences student learning.

### Theoretical Framework

The theoretical framework for this study begins on the premise that effective feedback is essential for effective student learning. In order for feedback to be effective, it is vital for teachers to use assessment in a manner that promotes student learning (Black & Wiliam, 2009). This study's theoretical framework is the amalgamation of Black and Wiliam's (2009) theory of formative assessment in which they proposed five aspects that are found in formative assessment, in which the first three aspects focus on

the role of the teacher. Then Hattie and Timperley's (2007) model of feedback will be addressed as a method to effectively incorporate the feedback aspect of Black and Wiliam's theory of formative assessment. Black and Wiliam and Hattie and Timperley are significant seminal works in understanding the issue of providing feedback that leads to future student learning. These two sources were selected as a basis for the theoretical framework of this study due to their wide spread reference and use in many current studies on the subject, and are cited in the NCTM Principles to Action (2014). The theoretical framework for this study is then proposed as an approach to determine if teachers in the school that is the subject of this study incorporate aspects of formative feedback in their classroom practice.

**Black and Wiliam's theory of formative assessment.** There are many suggestions regarding the definition of formative assessment, however for this project study I used the definition proposed by Black and Wiliam (2009):

> Practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted and used by teacher, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited. (p. 9)

This definition includes some noteworthy characteristics. First, the purpose of the assessment is to elicit evidence about the learning progress of the student so that instructional decisions can be made for the benefit of the student. This is a key distinction from summative assessment in which assessment serves a certifying function at the end

of a learning session (Wiggins, 2012). In contrast to summative uses of assessment, when classroom practice is formative, it uses assessment as a point of contingency in which decisions are made on how to move the learning forward (Black & Wiliam, 2009).

Secondly, the "agent of assessment" (Black & Wiliam, 2009, p. 10) may include the learner or their peers, in addition to the traditional role of the teacher. Peer and self-assessment serve special roles in formative assessment in order to expand instructional resources for the learner and to promote self-regulatory aptitude.

Finally, the definition places an importance on the decisions that are made due to the evidence that the assessment brings to light. What is unique is that it states that decisions are "likely to be better, or better founded" (Black & Wiliam, 2009, p. 9) than decisions made without the assessment information. This is important in that the agent of assessment may not always have to change course based on the results of the assessment in order for it to be formative. The evidence may suggest that the original direction should continue, it just allows for a more evidence-based judgment (Black & Wiliam, 2009).

Black and Wiliam (2009) proposed a theory of formative assessment that looks at the three possible agents of assessment and the three processes that each of those agents might serve. The three processes are (a) where the learner is going, (b) where the learner is right now, and (c) how the learners can get to the desired outcome. In considering the possibilities that each might have, Black and Wiliam developed five interrelated aspects that are characteristics of formative assessment as shown in Figure 1.

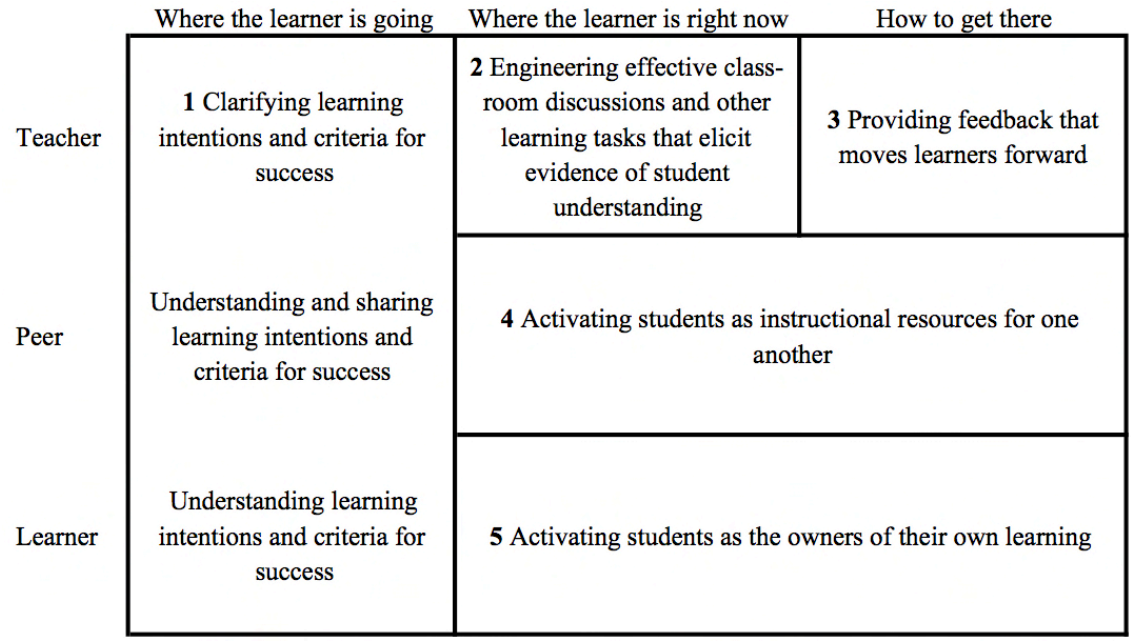



*Figure 1.* Aspects of formative assessment. From "Developing the theory of formative assessment" by P. Black & D. Wiliam, 2009, *Educational Assessment, Evaluation & Accountability, 21*(1), p. 8. Reprinted with permission.

The first aspect of the model is "clarifying and sharing learning intentions and criteria for success" (Black & Wiliam, 2009, p. 8). This aspect informs the learner of where they are going, and while typically the teacher makes this information known, the learner and peers may have a role in identifying where the learning is headed. This is a foundational aspect in that it is unlikely for a student to have consistent success in learning if they are unaware of what is to be learned. Communicating the learning intentions can be done at various times during the learning process and in a variety of methods depending on the subject matter and content to be learned (Chappius, 2015; Wiliam & Leahy, 2015).

Students do not always learn everything that is intended (Wiliam, 2011b; Wiliam & Leahy, 2015), which is why the second aspect of the Black and Wiliam (2009) model stresses the importance of engineering effective classroom environments in order to see the level of student learning. This aspect has the purpose of using classroom activities and discussions in determining where the learner is right now. Very often, this is accomplished by questioning. While the questioning can be verbal or written, how the teacher reacts to the student response is of vital importance. It is common for teachers to evaluate student responses for correct or incorrect answers, however Black and Wiliam suggested that teachers listen interpretively to the student response in order to elicit information regarding the student's thinking and level of learning.

Once the evidence of learning is determined, that data often show that students have not learned what was intended and it is important to assist the students (Wiliam & Leahy, 2015). The third aspect of the theory of formative assessment moves learners forward by providing feedback (Black & Wiliam, 2009). Feedback is the pivotal aspect of the formative assessment process since gives the learner information that can help them improve their current level of understanding and move toward the intended learning intentions and goals (Black & Wiliam, 2009). The use of feedback is complex and not easily prescribed because student learning can be influenced in a positive and negative manner depending on the fashion in which it is delivered and received (Fyfe & Rittle–Johnson, 2016; Gamlem, 2015). A more thorough examination of the feedback aspect will be addressed later.

The fourth aspect of the Black and Wiliam theory of formative assessment is "activating students as instructional resources for one another" (Black & Wiliam, 2009, p. 8). This aspect allows the learner's current level of learning to be identified and how to proceed further down the learning progression. Peer assessment promotes learning and benefits both the giver and receiver of the feedback. As feedback has to be used in a deliberate manner in order to positively impact student learning, it is important to tutor students in the proper methods of providing peer feedback (Wiliam & Leahy, 2015).

The final aspect activates students as owners of their own learning (Black & Wiliam, 2009). Wiliam and Leahy (2015) stated the importance of this strategy as "the one the other four strategies have been leading up to" (p. 169). This strategy is used by students to identify their current level of learning by self-assessing their work. In this manner, students can use and develop self-regulatory strategies to increase learning. This strategy is complex and involves student motivational mindsets, personal interests, values, and well-being. For students to develop self-regulation strategies takes time and guidance, but the better students are at self-regulating their own learning, the more effective learners they will become (Wiliam, 2011a, 2011b).

Black and Wiliam's (2009) original model of formative assessment encompasses five interrelated aspects of formative assessment. In order for assessment to move learning forward, it needs to provide evidence that can be used in feedback for the learner to identify the gap between the current level of understanding and the desired goal of the learning intention with the ultimate goal of fostering the self-regulatory abilities of students. The influence and role of the teacher, which is the focus of this study, is

addressed in the first three aspects of the theory. In the next section, the pivotal aspect of feedback will be addressed in more detail.

**Hattie and Timperley's model of feedback.** Feedback is a critical aspect of the formative assessment process, and its use determines the effectiveness of instruction (Chan et al., 2014) and is worthy of special consideration. The second theory selected for the study's overarching theoretical framework is the model of feedback developed by Hattie and Timperley (2007). The timing and purpose of feedback determine whether assessment is formative or summative. Hattie and Gan (2011) defined feedback as "information provided by an agent (e.g., teacher, peer, book, parent, and self/experience) regarding aspects of one's performance or understanding that reduces the discrepancy between what is understood and what is aimed to be understood" (p. 258). In formative assessment, this feedback information is used for the purpose of reducing "discrepancies between current understandings and performance and a goal" (Hattie & Timperley, 2007, p. 86). This model aligns with the use of feedback within the Black and Wiliam (2009) theory of formative assessment.

According to the model of Hattie and Timperley (2007) (see Figure 2), feedback information needs to give information about three aspects of the student learning. The three aspects, which coincide with Black and Wiliam's (2009) theory of formative assessment, should not be viewed as stages, but an integrated part of the instructional and learning process. The first aspect asks the question, "Where am I going?" This feedback must give specific information regarding the learning goal. In order for feedback to be effective, it is vital that the learning goal be clearly articulated and that the feedback be

aligned with the stated learning goal (Hattie & Gan, 2011). Feedback cannot achieve its purpose of reducing the gap between current and desired performance level if the goal is not clear. The goal should communicate what successful learning looks like in order to increase the power of feedback (Hattie & Gan, 2011).

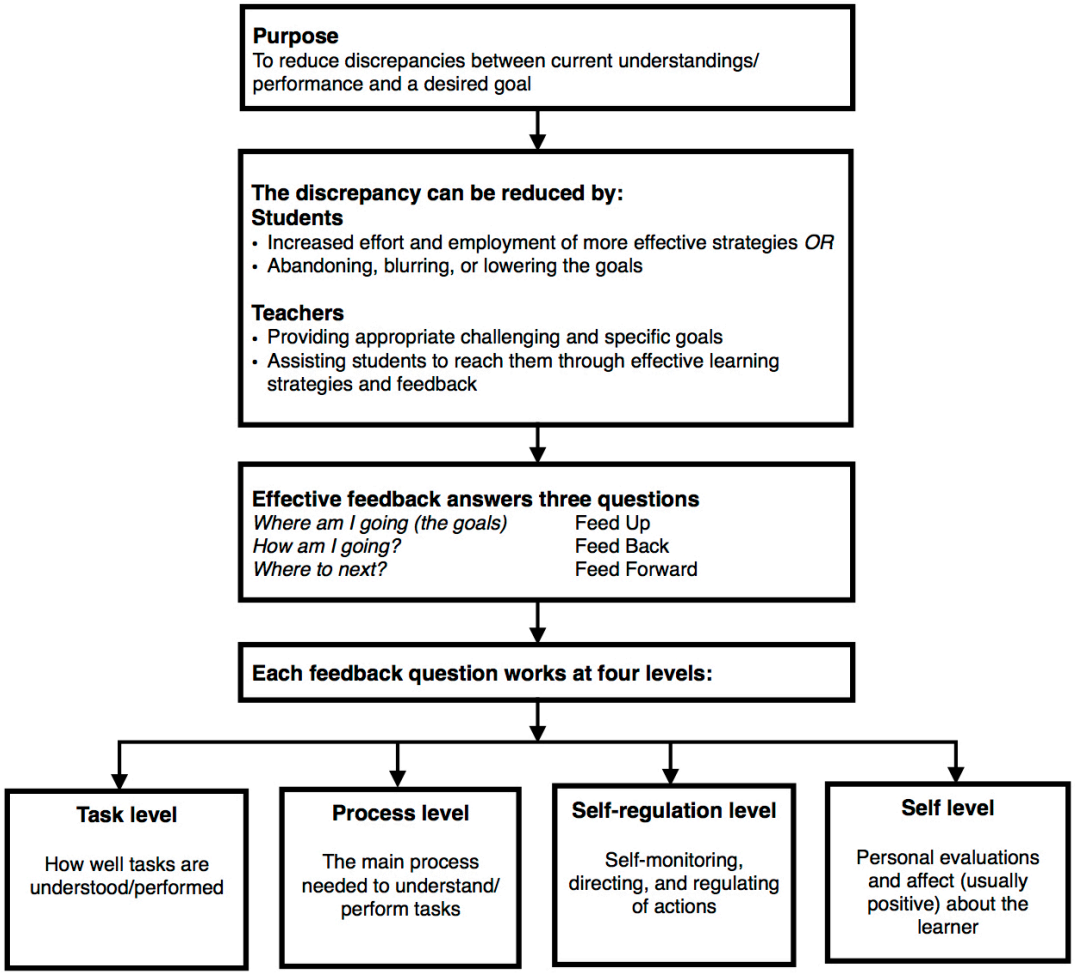



*Figure 2.* A model of feedback to enhance learning. From "The power of feedback," by J. Hattie & H. Timperley, 2007, *Review of Educational Research*, *77*(1), p. 87. Reprinted with permission.

Hattie and Timperley's (2007) second aspect of feedback information is "How am I going?" The feedback must provide details relative to where the student is in relation to

the stated learning goal (Hattie & Timperley, 2007)). It can contain both normative and criterion referenced information to assist in identifying the student's current level of achievement (Hattie, 2012; Hattie & Gan, 2011).

The final question is "Where to next?" and leads students forward toward further opportunities for increased learning (Hattie & Timperley, 2007). This aspect of feedback assists the metacognitive self-regulating strategies of students (Hattie & Gan, 2011) and guides the choosing of the next steps in the learning process.

Hattie and Timperley (2007) identified four levels of feedback usage and their effectiveness in the learning process: task level feedback, process level feedback, self-regulation level feedback, and self-level feedback. Task level feedback is common in classrooms and typically manifests itself as knowledge of results or corrective feedback. Task level feedback is powerful when it addresses misconceptions and is addressing the beginning learner (Hattie & Gan, 2011), but can lead to student dependence on teachers if used too frequently. Prevalent use of task level feedback can lead to less cognitive effort by students as they could resort to trial and error strategies (Hattie & Timperley, 2007). Task level feedback is specific and clarifies what a student needs to accomplish. but does not generalize well across learning sessions.

Process level feedback gives information about student understanding and construction of conceptual procedures and relationships between ideas (Hattie, 2012). This process level feedback is more effective than task level feedback in enhancing deeper levels of learning and is more generalizable to future learning (Hattie & Timperley, 2007). Deeper learning involves the ability to understand the cognitive

processes associated with the learning and be able to generalize it to a novel situation (Hattie & Timperley, 2007).

Self-regulation feedback "addresses the way students monitor, direct, and regulate actions toward the learning goal" (Hattie & Timperley, 2007, p. 93). This level of feedback requires students to have an advanced knowledge of the intended goal, their current level of performance, and the intrinsic motivation to self-monitor, self-assess and regulate their own actions (Black & Wiliam, 2009; Hattie & Gan, 2011).

Self-level feedback is very common in classrooms but is ineffective and does not promote student learning (Hattie & Timperley, 2007). Self-level feedback does not address the learning goal and gives no information on how to progress toward the learning goal (Hattie & Gan, 2011). Self-level feedback often takes the form of praise and typically gives positive evaluations about the student's personal qualities or effort. Self-level feedback can be counterproductive, weaken intrinsic motivation (Hargreaves, 2012), and have a negative effect on student learning since it does not address the learning target (Hattie & Timperley, 2007).

**Effective feedback supports formative assessment.** This project study's theoretical framework amalgamates Black and Wiliam's (2009) theory of formative assessment and Hattie and Timperley's (2007) model of effective feedback. These works influenced the framework upon which Figure 3 is based. Formative assessment is the bridge that can be used to connect classroom instruction to improved student learning. Assessment activities are engineered and employed in a formative manner with the intent and expressed purpose to elicit information about student learning that can be used as

feedback. However, only task level, process level, and self-regulatory level feedback support the formative assessment process and lead toward improved student learning. In order for formative assessment to be successful in leading to improved student learning, it is vital that effective feedback strategies be structured to support the purpose of formative assessment.

This structural role of feedback in supporting the aims of formative assessment guided this qualitative instrumental case study. As the assessment and feedback practices of mathematics teachers at the school were explored, data was evaluated to understand the purpose of assessment in the classroom and in what manner feedback supported the aims of formative assessment in promoting student learning.

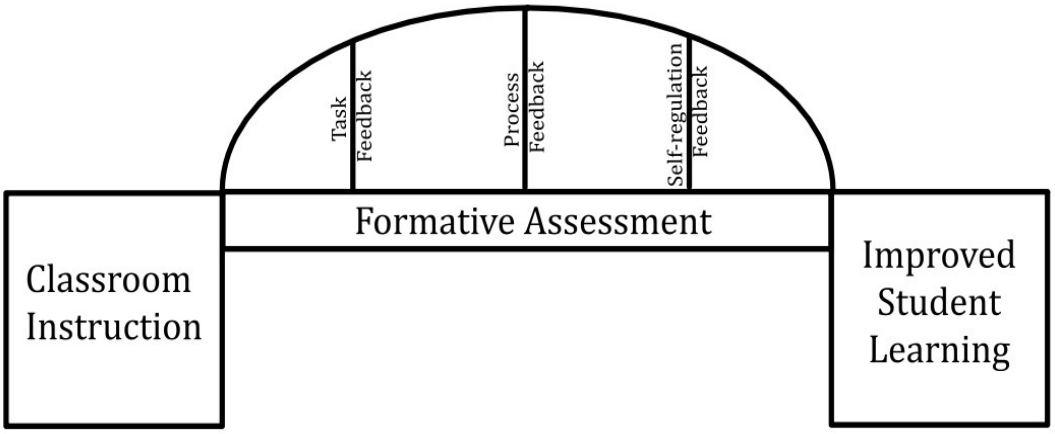



*Figure 3.* Effective feedback: The structural support for formative assessment.

This section described the theoretical framework for the proposed study, which promotes effective feedback as a necessary support for formative assessment. Black and Wiliam's (2009) model of formative assessment described the conditions needed to advance student learning. Included in those conditions was the prominent role and

purpose of feedback, which can have powerful impact if used effectively. Hattie and Timperley's (2007) model of feedback detailed four different levels of feedback and recommended how feedback should and should not be used. Both of these models were cited by the NCTM (2014) in their promotion of increased formative assessment and feedback. The amalgamation of these two models served as the framework for this study and aligns with the NCTM's (2013) recommendation for increased formative assessment methods in mathematics classrooms. In the next section a more detailed treatment of classroom assessment will be addressed.

**Classroom Assessment**

Regardless of the developmental level or curricular subject, classroom assessment plays a key factor in the process of student learning (Jiang, 2014). In arguing for the importance of assessment in connecting instruction with student learning, Wiliam stated that "assessment is *the* central process in instruction" (2011a, p. 47). Assessment can take a variety of forms and serve many purposes, but ultimately classroom assessments are administered in order to determine to what extent the intended learning goals were achieved by the students (Wiliam, 2011b) and to infer some judgment about the student's level of learning or performance (Black & Wiliam, 1998b, 2009; Sadler, 1989).

The results of classroom assessments can serve a certifying function, often referred to as summative assessment, or to promote further learning, commonly designated as formative assessment. The same assessment may be used in both a summative and formative manner, the difference between the two is the intended purpose for the evidence that is elicited from the assessment (Sadler, 1989). Summative uses of

assessment evidence are often termed “assessment *of* learning”, while formative purposes are commonly referred to as “assessment *for* learning” (Black & Wiliam, 2009).

The principal at the proposed research site was concerned that the mathematics teachers in the school are using assessment in a mostly summative manner and that the lack of formative assessment may be hindering the learning of the students. The principal’s concern regarding the amount of summative assessment in mathematics was echoed by See Ling and Saw Lan (2012) in their study of current assessment practices of 406 in-service teachers in Malaysia. Using a quantitative cross-sectional survey design, they investigated the differences in assessment practices between teachers in primary and secondary schools, language and science-mathematics teachers and teachers with more than ten years of experience and those with less than ten years of experience. See Ling and Saw Lan (2012) developed an inventory instrument specifically for this study and had it validated by outside experts in educational assessment. Using the Rasch model to identify how often various assessment practices were utilized and differential functioning analysis to compare between groups, the authors found that assessment practices varied based on teaching experience, subject area, and school level. More specifically, they discovered that secondary mathematics teachers tended to use more summative and traditional assessment methods and they relied heavily on homework as an alternative source of grades, especially for those teachers with more than ten years of teaching experience (See Ling & Saw Lan, 2012). The authors recommended that more professional development regarding specific assessment strategies and methods is needed for in-service teachers to support learning.

This next section will focus on the aspects, characteristics, and goals of formative assessment and how it may be applied to effective mathematics assessment in the classroom so that student learning might be improved.

**Formative assessment.** The overarching goal of formative assessment is to promote increased student learning (Clark, 2012; Hattie, 2012; Suurtamm, Koch, & Arden, 2010; Wiggins, 2012; Wingate, 2010), but yet it is not widely practiced at the local level (Gamlem & Munthe, 2014; Lee et. al., 2016). Because of the lack of formative assessment found in classrooms, Heitink, Van der Kleij, Veldkamp, Schildkamp, and Kippers (2016) examined the necessary conditions for implementing formative assessment successfully in the classroom. In their literature review of 25 relevant studies that met their search criteria, they found that for formative assessment to be effective, "it is crucial to invest in professional development" (Heitink et al., 2016, p. 60) that is sustained and prolonged in order for change to occur beyond a surface level. Their findings suggested that professional development should address teachers' attitudes and beliefs regarding assessment since those beliefs impact the fundamental purpose of assessment and the successful implementation of formative assessment at the classroom level. They suggest that teachers who hold a constructivist, student-centered view of learning are more likely to perform formative assessment strategies effectively.

Successful classroom implementation also requires teachers to hold pedagogical content knowledge and assessment literacy that can provide feedback to students on their level of learning. The authors state that an "exact prescription for success cannot be provided" (Heitink et al., 2016, p. 61) due to the unique conditions at the local level, and

that increased student learning depends on a custom implementation of the suggested prerequisites for effective implementation of formative assessment.

Box et al. (2015) also observed that formative assessment had not been widely implemented in schools in Texas. Using a qualitative case study design involving three high school science teachers they sought to understand the complexities of teachers' personal assessment beliefs and how those beliefs influenced the implementation of formative assessment. Simlar to Heitink et al. (2016), their findings did reveal that the teachers' beliefs heavily impacted formative assessment implementation, and those teachers with a constructivist viewpoint embraced formative assessment methods more readily. The authors suggested that identifying teachers' assessment beliefs and philosophies should be identified and understood prior to taking steps to promoting formative assessment practices (Box et al., 2015).

In their influential theoretical article, Black and Wiliam (2009) propose that classroom practice is formative when assessment evidence is used by teachers, students, or peers to make instructional decisions about the next steps in the learning process. The key distinction are the decisions that are made in relation to the assessment evidence, because formative assessment is a continuing process, whereas summative purposes of assessment serve a final certifying function.

The Black and Wiliam (2009) model consists of five strategies for conceptualizing formative assessment practice (see Figure 1). The role and beliefs of the teacher in the process is vital as the teacher is the one responsible with constructing an environment that can satisfy and promote the five formative assessment strategies.

The first two strategies, clarifying and sharing the learning intentions and engineering effective classroom activities to provide evidence of student understanding, can be found in a summative or formative process, but are foundational in setting the stage for the next three strategies that set formative assessment apart from its summative counterpart. The significant difference between formative and summative assessment is that formative assessment uses the assessment evidence and adapts to the needs of the learners. Black and Wiliam's (2009) final three strategies of "providing feedback that moves learners forward" (p. 8), "activating students as resources for one another" (p. 8), and "activating students as owners of their own learning" (p. 8) are all contingent on the utilization of assessment evidence to make adaptations to further advance student learning, which Black and Wiliam call "moments of contingency" (2009, p. 10).

The third strategy of providing feedback is endorsed by many researchers as the central purpose of assessment (Clark, 2012; Dukor & Holmberg, 2013; Hattie, 2012; Hattie & Timperley, 2007; Hattie & Gan, 2011; Wiggins, 2012; Wiliam, 2011b; Wiliam & Leahy, 2015; Wingate, 2010; Yang & Carless, 2013) and can be used by teachers, the students themselves, and their peers. There are various types of feedback that have varying effects on student learning. A more in-depth treatment of feedback will be addressed in a later section.

***Self-regulation.*** In the past, and up to the recent day, researchers have long placed an emphasis on students developing and using self-regulating strategies in order to advance their own learning (Bandura, 1991; Clark, 2012; Hudesman et al., 2013; Nicol & Macfarlane-Dick, 2006; Sadler, 1989; Tay, 2015; Wiliam 2011b; Wiliam & Leahy, 2015;

Yang & Carless, 2013). In his seminal theoretical article, Sadler (1989) suggested that the design of the entire instructional system should focus on the promotion of student self-regulation based on feedback that clearly identifies the gap between the current and desired level of performance, and also gives students a direction in order to address the gap. Self-regulation "refers to the degree to which students can regulate aspects of their thinking, motivation, and behavior during learning" (Nicol & Macfarlane-Dick, 2006, p. 199).

Hudesman et al. (2014) conducted a quasi-experimental study examining whether the effect of a formative assessment program that developed self-regulation strategies among 125 developmental mathematics students had an impact on mathematic achievement of the students at two 2-year colleges. The mean grade for the students increased 1.1 grade points (on a scale of 12), and the percentage of students passing the course rose 15.7% (Hudesman et al., 2014).

The authors concluded that the inclusion of self-regulatory strategies within formative assessment positively impacted student achievement but did caution that the instructors of the courses expressed concern over the labor intensity of implementing such a system. Hudesman et al. (2014) suggested that implementation of any new method will require extra time initially but will subside over time and the investment of time is worth the result.

In his theoretical article, Clark (2012) extended Sadler's (1989) preposition that assessment's purpose is to promote self-regulation in students. Built on the foundation of formative assessment as advocated by Black and Wiliam (2009) and Nicol and

Macfarlane-Dick (2006), and the feedback model of Hattie and Timperley (2007), the main tenet of Clark's theory explained how the theory of how formative assessment should promote self-regulated learning in students. Clark (2012) proposed that students who self-regulate their learning generate more internal feedback, are more inclined to accept external feedback, take more responsibility for their learning, are increasingly motivated to learn, and are more self-efficacious, in turn leading to life-long learning.

Clark's theory aligns and agrees with the five aspects for effective formative assessment found in Black and Wiliam's (2009) theory of formative assessment. Similarly, Clark also trumpeted the role of feedback, which is at the core of his model and stated that formative assessments "are specifically aimed at generating feedback, both internal and external" (Clark, 2012, p. 213) to assist student learning progress. As such, teachers play a vital role in carefully and deliberately constructing a non-threatening environment and classroom culture were the aspects of formative assessment increase the opportunities for students to seek and receive feedback that promotes self-regulation in the learning process. Clark posited that if these opportunities are done consistently, "the learner will generate internal feedback which make them more engaged, effortful, and self-regulated" (Clark, 2012, p.214) which increases further learning.

Students need the opportunity to develop self-regulatory skills under the guidance of the teacher to prepare them life-long learning (Nicol & Macfarlane-Dick, 2006; Yang & Carless, 2013). The formative assessment process can accomplish this purpose as it intertwines five strategies in order to advance student learning in the

classroom (Wiliam, 2016a). During the process, moments of contingency (Black & Wiliam, 2009) are created resulting in feedback that is conveyed to various agents to make decisions about the future course of learning. Feedback is pivotal to the formative nature of the process to promote continued student learning and to ultimately develop self-regulation strategies for life-long learning.

**Effective mathematics assessment.** The National Council of Teachers of Mathematics (NCTM) has endorsed assessment reform in mathematics classrooms (National Council of Teachers of Mathematics, 2000, 2014) in order that all students learn mathematics at higher levels. NCTM proposed that mathematics assessment be an integrated part of instruction, provide feedback to students, allow for instructional adjustments to be made, and be "a process whose primary purpose is to gather data that support the teaching and learning of mathematics" (2014, p. 89). NCTM has promoted the use of formative assessment strategies (National Council of Teachers of Mathematics, 2013) in order to enhance student learning, make instructional decisions, and promote student self-regulation strategies (National Council of Teachers of Mathematics, 2014).

While the formative assessment process can be used in any curricular subject area and for a variety of developmental levels, investigation within specific academic disciplines is needed (Gotwals, Philhower, Cisterna, & Bennett, 2015). In their mixed method study of the use of formative assessment in mathematics and science classrooms in Michigan, Gotwals et al., (2015) contended that subject discipline teachers need to have pedagogical expertise within their discipline to fully realize and implement formative assessment strategies. They recommended further investigation in the

mathematics and science disciplines in order to ascertain characteristics and aspects of expertise of using formative assessment in these particular disciplines.

Hodgen and Wiliam's (2006) adaptation of Black and Wiliam's (1989b) influential review targeted the use of formative assessment in mathematics and noted that most teachers corrected and marked student work very quickly, but the method provided very little information regarding student understanding to use as formative feedback. In a qualitative case study of six public middle school mathematics teachers in the United States, Kobrin (2016) found that teachers used assessment to find out if students mastered content rather than to use assessment as a way of understanding student thinking and providing feedback. The NCTM encourages teachers to not view assessment in the same perspective as grading or marking, but to use the assessment data to gain insight into students' thinking and understanding in order that decisions can be made about the next steps of instruction (National Council of Teachers of Mathematics, 2014).

In their quasi-experimental mixed-method convergent parallel design study, An and Wu (2012) studied the problem of mathematics teachers who did not take the time to analyze student homework in order to gain knowledge of students' thinking. They investigated whether analyzing student homework errors would increase teacher knowledge of student thinking and pedagogical content knowledge. The researchers noticed a problem that, in comparison to their Chinese counterparts, teachers in the United States lack the time to review and analyze student homework on a daily basis and that "teachers lack training or expertise in sound practice, which implies that teachers

need to be guided in finding an effective approach to grading homework" (An & Wu, 2012, p. 720).

Ten teachers in the fifth to eighth grades from four different schools in a district in California participated in the two-semester experimental study and were assigned to two different treatment groups. An and Wu (2012) collected qualitative data through classroom observations, interviews, daily grading logs, and questionnaires. The quantitative and comparison data were reported in a different article. The participants in the experimental group were trained by the authors in methods to identify errors, analyze reasons for those errors, design a plan for correction, and implement the action. The control group was trained only to use their current method of grading in completing the daily grading logs. 20 scoring logs per teacher were rubric-scored based on their ability to address the four steps of error analysis. Analysis of the data (see Table 1) showed that the teachers in the experimental group increased their ability and knowledge in all four categorical steps of error analysis from the first semester to the second semester.

Table 1

*Scores of Teachers' Knowledge of Error Analysis*

| | Fall Semester | | Spring Semester | |
|---|---|---|---|---|
| Criteria | Mean | Standard Error | Mean | Standard Error |

| | | | | |
|---|---|---|---|---|
| Identify | 2.875 | 0.187 | 3.650 | 0.071 |
| Analyze | 3.025 | 0.187 | 3.750 | 0.071 |
| Design | 2.633 | 0.215 | 3.467 | 0.081 |
| Action | 3.220 | 0.167 | 3.740 | 0.063 |

From "Enhancing mathematics teachers' knowledge of students' thinking from assessing and analyzing misconceptions in homework" by S. An & Z. Wu, 2012, *International Journal of Science & Mathematics Education, 10(3),* p. 733. Reprinted with permission.

In order to significantly improve mathematics teaching in the United States, An and Wu (2012) recommend that researchers focus their attention on the effects of analyzing errors and the assessment of homework and provided a recommended procedure to assist teachers in using homework as a tool for formative assessment. The recommendations for teacher practice from the An and Wu (2012) study align with the suggestions of effective mathematics assessment advocated by the NCTM, which recommends moving away from assessment as an accountability tool and toward a method of generating evidence of student learning and then adjusting instruction accordingly (National Council of Teachers of Mathematics, 2014).

While it was not stated that any member checks, peer debriefing, or external audits were incorporated as part of their study (An & Wu, 2012), the article detailed the procedures for multiple points of data collection and analysis, including a thorough description of the setting and interactions of the researcher and participants sufficiently enough that the credibility and dependability of the research did not suffer. While the research focused on mathematics at the middle school level, the descriptions of the process would allow other teachers in other subjects and developmental levels to transfer

these findings and strategies into other contexts such as high schools, as is the focus of this proposed study. It should be noted that the relatively small participant sample is a limitation, as is the exclusion of any of the quantitative student achievement data.

Classroom assessment can serve a summative or formative purpose. The process of formative assessment is divergent from summative assessment by its use of assessment evidence to provide insights about student thinking so that effective feedback can be provided, and sound instructional decisions can be made to promote student learning and support self-regulation. The National Council of Teachers of Mathematics endorses formative assessment in mathematics education and recommends that teachers establish a practice of using assessment information to "inform and improve the teaching and learning of mathematics" (National Council of Teachers of Mathematics, 2014, p. 91). The next section will address the pivotal role of feedback and how the effective practice of feedback supports the goals of formative assessment.

**Feedback**

In order to incorporate formative assessment practices into mathematics education, it is imperative to examine the critical role of feedback in the learning process (Carless et al., 2011; Wingate, 2010). In this section the role of feedback within the process of formative assessment will be presented, followed by the characteristics of effective feedback practice, the role of the teacher in the process and finally its implications for mathematics education.

**The supporting role of feedback within formative assessment.** Black and Wiliam's (2009) theory of formative assessment includes feedback as a key strategy for

advancing the goals of formative assessment. Ramaprasad's (1983) classic definition of feedback within systems is "information about the gap between the actual level and the reference level of a system parameter which is used to alter the gap in some way" (p.4). He further proposed that feedback is not considered feedback unless the information is actually used to alter the gap between the current and desired level. While Ramaprasad (1983) was concerned with management theory systems and did not specifically address feedback in education, his definition has been influential in shaping the conversation around educational feedback in the formative assessment process and is fitting to assimilate the Ramaprasad's feedback system model toward educational purposes (Wiliam, 2012). More recently, Hattie and Gan (2011) define feedback as "information provided by an agent (e.g., teacher, peer, book, parent, and self/experience) regarding aspects of one's performance or understand that reduces the discrepancy between what is understood and what is aimed to be understood" (p. 258). Chappuis (2012), Hattie (2012), Sadler (2010), and Wiliam (2011b) contend that classroom practice does not become formative unless the feedback is acted upon to reduce the gap between the current understandings and the desired goal.

While the purpose of feedback is to improve learning by explicitly communicating the gap between the student's current performance level and what is desired, the target of that feedback information can be directed at the teacher or the student (Sadler, 1989). In a formative process, the resulting feedback information allows teachers to make instructional decisions to help design the next steps of teaching (Nicol & Macfarlane-Dick, 2006). The feedback information that is returned to the students will

indicate whether the performance met the learning expectations or if the expectation was not met. As depicted in Table 2, the students can respond to this information in four different manners, resulting in eight possible responses to the feedback message (Wiliam, 2011a). Of the eight possible student responses to feedback interventions, only two of them, increased aspiration and increased effort, are positive. With the possibility of feedback having negative effects on students, it is imperative to identify the characteristics of effective feedback practice that result in positive outcomes.

Table 2

*Possible Responses to Feedback Interventions*

| Response type | Performance exceeds goal | Performance falls short of goal |
|---|---|---|
| Change behavior | Exert less effort | **Increase effort** |
| Change goal | **Increase aspiration** | Reduc**e** aspiration |
| Abandon goal | Decide if goal is too easy | Decide goal is too hard |
| Reject feedback | Feedback is ignored | Feedback is ignored |

From "What is Assessment for Learning?" by D. Wiliam, 2011a, *Studies in Educational Evaluation, 37(1),* p. 6. Adapted with permission.

**Effective feedback practice.** Feedback is a critical part of the learning process (Carless et al., 2011; Wingate, 2010). When administered in effective manner, Hattie and Gan (2011) stated in their meta-analysis that feedback is one of the highest influencers of student achievement. Information elicited from assessments and communicated to students from teachers in the form of feedback in order to guide students is vital to promote further learning (Fyfe et al., 2012; Price, Handley, Millar, & O'Donovan, 2010;

Tovani, 2012). Despite the promotion of the positive effects of feedback, it is not widely practiced in an effective manner (Havnes et al., 2012). Researchers continue to study the nuances of feedback within a formative system of assessment in order to explore the problems that inhibit the widespread implementation of effective feedback practices in education.

In order for feedback to be most effective, two preconditions need to be satisfied. These preconditions align with Black and Wiliam's (2009) theory of formative assessment. The first condition is that the learning goals and intentions need to be clarified and communicated (Goodwin & Miller, 2012; Lalor, 2012). In order for feedback to reduce the gap between the student's current performance and what is desired, then the goal naturally has to be established. In a qualitative case study that sought to understand the feedback practices of 33 elementary school teachers in the Netherlands, van den Bergh, Ros, and Beijaard (2013) found through a questionnaire that only about 25% of the teachers conveyed the importance of feedback addressing the learning goal. The authors' observations of the teachers' feedback interactions found that less than 5% of those interactions were directly related to the goal of the learning and stated that "the lack of goal-related feedback in the classroom is problematic" (van den Bergh, et al., 2013, p. 427). The second precondition is the teacher needs to select assessment activities that will provide appropriate evidence that will be used in the feedback message (Akpan, Notar, & Padgett, 2012; Black, 2015; Santos & Semana, 2015; Tay, 2015). Only when these preconditions are fulfilled will feedback have the potential to be effective.

The content of the feedback message is important as it communicates to the student what is needed to improve learning (Bilbro, Iluzada, & Clark, 2013). The Hattie and Timperley (2007) model categorizes feedback content into four category levels: task level, process level, self-regulatory level, and self-level. As was stated earlier, task level, process level, and self-regulatory level feedback can be effective when delivered appropriately to match the instructional task (Hattie, Fischer, & Frey, 2016), but self-level feedback should be avoided as it does not provide students with any knowledge on how to reduce the gap in their understanding. Wiliam (2016b) also warned that the content of the feedback should not reveal everything to the student. He recommended that feedback be turned into "detective work" so that the "intellectual heavy lifting" (Wiliam, 2016b, p. 12) is done by the student and not the teacher. The danger of correcting all the errors for a student is that it leaves nothing for them to note other than what responses were incorrect, losing out on valuable opportunities to be active in the learning process and promote further thinking and self-regulation (Fisher & Frey, 2012; Wiliam, 2016b; Wilson, 2012).

The timing of the feedback message is vital and needs to be delivered in an appropriate timeframe in order to be useful for students (Brookhart, 2012; Siewert, 2010; Tovani, 2012; Wiggins, 2012; Yang & Carless, 2013). In their review of the literature, Goodwin and Miller suggested that "the optimal timing of feedback seems to depend on the nature of the learning task" (2012, p. 83). There is a delicate balance in the timing since if feedback arrives too late it will not be used by students, however, it can also arrive too early and lead to student dependence on external feedback which suppresses

their ability to develop self-regulatory strategies (Goodwin & Miller, 2012; Yang & Carless, 2013). Immediate feedback seems to be beneficial for initial procedural learning and messages that are considered at the task level so that error correction at the early stages of learning can occur (Hattie & Timperley, 2007; Wiliam, 2011a). Process level feedback messages benefit from a delay in the delivery. Since students working at the process level are working on higher order tasks, the delay in the feedback message promotes student thinking, reflection, and self-regulation (Hattie & Timperley, 2007; William, 2011a). Feedback should be delivered in a timely manner while the student still has the opportunity to act on it and use it in the learning cycle (Moss, 2015; Wiliam, 2012). To be effective, feedback need to be based on student's prior knowledge and understanding (Hattie & Timperley, 2007).

Based on their quantitative experimental study, Fyfe, et al. (2012) showed that the effects of feedback are also variable depending on prior conceptual knowledge of the students. The findings of their study suggest that feedback had a higher level of impact for low-knowledge students. Since the goal of feedback is to "facilitate the correction of misconceptions of errors" (p. 1105), they found that for students who already possessed procedural knowledge, they do not require feedback as it is unnecessary to reconcile current understandings with the learning goal.

Problems can exist regarding student reception of teacher feedback. Students often fail to understand teacher feedback (Lalor, 2012), and feel frustrated when papers are returned full of marking and corrections (Mahfoodh & Pandian, 2011). This is a

problem since “feedback can only be effective when the learner understands the feedback and is willing and able to act on it” (Price et al.., 2010, p. 279).

A number of studies have identified various barriers and problems as they relate to delivering effective feedback. One major issue is a lack of knowledge and training in effective feedback methods (An & Wu, 2012; Dixon & Haigh, 2009; Lee, 2011). In a quasi-experimental study to investigate the effectiveness of feedback across nine primary schools in England, See, Gorard, and Siddiqui (2016) found that implementation of formative feedback is a complex process and teachers need guidance, practice, and support in order for feedback to positively impact student learning. Knowledge of how to use feedback effectively is important since the result of certain types of feedback do not result in positive learning outcomes (Hattie, 2012; Hattie & Gan, 2011; Hargreaves, 2012; Havens et al.., 2012; Price et al.., 2010). Havens et al. (2012) concluded that there is more of an emphasis on obtaining correct answers in mathematics, which has been shown to impede future learning and other positive aspects of formative assessment (Kluger & DeNisi, 1996).

An and Wu (2012) found that mathematics teachers “lack training or expertise in sound practices” (p. 720) in assessing student work, making effective feedback difficult. The lack of training can be remedied by professional development, however, Opfer and Pedder (2011) found in their review of literature on teacher professional development practices that the beliefs and perceptions of teachers need to be understood if professional learning and training are to have a deep impact.

A qualitative case study with the intent to understand secondary school teachers' perceptions and practices related to classroom feedback was conducted by Gamlem (2015) in which three teachers in Norway were purposely selected to participate in a six-month professional development intervention intended to improve instructional feedback. Baseline data were collected prior to the intervention in the form of semi-structured interviews and two video recorded classroom lessons.

The intervention was structured as three knowledge-building stages that included (a) a two-hour workshop to build feedback capacity, (b) video recording of subsequent teacher lessons, and (c) an individual teacher workshop in which the teachers reflectively analyzed their video recorded lessons (Gamlem, 2015). The teachers participated in three cycles of the three knowledge-building stages over the course of the study, which was aimed to progressively build their instructional feedback practice.

Through an inductive coding process of the data, five categories emerged regarding the teachers' practices and beliefs about the role of feedback in the learning process: "the purpose of feedback, feedback content (types), timing of feedback, relationships to pupils, and learning targets(s)/aim(s)" (Gamlem, 2015, p. 470). The results indicated that each of the three teachers progressed toward more formative uses of feedback through the course of the intervention, although the author stated that the speed of the progression was unique for each participant within each category. The author stated that if "teachers are to develop feedback practice, they must see that there is a gap between current and desired performance" (Gamlem, 2015, p. 477) and that there is a need for external expertise in challenging teachers' current belief system and moving

them toward a more formative use of feedback that views assessment information as an integral part of the teaching and learning process.

This study had limitations typical of a qualitative case study that had a small sample size. The lack of participant and school demographic information limits some of the ability to translate the study and its findings into a different context. The author did identify that the reported change in teachers' "beliefs and practice during an intervention study might be affected by other factors that this study did not take into account" (Gamlem, 2015, p. 478) such as personality traits and learning styles. The author recommends that investigation into teachers' feedback beliefs can be substantiated by continuing to conduct research of this type in various locations and with larger population samples (Gamlem, 2015).

An additional barrier to effective feedback is the widespread use of grades as a form of feedback. While many teachers consider grades as part of feedback, Wiggins called grades "useless as actionable feedback" (Wiggins, 2012, p.16) and that they should not be relied on as a source of feedback. Wiliam (2012) stated the studies have shown that when grades are used as a form of feedback, student learning suffers. A number of researchers have issues with grades as feedback and contend that even if comments are included with the grade, the grade overshadows the feedback message and leads to the students ignoring the comments meant to move learning forward (Dukor & Holmberg, 2013; Price, et al., 2010; William, 2012).

Because grades are such a traditional part of the educational system, it is difficult for purely formative feedback to take root as students and parents are often focused to

achieve high grades as early as primary school reaching up to the university years (Beaumont, O'Doherty, & Shannon, 2011; Dorn, 2010; Havnes, et al., 2012; Nichols, 2012; Sadler, 1989, Wiliam, 2012). The use of traditional grades not only is a poor form of feedback since it does not identify or help reduce the gap in student learning compared to the instructional goal, but also leads students to make ego-involving judgments about themselves or their peers, lowers self-esteem of lower-ability students, engagement suffers, and leads to a performance orientation as opposed to a learning orientation in the student (Dukor & Holmberg, 2013; Nicol & Macfarlane-Dick, 2006; Wiliam, 2012). Sadler (2010) argued that grades are not compatible with the formative assessment process and recommended that the evidence used for formative feedback be used for improving learning, not calculating a grade. Wiliam and Leahy (2015) suggested that the frequency of grades be lessened, that feedback not be mixed with grades, and to not assign grades while learning is still in progress.

Due to the many traditional practices in education, such as grades, there may be some conflict and political pressure hindering a move toward a purely formative feedback system (Dorn, 2010). The classroom teacher is a key player in combating outside influences and deliberately constructing formative assessment systems that provide opportunities for students (Moss, 2015) to receive feedback yielded from assessment evidence that can be used extend their learning.

**The role of the teacher.** The importance of the teacher's role in providing feedback is noted by many researchers as a vital part of the learning process (Box, et al., 2015; Hattie & Gan, 2011) and is highlighted in the first three aspects of the Black and

Wiliam (2009) theory of formative assessment and is inherent in the feedback decisions of teachers in the Hattie and Timperley (2007) feedback model. Wiliam (2012) stated that in order for feedback to be effective in advancing student learning, the first thing a teacher must do is establish an environment where mistakes are not feared but seen as a natural part of the learning progression. A culture of trust between the teacher and the student is necessary for students to receive feedback in a manner that is aimed at improving their performance and not seen as a personal judgment (Hattie & Gan, 2011; Price, et al., 2010). The overall classroom environment needs to be one in which students can openly be challenged with content or tasks that are beyond their current level of skill and not be fearful of the reactions of others, including the teacher or their peers (Hargeaves, 2012; Hattie, 2012). Hattie and Gan (2011) went as far as to suggest that errors should be openly welcomed in classroom since it is learning from them leads to higher performance, instead of the typical classroom climate where students are error-avoidant.

In addition to establishing an environment conducive to feedback, it is important teachers also have insight into pedagogical content knowledge of the subject matter in order to assist students by providing feedback that identifies the next steps that students need to take. It was noted by Sadler when he stated that feedback needs a "teacher who can recognize and describe a fine performance, demonstrate a fine performance, and indicate how a poor performance can be improved" (Sadler, 1989, p. 120). Additionally, teachers need to have a diverse in-depth knowledge of instructional objectives, common student misconceptions, learner abilities and background knowledge, as well as the

proper feedback type for each circumstance (Hattie & Gan, 2011; van den Bergh, et al., 2013).

Due to teachers being the primary "deliverers of feedback and agents of change in the classroom" (Lee, 2011, p. 2), Lee used an embedded mixed method design to study if 48 teachers in Hong Kong were ready to revolutionize feedback practice and identified what factors may inhibit teachers from changing their feedback practice. Lee's (2011) findings from the quantitative survey showed that over half of the educators that participated indicted that they would consider adopting feedback practices that they were not currently using. Through the analysis of the data, Lee (2011) found that the culture of the educational environment due to high accountability in Hong Kong inhibits teachers from experimenting with alternative methods. He also found that the lack of professional training in feedback was a "major stumbling block" (Lee, 2011, p. 6). This lack of training led to a "chasm" (Lee, 2011, p. 9) between the espoused beliefs of teachers and their classroom practice. Lee (2011) recommended that in order to change teacher feedback practice, teacher professional training in feedback techniques needed to be enhanced. This training would need to incorporate an evaluation of traditional instructional practices and empower teachers to have the autonomy and freedom to experiment with innovative methods.

Many teachers have reported that feedback is difficult because providing it effectively is time-intensive (An & Wu, 2012; Carless et al., 2011; Fisher & Frey, 2012; Havnes et al., 2012; Mahfoodh & Pandian, 2011; van den Bergh, et al., 2013; Wingate, 2010), especially to large class sizes (Lee, 2011; Owen, 2016). Additionally, teachers feel

that feedback is not utilized or considered valuable by students (Havnes et al., 2012; Lee, 2011).

As a part of their explanatory sequential mixed method study in Norway, Havnes et al. (2012) investigated the perceptions of feedback practices of secondary school teachers. The study focused on identifying current feedback practices and strategies for improvement. They targeted the feedback practices in the three core subjects, English, Norwegian, and mathematics. Using a survey questionnaire and focus group interviews they investigated the how both the 391 students and the 192 teachers perceived the effectiveness of teacher feedback practice in five different schools. The researchers collected quantitative and qualitative data and categorized the data into four dimensions of the level of engagement each group had with feedback: (a) quality of feedback, (b) student use of feedback, (c) peer feedback, and (d) student involvement in assessment practice. The quantitative data was analyzed using factor analysis and informed the subsequent coding of qualitative interview data.

Similar to the findings of An and Wu (2012), Dixon and Haigh (2009), and Lee (2011) in regard to teachers in general, Havnes et al. found that mathematics teachers often have a limited perspective of feedback where answers are verified and view feedback as "corrections of completed work" (Havnes et al., 2012, p. 25). They found that when feedback was given, it was usually attached to an evaluative grade, which has been shown to reduce the impact of feedback by other researchers (An & Wu, 2012, Black & Wiliam, 2009; Price et al., 2010). Havnes et al. discovered that formative feedback is uncommon in education and that schools do not have systematic use of

feedback or a "culture of assessment for learning" (2012, p. 26) where true formative feedback can flourish. They concluded with four situations in which feedback opportunities are plentiful: posttest evaluation of work, student presentations, group-work, and dialogue between teachers and students.

Several implications emerged from the study. The researchers suggest that at the school-level, feedback is not systematic and there was a lack of a "culture of assessment for learning" (Havnes et al., 2012, p. 26). They suggest that teachers be more explicit with their feedback and give students progress on their attainment of the learning goal and what they can do to improve. This point aligns with Hattie and Timperley's (2007) model of effective feedback providing three pieces of knowledge: providing clear goals to students, giving them progress on the goal, and then what students should do next to further their learning.

Feedback was found to have an emphasis on knowledge of results and the correct answer, especially in mathematics. The researchers found that at the systemic level, assessment was mainly focused on the correction and grading function and that teachers and students did not view this form of communication as feedback. They advocated a need to "re-conceptualize feedback to emphasize assessment and feedback as an integral aspect of learning and problem solving" (Havnes et al., 2012, p. 26), which would assist in developing a culture of using assessment for the purpose of learning. While every teacher in all the schools participated in the study, it should be noted that the authors identified that the focus group sample of students had an overrepresentation of high

achievers due to a self-recruitment method, which represents a potential threat to validity due to selection bias (Havnes et al., 2012).

The teacher's role in establishing an environment for formative feedback to flourish cannot be understated. However, it takes training, time, and practice for the teacher to master the subtleties of constructing such an environment (Dukor & Holmburg, 2013). While some curricular subject areas may adopt formative assessment strategies more easily, the mathematics field needs teachers that can design such environments and implement formative assessment strategies (An & Wu, 2012).

**Feedback implications in mathematics.** The body of research on formative assessment and the use of feedback show that its implementation into the educational setting is varied. If not implemented correctly, feedback may have a negative effect on student learning. Hodgen and Wiliam (2006) experienced that most mathematics teachers used ticks and marks to communicate knowledge of results to students and then summarized the amount of marks to give an overall grade. While an efficient method of marking, they noted that it had minimal use for formative feedback since it does not give the students any information on how to reduce the gap between the current and desired level of understanding. Instead they recommended teachers:

- "provide specific feedback on a particular aspect of a pupil's work
- identify particular patterns of errors in a pupil's work
- give structured feedback that enables a pupil to identify errors for themselves
- encourage pupils to use their existing knowledge in assessing their own work" (Hodgen & Wiliam, 2006, p. 19).

In keeping with the philosophy of formative assessment, mathematics assessment needs to not just provide knowledge of results to students but provide on-going formative feedback and investigate students' mathematical understandings to further their learning (Attali, 2015; Dukor & Holmberg, 2013; Kearney, et al., 2013; National Council of Teachers of Mathematics, 2014; Suurtam, et al., 2010). It was the intent of this study to investigate the feedback practices of mathematics teachers in order to better understand what is needed in terms of further training and education so that effective feedback practices may be implemented.

This review of the literature examined the purpose and characteristics of formative assessment and the vital role that feedback plays in promoting student learning. Formative assessment is a process in which assessment-based evidence is used to make the instructional decisions to move student's learning forward (Black & Wiliam, 2009). The resulting information from the assessment evidence is used as feedback to reduce the gap of the student's current learning status and the desired goal. In order for feedback to have a positive impact on student learning, it must specifically address the learning task, the process of learning, or the self-regulation strategies needed for improvement (Hattie & Timperley, 2007). When feedback is delivered effectively within a classroom learning environment, it can be one of the most powerful influencers on student learning, result in developing student self-regulation strategies, and foster a love of life-long learning. Unfortunately, teachers need training to use assessments to elicit information that can be used to give effective feedback to positively impact student learning (An & Wu, 2012; Lee, 2011).

## Implications

In some mathematics classrooms at a Midwest private high school in the United States there is a gap in practice between what research suggests as effective assessment and feedback practice and what may be happening in local classroom practice. As a consequence of learning about the assessment and feedback beliefs and practices of these mathematics teachers, a greater awareness of this gap can be achieved for potentially bringing about positive change and improvement in student learning and more effective teacher practice.

The qualitative data from this study will provide insight to teacher thinking and other specific obstacles that may prevent teachers from reducing the gap in practice. Additionally, this information may provide the school with baseline information for conducting a needs assessment for targeted professional development for these mathematics teachers. The results of this study will be communicated to the school's leadership along with recommended professional development to address the gap in practice and assist these teachers in moving toward a classroom assessment process that utilizes the power of feedback within a formative assessment system that will promote increased student learning.

## Summary

In the never-ending search for improved educational techniques that can improve student learning, formative assessment has displayed the ability to increase student achievement (Black & Wiliam, 2009; William, 2011b). The National Council of Teachers of Mathematics (2014) has endorsed the use of formative assessment strategies in order

to achieve its objective to increase the level of mathematics achievement for all students at all levels of education.

The central philosophy of formative assessment as advocated by Black and Wiliam (2009) is to use assessments during the learning cycle for the benefit of student learning and to make decisions regarding the next steps in helping students learn. In contrast to summative assessment, which generally takes place at the end of a learning cycle for the purpose of certifying the level of student achievement, formative assessment uses assessment evidence as information for feedback to move student learning forward and promote student self-regulation.

The feedback aspect of the formative learning process is a vital cog in the system and can have one of the highest effects on student learning if used properly. The impact of feedback on student learning can be positive or negative depending on its use, so it is important to have an awareness of the various forms, characteristics, and the environment necessary for feedback to positively impact student learning. Hattie and Timperley's model (2007) of feedback aligns with the NCTM (2014) vision of improving mathematics education for all students. Investigating the feedback and assessment practices of mathematics teachers at the local school site will help the school administrators identify the specific gap in practice and develop professional training for its teachers in order to reduce the gap.

Section 2: The Methodology

## Introduction

The problem in some mathematics classrooms at a Midwest private high school in the United States, as reported by the school principal, is that the assessment and feedback practices may not align with what research suggests as effective practices that support student learning and that teachers may not have received training in these practices (personal communication, May 5, 2017). The school's average ACT mathematics score in 2012 was 24.1 and trended downward to a 23.5 in 2015 (ACT School Summary Statistics, 2016). The purpose of this instrumental qualitative case study was to explore the assessment and feedback practices of mathematics teachers in a private high school mathematics setting. The following research questions guided this study:

1. How do current practices of mathematics teachers align with the purpose and classroom application of both the Black and Wiliam (2009) assessment model and the Hattie and Timperley (2007) feedback model?

    1.1 In what ways do current practices identify the learning intentions for students?

    1.2 How do teachers design tasks to uncover evidence of student learning?

    1.3 What aspects and levels of feedback are present in current classroom practice?

2. What are mathematics teacher beliefs about the purpose of assessment and feedback?

3. What types of training have mathematics teachers received related to formative assessment and feedback?

## Research Design and Approach

In this project study, I used a qualitative instrumental case study design. A qualitative researcher looks to develop an understanding of a central phenomenon (Creswell, 2012). Inductive in nature and seeking to explore a problem, researchers that use qualitative methods typically gather data from interviews and observations in an effort to construct knowledge and understanding of the central phenomenon that is aimed to be understood (Creswell, 2012; Merriam, 2009). Since I sought to explore and understand the use of assessment and feedback within mathematics classrooms, an inductive research approach seemed appropriate. I chose an inductive approach over a quantitative deductive approach, which seeks to explain a cause and effect relationship between variables, test specific and narrow hypotheses, and summarize results numerically (Creswell, 2012; Merriam, 2009).

Several types of qualitative methods were considered for the study. Since this study was not attempting to build theory or seeking to understand the interaction of participants within their culture, grounded theory and ethnographic methods were not appropriate. The mathematics teachers would be sharing their beliefs, so a phenomenological study, which stresses the importance of individual perspective (Lodico, Spaulding, & Voegtle, 2010), could be attempted; however, the focus of this study was not on the teachers' perspective of the phenomenon, but to use their views to gain understanding about the use of assessment and feedback within their classroom practice.

In evaluating the local problem and identifying that a small number of mathematics teachers at a particular high school have a potential gap in practice in relation to their assessment and feedback practices, a case study research design was selected as it aligned with Creswell's (2012) definition of "an in-depth exploration of a bounded system (e.g., activity, event, process, or individuals) based on extensive data collection" (Creswell, 2012, p. 465). This design was an appropriate choice since the purpose of the case study is "to generate in-depth understanding of a specific topic . . . to generate knowledge and/or inform policy development, [or] professional practice" (Simons, 2009, p. 21). Since I used the case to study formative feedback, an instrumental case study design was selected in favor over an intrinsic case study design in which the case itself is of main interest (see Creswell, 2012). The purpose of the study aligns with the purpose of an instrumental case study in which research is conducted "on a case to gain an understanding of something else" (Stake, 1995, p. 171). In this study I used a case comprised of private high school mathematics teachers to investigate the issue of formative feedback within classroom practice.

## Participants

A purposeful sampling method was used to select participants. The school where the participants are employed has an enrollment of 141 students in Grades 9-12 in which 57% of the students are male and 43% are female. The school's mathematics department is made of up three teachers who teach various classes of the six levels of the mathematics curriculum ranging from general math to calculus. The city in which the school is located has a population of 75,000 and is considered a suburb of a major

metropolitan area. Seventy-nine percent of the city's population is White, 8% is Asian, and 5% is African American. The median income of the city is $88,000, which is $25,000 higher than the state median.

The school was purposefully selected due to similarities with the researcher's own school in size of enrollment, population demographics, and that it is part of the same nationwide private school system in which most teachers hold similar educational backgrounds and certifications. While each case is unique, it is possible with the number of similarities that transfer of results might be a possibility. Similar to the case study conducted by Box et al. (2015) in which the formative assessment practices of three high school teachers were investigated and the Gamlem (2015) case study regarding the feedback practices of three teachers in Norway, the target population for this study was all three of the high school mathematics teachers at the school. Generally, transferability may be limited when a target population is relatively small (Lodico et al., 2010); however, most of the schools in this particular private school system are as small or smaller than the target school. While the transferability may be limited in the general case, its potential transferability within this school system and possibly other small private schools where there are a small number of teachers in a single department is higher than the general case. The selection criteria were any teachers in the school who are involved in teaching or assessing mathematics who are interested in participating in the study.

Permission to conduct research at the site was gained through the school principal, who serves as the head administrator for the private school. The school has no

special formal process or board that grants permission to conduct research; it empowers the principal as the gatekeeper to make those decisions. The principal was approached by email and telephone conversation to gauge possibility for site access and official approval was secured via written document.

Once this study was approved through Walden's institutional review board (IRB) (approval number: 12-22-17-0290790), email addresses of all the mathematics teachers for recruitment into this study were obtained through the school website. A recruitment letter was sent to the three potential participants via email attachment. All three potential participants agreed to participate in the study and were given via email attachment the informed consent form to sign. Participants were given 7-10 days to review the form and ask pertinent questions. Participants were allowed to return the form via email attachment or in person at the interview.

The three participants consisted of the mathematics teachers at the high school. Six levels of mathematics courses were taught among these three teachers. Two of the teachers were male, and one was female with years of experience ranging from 2- 30 years. All three teachers were graduates of the same undergraduate institution and did not possess advanced degrees. To protect confidentiality, numbers were assigned to each teacher.

To reduce ethical dilemmas in conjunction with conducting the research for this study, a number of procedures were followed. The project study followed all regulations of Walden University's IRB protocol and recruitment procedures. Permission to conduct research at the school was obtained through the school's principal. No contact with

potential participants was sought until IRB approval had been secured. Guided by the Belmont Principles (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1978), participation was completely voluntary, and the participants' identities and responses were kept confidential. The location of the school in addition to the participants' information were de-identified to further preserve confidentiality.

Due to the small size of the school and limited number of available mathematics teachers able to participate in the study, there were limitations with respect to privacy of participation in the study. However, like previous case studies that have been conducted with small sample sizes of a bounded group of teachers (Box et al., 2015; Gamlem, 2015; Kelly, Gningue, & Qian, 2015; Ketsman, 2012; Kobrin, 2016), I sought to understand and explore a small number of teachers within a specific bounded case. Due to the small number of participants available within this small private high school, care was taken during all phases of the study to protect the participants in order to assure them that their information would remain confidential. Their participation was entirely voluntary, and they were given the opportunity to cease to participate at any time. The informed consent form clearly provided the information regarding potential risks associated with participation.

All of the participants are adult teachers of the school. The teachers may be considered a vulnerable population if there are concerns present that information that is shared or uncovered through the process might negatively impact their employment. However, such concerns at the target school are minimal as teachers are employed

permanently and are not able to be terminated unless a lengthy, multistep process is conducted by the school's independent governing body. The initial hiring, subsequent employment, and the possible termination of teachers are not conducted by the principal or school administration, but by the school's independent volunteer governing body (personal communication, May 5, 2017). This unique structure safeguards the teachers and means minimal risk of coercion for the potential participants from the administration. All the adult participants signed a consent form informing them of the study and its benefits and risks. Participants did not immediately or directly benefit from the study, nor did the study pose any risk to the participants' safety or wellbeing.

## Data Collection

For this qualitative case study, multiple data sources were employed. The mathematics teachers of the school served as a data source. Archival documents such as curriculum documents, course syllabi, lesson plans, assessment tools, teacher professional development records, observational field notes, and classroom artifacts were also used as data sources.

While the researcher in qualitative studies is the primary instrument, multiple data sources and collection tools were used. I constructed a document summary/analysis form (Appendix B) to assist me in the organization, collection, and analysis of curriculum documents, course syllabi, lesson plans, professional development records, and other classroom artifacts. This form was influenced by a document summary form by Miles and Huberman (Miles & Huberman, 1994, p. 55) and aligned with the framework of this

study. The observation field notes form (Appendix D) was used to assist my organization of the observation data according to the frameworks of the study.

A semistructured interview protocol, featuring both open and close-ended questions was developed by the researcher. Semistructured interviewing is advocated by Gillham (2000) as "the most important form of interview in case study research" (p. 65) due to its flexible, productive nature and its potential to produce rich data and was used in qualitative case study research conducted by Dixon and Haigh (2009) regarding mathematics teachers' perceptions of feedback. The interview protocol, containing the interview questions plus the interview script (see Appendix C) contained prompts that aligned with the study's research questions, which were designed to allow the participants to share their beliefs, perspectives, and experiences with assessment and feedback in their classroom practice.

Once IRB approval was granted by Walden University, permission from the school was secured, and the recruited participants agreed and signed the informed consent, data collection began. The first pieces of data that were collected were the curriculum documents, course syllabi, assessment tools, and teacher professional development records. These archival documents served as an initial reference point to the teacher's classroom practice.

After the initial documents were collected, the participants were contacted to set up a time and date for a classroom observation. Prior to the observation, lesson plans for the week of the observation were requested. The observation took place during the teacher's regularly scheduled mathematics class with the intent on seeing the teacher in

action and not on a day that has minimal teacher/student interaction (e.g., giving a test). Observation field notes (Appendix D) were used and focused on the teacher's interaction with the students and their use of feedback and assessment in relation to the framework of this study. Classroom artifacts, such as copies of completed anonymous student work that had been assessed during the week, were requested and received from the participant. These classroom artifacts were analyzed for how the assessment was used and the characteristics of the feedback that was delivered to the students from the teacher and if they were being used in a formative manner.

Finally, an interview was conducted with the participants. The interviews took place near the end of data collection phase so that the interview questions would not influence the teachers' normal classroom behavior. The interview was conducted at the school property in a private area selected by the participants so they felt comfortable, and was scheduled for 1 hour in duration. The interview protocol was the main structure of the interview; however, clarifying questions and prompts were added based on the prior analysis of various documents and the classroom observation. The interview was audio recorded, transcribed, coded, and analyzed for alignment with this study's conceptual framework. A draft of the preliminary findings was member checked with the participants in order to increase accuracy of the findings (see Creswell, 2012).

As the researcher, I had no past or current professional or personal relationship with any of the participants, minimizing any potential conflict of interest.

## Data Analysis

For this study, I used a coding process with archival documents, observational field notes, and interview transcripts. The qualitative data was analyzed using a two-cycle descriptive coding process. Throughout the coding process, data were examined for alignment with the aspects of the Black and Wiliam (2009) theory of formative assessment and the Hattie and Timperley (2007) model of feedback. The first cycle used a descriptive coding process that employed a short noun-based phrase that summarized the data (Saldana, 2013). Saldana (2013) endorsed descriptive coding for being "appropriate for virtually all qualitative studies but particularly" (p. 88) for beginning qualitative researchers learning how to conduct research with a variety of data forms. Following the first cycle of coding, a second cycle descriptive coding was employed to recode or revise the initial codes into longer elaborated themes for further analysis. The codes were then placed into categories that aligned with the study's conceptual framework.

During both cycles of descriptive coding, analytic memo writing was used as a method to generate further codes and categories and document the researcher's analytic thinking and coding choices during the coding and analysis process (see Saldana, 2013). This analytic memo writing process was recommended by Saldana (2013) as a means to assist in the transition from coding to the formal write-up of the study.

The resulting themes from the coding and analysis from the qualitative data assisted in generating a rich description of the teachers' beliefs and practice in understanding how they use assessment and feedback in their classroom practice.

I used several strategies in order to increase the credibility, transferability, and trustworthiness of the project study. Observation notes, teacher interviews, course syllabi, curriculum documents, lesson plans, teacher professional development records, and classroom artifacts served as multiple sources of data to validate my findings and conclusions. A thick, rich description of the setting, study, and participants allows readers to determine the degree of potential transferability to their own context (Creswell, 2012).

Member checking was employed to increase accuracy of the preliminary findings (Creswell, 2012). Using a similar procedure to the case study conducted by Fisher and Frey (2013), I provided the participants with a preliminary draft of the findings and asked them to read and verify that the information they provided was accurately conveyed. I provided them the opportunity to give feedback, elaborate on any of the interview questions, and make appropriate adjustments based on their feedback to increase the accuracy of interview findings and reduce the likelihood of discrepant data. While no significant discrepant data were identified in the study, had any cases emerged I would have further examined the data sources in the attempt to resolve the issue (see Lodico et al., 2010). If a discrepant case could not have been resolved, it would be noted in the findings of the study.

## Limitations

The nature of a qualitative case study has inherent limitations. The non-experimental nature of the study does not allow much room for replication to verify the findings. The small number of participants in the study and their accuracy and truthfulness in the interview is a limiting factor. The short duration of the time at the site

also limits the ability for the findings to make sweeping generalizations. Finally, since in qualitative research the primary instrument of data collection and analysis is the researcher's observations and judgments, a limitation exists in that the researcher can never fully come to know the absolute truth of the case that is being studied.

## Data Analysis Results

The problem in some mathematics classrooms at a Midwest private high school in the United States, as reported by the school principal, is that assessment and feedback practices may not align with what research suggests as effective practices that support student learning, and that the teachers may not have received training in these practices. The purpose of this instrumental qualitative case study was to explore and understand the assessment and feedback practices of mathematics teachers in a private high school setting. The research questions explored the beliefs and practices of mathematics teachers regarding the role and purpose of assessment and feedback. Qualitative data was collected from archival documents, observations, and semi-structured interviews. Data was analyzed by multi-cycle descriptive coding.

### Theme 1: How teachers communicate learning intentions for students

Research Question 1.1: In what ways do current practices identify the learning intentions for students?

This theme is aligned with the first strategy of Black and Wiliam's (2009) model of formative assessment in which the teacher clarifies "the learning intentions and criteria for success" (p. 8). All three participants communicated the learning intentions for their courses in various forms of written communication. The learning intentions were

articulated on a syllabus for each course which was given to the students at the beginning of the year. Teacher 1 and Teacher 2 also provided students with a study guide prior to an end of chapter assessment that communicated the expected learning intentions. Teacher 1 also had the current relevant targets posted in the classroom and shared them with the students via a shared Google document.

All three teachers expressed that they communicated learning intentions orally as well. Often spoken to the students at the beginning of a lesson or chapter, the teachers would set up the lesson by describing the intended learning for the lesson. All three teachers expressed that they would orally inform students of what would be assessed on a quiz or test on a day prior to the assessment so that the student would know what the content of the assessment. Teacher 3 stated that the information would be communicated orally at least "two days ahead of time, if not three, so that they can start zeroing in" on the learning intentions that would be assessed.

**Theme 2: How teachers design tasks to uncover evidence of student learning**

Research Question 1.2: How do teachers design tasks to uncover evidence of student learning?

Theme 2 was generated from participant data and aligned with second strategy of the Black and Wiliam theory of formative assessment in which teachers are "engineering effective classroom discussions and other learning tasks that elicit evidence of student learning" (Black & Wiliam, 2007, p. 8).

All three participants elicited learning evidence from students in similar manners. The main format of gathering evidence of learning from students was through written

regular assignments, quizzes, and tests. Assignments, quizzes, and tests were also the determining factors in the grades the students received for the course, although the percentage of each of the categories varied based on the teacher and course. The frequency of each of the types also were similar for all the teachers. All the teachers gave assignments for students to complete very regularly, if not daily. While the weight of the grades from these regular assignments were not weighted as heavily as quizzes or tests, all of the teachers stressed the importance of the students completing them. Each of the teachers gave quizzes typically once a week, with tests more infrequently.

The assignments, quizzes, and tests were primarily derived from the textbook resources. All the teachers stated they created or modified some of their own materials, however, doing so was the exception. Teacher 1 stated, "it's hard to create materials all the time" and mentioned the difficulty in balancing time between school and home and how much time it takes to prepare materials. Teacher 1 further lamented, "it took me like an hour yesterday to prep (materials) for a 40 minutes class, that's—you know—that's more time spent prepping it than they are going to spend doing it."

In addition to the written method of gathering student evidence of learning, all three teachers were observed in the classroom setting orally asking questions of students to gauge their understanding of the lesson that was being presented. The teachers were observed engaging the students in an initiation, response, and feedback pattern in order to check the understanding of student learning.

All three teachers made reference to the various student levels that they taught, and how the structure of expectations differed based on the academic level of the course

based on the achievement of the student, a term all three teachers referred to as "lower-level" students. The data showed that the teachers placed more weight on the daily assignments and checked the assignments of these students more frequently. Teacher 3 also commented that the amount of homework was reduced for lower-level students and that the opportunities to redo assessments was greater for these students when compared to Teacher 3's higher level students.

**Theme 3: Feedback that teachers give students**

Research Question 1.3: What aspects and levels of feedback are present in current classroom practice?

Theme 3 was generated from participant data and aligned with the four levels of feedback from the Hattie and Timperley (2007) model: task level feedback, process level feedback, self-regulation level feedback, and self-level feedback.

**Task level feedback.** The data show that task level feedback was the most prevalent form of feedback given by the three teachers. In written form, this was evidenced by the anonymous student work that had been previously assessed and was provided by each of the teachers. The student work provided from Teacher 1 and Teacher 2 used a type of task level feedback called knowledge of results in which the teachers identified the incorrect answers on student papers and provided a letter grade for the piece of evidence. No other form of feedback on written student work was observed for Teacher 1 or Teacher 2.

During classroom observations of the participants, task level feedback was also the dominant feature. All three teachers used an IRF (initiation, response, feedback) cycle

the majority of the class period. The IRF cycle used by the teachers was typically a cycle in which the teacher would ask a question that had a particular correct answer, the student would offer up an answer, and then the teacher would certify if the answer was correct or incorrect, which provided knowledge of results orally. An example IRF dialog from Teacher 2 proceeded as follows: "What did you get?" Teacher 2 asked. "2 times 2 times 2 times 7," the student replied. "Very good," responded Teacher 2. This IRF sequence was the typical dominant pattern of verbal feedback observed during the classroom observations for all three participants.

**Process level feedback.** The interview data show that all three teachers mention the importance of mathematical processes in assessment and feedback with their students. Teacher 2 stated, "I think that's a nice thing about teaching math that you can specifically show them where they went off when you see the work that they did. I'd say most of the time it's, um, this is where your method was incorrect, so we can fix just that part." Teacher 1 had similar feelings regarding the process in which the teacher would identify "where someone derailed off a problem."

Despite their stated views during the interview about the importance of giving feedback about the mathematical process, only Teacher 3 was observed giving any process level feedback during the classroom observation. During the classroom observation Teacher 3 reviewed the most common errors from the previous day's work and gave feedback regarding the process to the whole group. Teacher 3 was also the only participant who provided process level feedback on the written student tests that were provided as part of data collection.

**Self-regulation feedback.** Teacher 1 discussed in the interview data giving feedback that could be described as self-regulatory in manner. The teacher discussed giving guiding or leading questions that would help the students self-assess their learning without having it be solved for them. Teacher 1 was also observed promoting self-regulation as the students were instructed to self-assess their work from the previous day as they compared their work with the course's rubric.

**Self-level feedback.** Despite the common occurrence of self-level feedback in many classrooms (Hattie & Timperley, 2007), the data did not appear to reveal any instances of self-level feedback by any of the participants during the study.

**Theme 4: Teacher perceptions and beliefs about assessment and feedback**

Research Question 2: What are mathematics teacher beliefs about the purpose of assessment and feedback?

**Assessment beliefs.** As the participants responded to interview questions that probed their perceptions and beliefs about assessment, a shared belief among all three participants was that the purpose of assessment was to check for understanding of the level of student learning of the curricular content. Teacher 1 said that assessments were "to show where they are, their level of understanding." Teacher 2 stated that assignments were given in order to "gauge if the students are learning" and to "gauge that they got the concept down." Teacher 3 expressed that the assessments were "to make sure that kids are mastering the concepts they need to take steps forward" and to "make sure that they understand the steps." The assessments shared by the participants corroborated this belief

and were aligned with the lesson topic to see if student understood the concepts that were taught by the teacher.

Additionally, the syllabi for Teacher 2 stated that students "are checked for understanding through dialogue and guided practice problems." While only the syllabi for Teacher 2 had data that related to checking for understanding, the practice of checking for understanding was evident during the classroom observation of all three teachers in the form of teacher questioning and reviewing of practice problems.

All three teachers expressed through interview data their assessment beliefs included the stance that students should have the opportunity for multiple or repeated attempts. However, the implementation of this belief into their teaching practice differed. Teacher 1 would let "lower level students" redo daily work, but not allow it on quizzes or tests. Teacher 2 stated, "if they don't get it the first time, well, then try again. Don't get it the second time? We're going to try it again." Teacher 2 expressed the strategy of using multiple attempts for students earlier in the learning process prior to a more significant assessment rather than redoing the assessment and mentioned being "strict as in a sense of we are going to keep at this until we get it right." Teacher 3 preferred to "give the kids as many opportunities to show me that have the stuff down" and stated that opportunities are offered outside of class to redo any problems students got wrong and to take a secondary test. Teacher 2 credited being a parent as an influencing factor in giving repeated attempts to students, while Teacher 3's belief stemmed from having lower level students who "struggle a bit more in math so I think I need to give them opportunities."

**Feedback beliefs.** From interview data, all three teacher participants communicated their beliefs regarding the importance of feedback. According to Teacher 1, feedback should clarify students' understanding with the purpose of guiding and modeling correct mathematics procedures. Additionally, Teacher 1 expressed using feedback to help students find their own mistakes, stating "I try not to solve the whole problem for them but maybe circling or underlining or sometimes I write a sentence or a question or a leading question like—'What would you do if you do this?'" Teacher 1 described good feedback as "giving a student a chance to think about where their error is" and poor feedback as information that is "inconsistent, inaccurate", "meaningless", or "if it made them feel awful about themselves." The feedback information provided by Teacher 1 was typically knowledge of results in the form of the number wrong or correct and the resulting letter grade or percentage and it was stated that the teacher attempted to return corrected work by the next day.

Teacher 2 defined feedback as "giving information as to where the student stands so that they know how they are doing" and whether they have succeeded or not. Teacher 2 explained that the purpose of feedback "certainly can be motivating—if it's positive" and described good feedback as "detailed, so that it's not just 'good job'; it's *why* it is a good job." Poor feedback was characterized as "doing a poor job because it's just unmotivating and is not going to help them along the way. I think it can be poor also if it's given— you know— tritely, if you just complement everything that happens." The timing of feedback could be immediate as would happen during a lesson, or daily in the

form of returned student work. The type of information that Teacher 2 described as given to student was about the method in the mathematical process.

Showing students what they did wrong and how to perform the correct mathematical steps are "unbelievably valuable" and "super important" uses of feedback whether it comes from a teacher or another student, according to Teacher 3. Good feedback "comes from not so good work" in order to "show the correct way to do it," while feedback can be poor when a student doesn't know what it means. Teacher 3 described the importance of giving the lower-level students feedback daily in the form of corrected work and a grade while also taking time to give student individual verbal feedback during a class period.

**Theme 5: Teacher training and support**

Research Question 3: What types of training have mathematics teachers received related to formative assessment and feedback?

Even though their years of experience differ, all three teachers had bachelor's degrees in education from the same undergraduate institution and none of them had taken coursework for an advanced degree. For the two more experienced teachers, they did not provide any formal professional development documentation. Through interview data it was learned that that these two teachers did not hold state teaching licenses and their professional development was limited to occasional attendance at a professional teacher's conference. The most inexperienced teacher reported holding a valid state teaching license in mathematics and provided documentation of professional development and

clock hours, which included 23 sessions over the course of the previous three school years.

The data revealed an overall lack of training in formative assessment and feedback. None of the teachers reported having any formal training or any courses in how to assess students formatively or how to deliver feedback effectively. The most inexperienced teacher couldn't recall whether assessment and feedback were mentioned in undergraduate courses but stated that maybe it was addressed but "I just didn't have a way, you know, to file it away in a meaningful way" and if it was mentioned "it wasn't enough to, like, stick with me." More informally, Teacher 2 and Teacher 3 mentioned attending a workshop that addressed the concept of assessment. Teacher 1 became interested in standards-based assessment from informally reading a blog and watching a video the principal of the school showed at the beginning of the school year.

The interview data also revealed that the teachers learned how to assess students and give feedback from a combination of modeling others and learning by experience. Teacher 2 cited modeling their own parents, who were teachers, and learning by "trial and error." Teacher 3 stated, "I'm emulating what my student teaching supervisor did. That's probably a lot of it." Teacher 1 credited learning "from experience of what goes over well, . . . hearing what other people do in the building; collaboration is such a big part of teaching." In addition, Teacher 1 reflected on past exposure to assessment as a student and attributed learning how to assess "from my own experiences sitting in a high school classroom. I think people tend to default to what they experienced."

## Discussion of Findings

The findings of this study revealed that there appears to be a gap between the practice of the mathematics teachers that participated in the study and what the literature suggests as recommended practice in regard to formative assessment and feedback, and a need for additional training to address the current gap.

**Learning intentions.** The study suggests that while the teachers do technically identify the learning intentions for students, it is not done consistently in a manner that is aligned with the Black and Wiliam (2009) model. All the participants mentioned that they orally communicated the learning objectives at the beginning of a unit or lesson, but the alignment of this communication, how it was related to the learning intention, and it's resulting effectiveness was not addressed in the study or revealed in the data.

The communication that was provided prior to an assessment in oral format or by a study guide document were used more as a warning as to what or how the students would be tested on instead of being used as a goal for learning. The teachers partially viewed the communication of the learning intentions as being transparent of the testing format or its content instead of using the learning intentions as the foundation of the formative assessment process.

The written documents handed out to the students at the beginning of the year contained the course outline and content for the students, however, they are not written in a manner with enough specificity to measure the progress of a student in attaining the goal or to give feedback in relation to the goal. It is unclear how often the targets of learning are used by the students and teacher to direct the current and future learning.

**Designing tasks for evidence of student learning.** The findings revealed that the teachers elicited evidence of student learning in two main formats and that each format served a similar purpose. The use of written assignments, quizzes, and tests served as main format of assessing student learning. These written assessments were given to students at varying intervals of time and typically were from textbook resources. These written assessments were the main determinants of the resulting grade that students received. The use of oral questioning in the class was the second main method teachers used in their practice. The teachers used an initiation, response, and feedback pattern when questioning the students orally. This pattern was the dominant feature of the classroom observation.

The data showed that the teachers used the methods of written assessments and oral questioning for the same purpose, namely to check for student understanding and to certify the student responses for correct or incorrect answers. The certifying function of both the written and oral methods of assessment employed by the teachers served more of a summative purpose instead of a formative one. As Black and Wiliam stated, "Practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction" (Black & Wiliam, 2009, p. 9). Teachers in the study used the information from the students in an evaluative manner to check for understanding and provided the students with a knowledge of their results, often in the form of grades. The data did not show the planning or use of written assessments or oral questioning for the formative purpose of eliciting evidence of student understanding in

order to make decisions about instructional next steps or to provide information for feedback to move learning forward. The evaluative and summative manner of the teachers' practice corroborates with the principal's postulation of a potential gap in practice in mathematics classrooms.

**Aspects and levels of feedback.** Using feedback properly is a key component of improving student learning; if not used in the correct manner it has the possibility of negatively impacting student learning (Fyfe & Rittle-Johnson, 2016; Hattie & Timperley, 2007; Havnes et. al., 2012). The findings showed that the most prominent level of feedback used by the participants was task level feedback. Whether written or oral, feedback from the teacher was most often given in an evaluative manner as knowledge of results. In written assessments this knowledge of results was noted by wrong answers being marked incorrect and accompanied by a grade. In oral questioning, the response of a student was evaluated as correct or incorrect by the teacher.

The importance of process level feedback was evident from the teachers in interview data, but not common in practice. The findings suggest a gap exists between the espoused beliefs of the teachers and what was observed in their actual classroom practice. The data showed the use of self-regulation feedback was limited. The findings showed no apparent use of self level feedback which a welcome finding since self-level feedback is common in many classrooms despite its inability to increase learning (Hattie & Timperley, 2007).

Due to the findings showing that the learning intentions are not prominently used and communicated and used as learning targets, and that the tasks that teachers engineer

for evidence of student learning are used in mostly a summative manner, it is not surprising that the findings also show that feedback is used in an evaluative and summative manner. In order for feedback to be used in a formative manner, the preconditions of the Black and Wiliam model (2009) need to be satisfied. If the learning intentions are not the focus of instruction, and assessment is not designed and used for the purpose of measuring student progress against those targets, then producing feedback with information "that reduces the discrepancy between what is understood and what is aimed to be understood" (Hattie & Gan, 2011, p. 258) would be difficult. Effective formative feedback must also give the students information on what the next steps might be and what to do to correct their error (Maxfield, 2013). While task level feedback can be effective in the early stages of learning, the benefits of process level and self-regulation level feedback can occur more regularly through implementation of formative assessment strategies (Hattie & Timperley, 2007).

**Perceptions and beliefs about assessment and feedback.** The findings about the perceptions and beliefs of teachers regarding assessment and feedback align with the findings of the classroom practice of the teachers. The findings also showed that the teachers in this mathematics department shared similar perceptions and beliefs. The teachers shared the beliefs that the purpose of assessment was to check for understanding of student learning as a way to certify learning of the students. These beliefs of using assessment evidence as "assessment *of* learning" are summative in nature in contrast to the formative approach which uses "assessment *for* learning" (Black & Wiliam, 2009). The findings did not show that the teachers purposefully designed or used the assessment

evidence as a point of contingency in which to make decisions for the next steps in the learning process.

The feedback beliefs of the teachers also aligned with their beliefs regarding the use of assessment in which they communicated to the students their current standing and "how they are doing" (Teacher 2). While the teachers stated that feedback was important, they did not share a viewpoint that could be characterized as formative in nature, in which feedback was centered around the learning target and given to students "that reduces the discrepancy between what is understood and what is aimed to be understood" (Hattie & Gan, 2011, p. 258). The findings align with the research of Havnes et al. in which mathematics teachers had a narrow view of feedback where they viewed feedback as "corrections of completed work" (Havnes et al., 2012, p.25) and typically used grades as form of feedback.

**Formative assessment and feedback training.** Similar to the findings of An and Wu (2012), this study revealed a lack of training in how to use assessments or feedback in a formative manner. None of the teachers had any meaningful formal or informal professional development in how to use assessment and feedback in a formative manner to increase student learning. Instead, the teachers used assessment and feedback techniques that they learned by modeling others, replicating their own experiences as a student, or by trial and error. In order for the mathematics teachers in this school reduce the gap between what research suggests as effective assessment and feedback practice and current classroom practice, targeted professional development is needed.

## Summary

The findings of this study suggested that there is a gap in practice between what research suggests as effective assessment and feedback practice and what is happening in local classroom practice. The findings also suggested that the participants lack sufficient training in formative assessment and feedback practices. This information provided specific insight into developing a 3-day professional development project that may provide additional training in the formative assessment process and reduce the gap in practice of the participants.

# Section 3: The Project

## Introduction

This section contains the description of the project that was created to address the problem based on the findings of this study. The findings suggested that there was a lack of meaningful training or education for the participants of this study in relation to the formative assessment process. This project takes the form of a 3-day professional development training and aims to reduce the gap of the practice current classroom practice of mathematics teachers in comparison to what research suggests is effective formative assessment and feedback practice. The goals of this professional development training are to provide mathematics teachers with the foundational knowledge to integrate the first three aspects of the formative assessment process into their classroom practice and to provide the teachers with the opportunity to work together collaboratively while analyzing student learning data.

This section will provide a rationale for the project and a review of literature on the purpose of professional development, elements of effective professional development, and the connection to the project. A description of the project will be included, as well as a plan for evaluation of the project and its implications.

## Rationale

The findings of this study showed that the participating teachers had minimal training in how to use the formative assessment process and feedback effectively to move student learning forward. This is not a unique finding, as previous literature has identified that teachers often lack training in regard to formative assessment and feedback (An &

Wu, 2012; Black & Wiliam, 2009; Dukor & Holmburg, 2013; Gamlem, 2015; Hattie & Timperley, 2007; Havnes et al., 2012; Lee, 2011). The NCTM (2014) has also endorsed increased use of formative assessment by all mathematics teachers.

In exploring the assessment and feedback practices of the participating teachers, the findings of this study were helpful in identifying the specific gap in knowledge and practice so that the gap could be reduced and lead to increased student learning. To address this need, a 3-day professional development training was selected as the vehicle to begin to address the gap in teacher knowledge and practice. Professional development is an appropriate solution as its goals are to increase student learning through improving the knowledge and practice of teachers (Bradley, 2015; Guskey, 2014; Killion, 2018; Wiliam & Leahy, 2015). The content and structure of the project are based on the findings of the study and what the literature suggests are effective methods of professional development with the purpose of increasing the effectiveness of the teachers in using formative assessment and feedback.

## Review of the Literature

The findings of this study suggest that there is a need to increase the formative assessment knowledge and practices of teachers. To address this gap in knowledge and practice, the genre of the project selected was a 3-day professional development training targeted to the needs of the participants and aligned with the findings of this study. This section will present a scholarly review of literature related to professional development and the elements needed for professional development to be effective.

The search for literature was conducted using the Walden University online library resources. The research databases that were used included: Education Research Complete, Google Scholar, ERIC, ProQuest, and Thoreau. Search terms included: *professional development, professional development for educators, professional learning, effective professional development, professional development and formative assessment, designing professional development, professional development for mathematics teachers, professional learning and formative assessment, evaluating professional development, professional learning standards, professional development standards, professional development and mathematics assessment, professional development for mathematics educators,* and *professional development for teachers*. I considered the literature search complete when information became redundant and I was unable to find additional relevant literature that applied to the topic.

**Purpose of Professional Development**

Learning is at the core of education. While it is natural to think of school as the place where students go to learn, continuing to learn is vital for teachers as well (Olsen & Buchanan, 2017). Teachers can find a variety of avenues for continuing their education, some of which may include: conferences, personal research, formal degree programs, seminars, workshops, online networks, and professional learning communities. Due to the variety of options that are available for professional development and for clarity for the purposes of this review, we will use the following as the definition of a professional development program: "a set of planned and implemented actions, guided by research, evidence, and standards of effective professional learning" (Killion, 2018, p. 8). The

activities of the program should align with the intended purpose the professional development (Killion, 2018).

Merchie, Tuytens, Devos, and Vanderlinde (2018) described the purpose and goals of professional development as a process in which the knowledge, skills, and attitudes of teacher quality are increased which in turn leads to a change in teaching behavior, which in turn leads to improvement of student learning. This cause and effect progression between increased teacher quality and improved student learning is echoed as a goal of professional development by many others (Bradley, 2015; Collopy, 2015; Earley & Porritt, 2014; Guskey, 2014; Killion, 2018; Kutaka et al., 2017; Stewart, 2014; Thurlings & den Brok, 2017; Wiliam, 2016a; Wiliam & Leahy, 2015) who are proponents of professional development for educators.

Despite the near universal support of professional development for educators, there is concern regarding the large amount of budgetary resources spent on professional development (Wilson, 2013) and whether there is a return on the investment in terms of changing practice and student learning (Poskitt, 2014). For professional development to impact student learning, it needs to impact teachers so that they apply what they have learned into their teaching practice (Shuilleabhain & Seery, 2018). As a result of their study in which they measured the impact of professional development and proposed a model for implementing new instructional strategies, Baird and Clark (2018) posited the importance of teachers transferring their professional development learning into practice. They stated, “Teacher learning and implementation is the heart of professional learning. If teachers do not implement their learning, it is as if they did not learn anything” (Baird

& Clark, 2018, p. 335). If teachers do not implement their learning into practice, then the ultimate goal of increased student learning is in jeopardy. It is then paramount to explore the aspects of effective professional development that can help ensure that the intended student outcome of increased learning becomes a reality.

## Elements of Effective Professional Development

Schools exist in order to educate students. Since professional development is delivered to educators, its link to improving student learning is not direct. Researchers have explored what elements of professional development are necessary for it to be effective and ultimately lead to increased student learning. In their systematic narrative analysis of 54 studies on professional development, Merchie et al. (2018) provided a framework for the evaluation of the effectiveness of professional development in which they divided the features into two main categories: core features and structural features. Core features include the substance of the professional development, while the structural features contain the aspects related to the design of the learning (Merchie et al., 2018). This section will use the Merchie et al. (2018) categories as a framework to review various components of professional development.

**Core features of professional development.** A core feature mentioned by Merchie et al. (2018) is for the professional development to frame the content around the premise of increasing student learning. As discussed previously, this premise is echoed by many researchers. Coe et al. (2014) stated the focus of professional development should be "kept clearly on improving student outcomes" (p. 5).

In order for student learning to increase, professional development should also focus on enhancing the pedagogical knowledge of teachers (Abu-Tineh & Sadiq, 2018; Baird & Clark, 2018; Bibbo & D'Erizans, 2014; Guskey, 2014; Kutaka et al., 2017; Merchie et al., 2018; Stewart, 2014). In their qualitative case study of five secondary mathematics teachers in Ireland, Shuilleabhain and Seery (2018) investigated how the teachers' pedagogical practices and beliefs were impacted over the course of 1 year due to the implementation of professional development in the form of lesson study. Based on teacher interviews, audio recordings, field notes, observations, and student artifacts, the findings provided evidence that professional development, when structured appropriately, can positively impact the pedagogical practice and beliefs of mathematics teachers (Shuilleabhain & Seery, 2018).

Professional development should target the needs and interests of teachers and should take teacher autonomy into account (Bayer, 2014; Liljedahl, 2014; Merchie et al., 2018). In a 10-year longitudinal single-case study, Lopes and Cunha (2017) explored the conditions for effective professional development in a self-directed environment. The findings show that self-directed professional development can positively impact teacher practices over a longer period, however there are necessary conditions for success (Lopes & Cuhna, 2017). It was important for the content to focus on teachers' practices and for the teacher to possess a resilient drive to improve over the course of time and work collaboratively with peers (Lopes & Cuhna, 2017). It was also important for professional development activities to be grounded in evidence-based practices, connected to teacher and school goals (Abu-Tineh & Sadiq, 2018; Bayer, 2014; Bradley, 2015; Collopy, 2015;

Wiliam 2016a), and aligned with standards (Learning Forward, 2011; Merchie et al., 2018). The standards for professional development will be addressed below.

**Structure of professional development.** Lindvall, Helenius, and Wiberg (2018) recommended that a professional development program includes "multiple sessions spread out over a longer period of time" (p. 122). Having professional development extend for a longer duration is a common theme and recommendation by researchers (Abu-Tineh & Sadiq, 2018; Bradley, 2015; Bibbo & D'Erizans, 2014; Brown & Militello, 2016; Kutaka et al., 2017). Murchie et al. (2018) suggested that the duration of professional development exceed twenty hours of contact time, while Bibbo and D'Erizans (2014) recommended a duration of 1-3 years.

With a common call for longer duration professional development, the familiar shorter duration workshop-style method of delivering professional development has come under scrutiny (Abu-Tineh & Sadiq, 2018; Bayar, 2014; Poskitt, 2014). However, Collopy (2015) warned that the quality of professional development is not guaranteed by its extended duration, and that other factors impact the effectiveness of professional development.

In their literature review, Lauer, Christopher, Firpo-Triplett, and Buchting (2014), examined 23 studies on the impact of short-term professional development for educators for identifying design features that are associated with positive outcomes. Based on their research into programs that were less than 30 hours of contact time with participants, they uncovered a variety of features that still allowed short-term professional development to be effective (Lauer et al., 2014). In regard to the appropriate duration, they recommended

that the length of time be determined by the learning objective that will be addressed and the complexity of the topic (Lauer et al., 2014). Other features included a design based on communicated learning objectives, participant needs addressed, demonstrations of the intended learning, opportunity to practice new skills, group discussion, some amount of active learning, consideration of the work environment, and follow-up support (Lauer et al., 2014).

The opportunity for teacher collaboration is suggested as an important structural piece within professional development (Bibbo & D'Erizans, 2014; Bradley, 2015; Brown & Militello, 2016; Gaumer Erickson, Noonan, Brussow, & Supon Carter, 2017; Jonsson, Lundhal, & Holmgren, 2015) as is grounding the learning into daily work of the teachers (Abu-Tineh & Sadiq, 2018; Baird & Clark, 2018; Merchie et al., 2018; Superfine & Wenjuan, 2014). In a convergent parallel mixed method study, Tack, Valcke, Rots, Struyven and Vanderlinde (2018) explored the professional development needs as reported by 611 Dutch teachers. The participants stressed the importance of collaboration, not only with those they work in close proximity with, but also beyond their locality. The findings also showed that these teachers would prefer to have professional development that was not general in nature, but that was "closely linked to their own teacher educators' practices" (Tack et al., 2018, p. 98).

With all the variables that research has identified that may impact the effectiveness of professional development in leading to increased student learning, the Learning Forward organization (formerly the National Staff Development Council) published a comprehensive set of standards for professional development in 2011 in the

attempt to provide a structure and framework to ensure high quality professional development that can result in learning for all educators. The standards "enumerate the conditions, processes, and content of professional learning to support continuous improvement in leadership, teacher, and student learning" (Learning Forward, 2011, p. 6). The seven standards address the following: (a) learning communities, (b) leadership, (c) resources, (d) data, (e) learning designs, (f) implementation, and (g) outcomes. These standards are in harmony with the research previously presented and advocate for similar outcomes. One unique aspect prescribed by the standards is that time be dedicated several times per week and for all professional learning to occur during the work day (Learning Forward, 2011). This is a fairly significant departure from traditional professional development that takes place outside of the school day and occurs a handful of times per year.

Based on the literature, there is no singular variable or recipe that makes professional development effective or ineffective for all educators in all locations, rather, there are number of interconnected elements and aspects that should be considered in the development and implementation of professional development. The purpose, however, according to Guskey is clear: "to make a positive difference in teaching, to help educators reach high standards and, ultimately, to have a positive impact on students" (Guskey, 2014, p. 1219).

**Connection of the Research and the Project Study**

Similar to the research of Randel, Apthorp, Beesley, Clark, and Wang (2016), in which they found that teachers do not receive appropriate levels of training in classroom

assessment in teacher preparation programs, the findings of this project study showed that the participants need additional training in formative assessment and feedback to enhance student learning. Due to formative assessment aspects being integrated, professional development should also address the interconnectedness of formative assessment and not address the aspects in isolation (Andersson & Palm, 2017). It is the intent of the project to implement elements of effective professional development in order to provide the participants with the support and foundational knowledge to integrate the first three aspects of the formative assessment process into their practice. The key elements of effective professional development that are included into the design of this 3-day formative assessment training include: (a) grounded in teacher practice, (b) connected to student learning and data, (c) focused on pedagogical knowledge, (d) addresses the needs of teachers, (e) includes the opportunity for active learning and practice, and (e) collaboration. By integrating these aspects of effective professional development with the identified needs from the findings of this study, the project will fulfill its purpose in reducing the gap in practice and ultimately lead to increased student learning.

## Project Description

The project constructed for this study will take the form of a 3-day professional development training. The purpose of the training is to reduce the gap of the current classroom practice of mathematics teachers in comparison to what research suggests is effective formative assessment and feedback practice. The goals are to provide mathematics teachers with the foundational knowledge to integrate the first three aspects of the formative assessment process into their classroom practice and the opportunity to

work together collaboratively and to analyze student learning data. The learning outcomes consist of the following:

- Mathematics teachers will understand and integrate the first three aspects of the formative assessments process into their classroom practice.
- Mathematics teachers will clearly identify the learning targets for students and align curriculum assessments to the learning targets.
- Mathematics teachers will use student assessment data to provide feedback to students and make adjustments for the next stages of learning.
- Mathematics teachers will work collaboratively as a department to promote collective improvement and accountability while promoting increasing student learning.

The content and design of the sessions were explicitly constructed to integrate elements of effective professional development while providing the foundational knowledge and opportunities for the participants to practice and apply the first three aspects of formative assessment into their teaching practices. Participants will learn how to use the curriculum mapping process as a means to clarify learning intentions and as structural foundation for the formative assessment process. They will effectively engineer classroom tasks by aligning their classroom assessments to their learning targets and intentions, and then breakdown an administered student assessment in order to use the student data to deliver feedback and make instructional adjustments that moves the learning forward.

**Needed Resources and Existing Supports**

Implementation of this professional development training requires a number of needed resources. The presenter needs audio-visual projection equipment, and computer with the presentation files and copies of handouts (Appendix A). The training will take place at the school where the participants are employed and equipment that is needed is readily available. The participants need a writing instrument, and access to their curricular materials, such as teacher's manuals, syllabi, and assessments. Participants may use technology; however, it is optional and not required. For the final training session, participants will need access to completed student assessments for the assessment breakdown activity.

**Potential Barriers and Solutions to Barriers**

There are few potential barriers for implementation of the formative assessment training. The training requires three days. Ideally, the first two days would be held back to back in the weeks prior to the beginning of a school year and the final day about a month after school is in session. This timeframe may interfere with a currently published schedule by the school. However, this professional development schedule can be easily adapted create flexibility to meet the participants' needs.

**Implementation and Responsibilities**

As stated previously, the 3-day Formative Assessment Training should take place at the beginning of the school year. The first two days should take place in August prior to the start of the school year, with the last day taking place one month after the school

year has started in order to use actual classroom assessment information and data. A detailed agenda is included in Appendix A.

I would serve as the organizer and facilitator of the professional development training. I would contact the participants of the study to coordinate possible dates for the training and then be in communication with the school principal to reserve space in the school building with the appropriate accommodations. I would communicate with the participants about the details of the training and provide handout materials. Following each of the sessions I would be responsible for following up, offering support, and assistance of the participants as they implement the formative assessment process into their classroom practice.

The responsibility of the participants would include attendance at the sessions, participating in the scheduled activities and having access to the required materials. It is important to communicate to the participants that they would need to have access to completed student assessments for the third day of training. The participants would also be responsible for providing their own lunch, snacks, and drinks for the training sessions.

## Project Evaluation Plan

According to Killion, evaluation of professional development has the purpose of "judging merit, worth, value, and impact of a program based on established standards and sufficient data or evidence" (Killion, 2018, p. 14). The evaluation for this project will take the form of an outcome-based summative evaluation administered at the conclusion of the professional development training. At the end of the final session, I will use a short evaluation survey (Appendix A) to gather information from the participants. The items on

the first page of the evaluation form are specifically aligned with the stated outcomes for the training session. The items are in Likert scale format with a space for additional comments. The questions on the second page are more open-ended to gain further insight in the structural and core features of the professional development training. The purpose of this summative evaluation is to receive feedback on the training and use the information to make possible adjustments to make it more effective in the future. Additionally, it will provide the school administration with information about the current status of the gap in practice and provide further information for future action to reduce the gap of formative assessment practice.

## Project Implications

In participating in the professional development training, the participants should gain the foundational knowledge and skill to integrate the first three aspects of the formative assessment process into their classroom practice. This project was designed to address the need of these particular mathematics teachers in response to the findings of this study and provide them with specific knowledge and then provide practical examples that are grounded in their daily work so that it can impact the learning of the students in their classes. In addressing the three teacher-influenced foundational aspects of the Black and Wiliam (2009) formative assessment model, the participants can build upon that foundation and design their instructional environment to incorporate the final two aspects of the model, which promote using peers as resources and activating more self-regulatory strategies.

While this project was intended for a small-scale implementation of three mathematics teachers, formative assessment and feedback strategies are important in every curricular area and developmental level. If the project is successful in moving the mathematics department toward formative assessment practices, with very minimal adjustment, it can be used to reduce the gap in practice in other curricular subjects, levels of education, and beyond the walls of the building in the study. This project has the potential to impact how teachers implement formative assessment and feedback into their practices and promote an educational model that becomes more learning-centered, serves student needs, and increases student learning, which in turn could lead to positive social change in how in how students interact within the educational process and develop life-long self-regulatory strategies.

Section 4: Reflections and Conclusions

## Project Strengths and Limitations

### Project Strengths

This project has a number of strengths. A strength is that this project was developed to meet the needs of the teachers based on the findings in the study in order to reduce the gap in practice. This project also aligns the theoretical framework of the study and the goals of the professional development to the progression of the content delivered and the activities employed, but yet keeps the ultimate goal of professional development in mind—increasing student learning (see Guskey, 2014). It selectively scaffolds the content of the aspects of formative assessment and feedback, provides examples of implementation, and then provides the time and structures to embed their learning in their own classroom practice. This integration is an important key component of changing teacher beliefs and practices (Baird & Clark, 2018; Merchie et al., 2018; Shuilleabhain & Seery, 2018; Wiliam, 2016a; Wiliam & Leahy, 2015).

The particular activities were also designed based on recommended research. For example, the Assessment Breakdown activity was influenced by the recommendation to analyze students' errors (An & Wu, 2012), provide inquiry into student insights (Bartolini, Worth, & Jensen LaConte, 2014), and collect qualitative data to provide effective feedback to students (Shepard, 2018). The Curriculum Mapping and the Assessment Alignment activities are also grounded in research and designed to be embedded in the teacher's own classroom practice, take place in their local setting, and

contain individual and collaborative aspects, all with the goal of increasing teacher effectiveness and improving student learning.

An additional strength of the project is its versatility to be replicated, expanded, and used for other curricular areas and developmental levels with minimal adjustment. This project creates a structure where all teachers in a building or district can work together collaboratively, but yet is still completely applicable to each individual teacher's classroom context.

**Project Limitations**

One of the biggest limitations of this project is the topic of the professional development itself— formative assessment and feedback. Assessment practices and beliefs can be deeply rooted in tradition (Dorn, 2010; Dueck, 2014; Kohn, 2011; Marzano & Heflebower, 2011; Vatterott, 2015; Westerberg, 2016). Black and Wiliam (1998a) stated that "it is not possible to introduce formative assessment without some radical change in classroom pedagogy" (p. 10) and this radical change may prove to be difficult for some. I kept this limitation in mind during the development of the project to attempt to minimize the impact of prior beliefs.

Another limitation is the duration of the professional development led by a nonemployee of the school. Three days is not a long time to cover all the nuances of using the formative assessment process to provide feedback to students. Ideally, this would be a multiyear strategic initiative for an entire building or district and led by someone within the district to provide consistent and ongoing support— not three teachers for 3 days led by an outsider. It was outside the scope of my project study to

provide such a long-term, comprehensive program. However, it is possible that future projects built off of this one may meet that need.

## Recommendations for Alternative Approaches

As with any multifaceted problem, alternative solutions may exist. However, since the lack of formative techniques is not a recent phenomenon (Sadler, 1989) and much literature exists on the problem, it is my opinion that professional development that is integrated and grounded in teacher practice is a more advisable option than some indirect alternatives. As stated previously as a limitation of the project, a 3-day professional development training on the formative assessment process may not provide a deep understanding of all the aspects of using formative assessment to provide feedback to students. A recommended alternative approach to addressing this problem is to develop a comprehensive program of professional development that systematically and purposefully scaffolds the needed knowledge and skills over a number of years and grounds it in teachers' daily practice. While many of the aspects of the current project could be used and expanded, changing practices and beliefs about assessment is a significant challenge (William, 2016a) and to fully implement the formative assessment process across an entire organization will take time and resources. An additional recommendation would include having on-site coaching and support, employed by the organization, that is available to work with teachers on an on-going basis.

## Scholarship, Project Development and Evaluation, and Leadership and Change

Prior to the beginning of this doctoral journey, I had a limited understanding of what a *scholar-practitioner* meant. Through this process, I have gained a much deeper

appreciation and understanding of feedback and the formative assessment process. However, the process of becoming a doctoral level scholar-practitioner has been truly transformative. The process of locating, dissecting, and critiquing the methodology and findings of an extensive amount of research articles influenced my scholarly thinking and approach to establishing the validity and reliability of literature in many forms. The development of the study, the IRB process, and development of the project emphasized the level of depth and attention to detail that was necessary for doctoral level scholarship. This level of detail was frustrating at times; however, I learned to appreciate and embrace the process and slow down so that I could explore deeper and further in order to fully understand the problem, the literature, and potential solutions.

I currently work as a school leader, administrator, and classroom teacher, and the practitioner side of this process was never far from my thoughts. The increased knowledge and skills that I have attained through the process of the study and development of the project have far reaching effects. It had influenced my leadership, my ability to ask questions, seek information from a variety of perspectives, determine a plan of action, investigate and interpret data, and propose specific solutions that are aligned to address an identified need and grounded in teacher practice.

I began the doctoral journey because I wanted to be a better teacher and gain additional expertise. It did not take long for me to come to the realization that the more I learned, the more I realized how much I did not know. This realization has had a profound impact on my appreciation for the work of others and their perspectives. While I do possess new skills as a doctoral level scholar-practitioner, it is balanced with a

humble respect for the scholarly work of those who have gone before me, and a drive to continue the work of social change within my sphere of influence.

## Reflection on Importance of the Work

The purpose of this project study was to ultimately improve student learning through the formative assessment process. While there has been much written and published about formative assessment over the years, it has still not become commonplace in classrooms, including at the research site of this study. The formative assessment process has tremendous potential to positively impact students and their learning, so it is important to study this issue and help teachers and schools take the research and apply it to their local context.

Through this research, I gained valuable insights on the perspectives, beliefs, and practices of the participants of the study and the gaps in practice that needed to be addressed. Based on the literature, my experience in this study, and my experience in the field of education, I do not believe that this problem is isolated to my local context. While it was not the expressed purpose of this study to be generalizable, I do feel it provides a contribution to the literature base on formative assessment and promote further investigation for others.

## Implications, Applications, and Directions for Future Research

The project was designed to reduce the gap in formative assessment and feedback practice of mathematics teachers at the research site and may provide meaningful examples of using professional development activities to integrate formative assessment aspects into the daily practice of mathematics teachers in order to increase the prevalence

of formative assessment in mathematics. The use of the formative assessment process in these classrooms can have far-reaching impact on how learning is structured and reported, how feedback helps promote and develop learning and self-regulatory strategies of students, and on how teachers and students interact with one another. The possible implications for social change consist of the mathematics teachers using the formative assessment process to increase student learning, and ultimately promote a learning centered environment and self-regulatory strategies among the students which may positively impact how these students view themselves, the education process, and future learning.

Due to the limitations of this project study that were previously discussed, further research is recommended. Additional research could be conducted on a larger case and with different curricular areas and developmental levels. A different methodological approach could provide additional insights into the impact of formative assessment strategies on student learning. As the time frame of the current study was limited in regard to the amount of data collection time on site, it would be recommended to expand the amount of data collection time and perhaps perform a more in-depth study of how assessments and feedback are administered and delivered over the course of time as teachers learn to apply the formative assessment process into their daily practice.

## Conclusion

The purpose of this project study was to explore and understand the assessment and feedback practices of mathematics teachers in order to reduce a possible gap in practice. The theoretical framework of this study was guided by the amalgamation of

Black and Wiliam's (2009) theory of formative assessment and Hattie and Timperley's (2007) model of feedback. Using a qualitative case study design and various data sources, the findings showed that a gap in knowledge and practice did exist. To address this gap in practice, a 3-day professional development training was developed with the purpose of reducing the gap and integrating formative assessment into classroom practice.

While extremely powerful, the use of the formative assessment process to provide feedback to students is not common in daily educational practice (Black & Wiliam, 2009; Hattie & Timperley, 2007). It is my hope that this project study will contribute to the literature base, raise awareness to the issue, and provide some practical structures to promote classroom implementation of formative assessment with the result of increased student learning.

# References

Abu-Tineh, A. M., & Sadiq, H. M. (2018). Characteristics and models of effective professional development: the case of school teachers in Qatar. *Professional Development in Education*, *44*(2), 311-322. doi:10.1080/19415257.2017.1306788

Akpan, J. P., Notar, C. E., & Padgett, S. A. (2012). Formative assessment: A basic foundation for teaching and learning. *National Teacher Education Journal*, *5*(1), 83-97. doi: 10.1016/j.tate.2008.07.007

An, S., & Wu, Z. (2012). Enhancing mathematics teachers' knowledge of students' thinking from assessing and analyzing misconceptions in homework. *International Journal of Science & Mathematics Education*, *10*(3), 717-753. doi:10.1007/s10763-011-9324-x

Andersson, C., & Palm, T. (2017). The impact of formative assessment on student achievement: A study of the effects of changes to classroom practice after a comprehensive professional development programme. *Learning & Instruction*, 4992-102. doi:10.1016/j.learninstruc.2016.12.006

Attali, Y. (2015). Effects of multiple-try feedback and question type during mathematics problem solving on performance in similar problems. *Computers & Education*, *86,* 260-267. doi:10.1016/j.compedu.2015.08.011

Baird, T., & Clark, L. E. (2018). The 'look-ahead' professional development model: A professional development model for implementing new curriculum with a focus on instructional strategies. *Professional Development in Education*, *44*(3), 326-341. doi:10.1080/19415257.2017.1308424

Bandura, A. (1991). Social cognitive theory of self-regulation. *Organizational behavior and human decision processes*, *50*(2), 248-287. doi:10.1016/0749-5978(91)90022-L

Bartolini, V., Worth, K., & Jensen LaConte, J. E. (2014). A shift to inquiry: The heart of effective teaching and professional development for the twenty-first century. *New Educator*, *10*(1), 53-61. doi:10.1080/1547688X.2014.868229

Bayar, A. (2014). The components of effective professional development activities in terms of teachers' perspective. *International Online Journal of Educational Sciences*, *6*(2), 319-327. doi:10.15345/iojes.2014.02.006

Beaumont, C., O'Doherty, M., & Shannon, L. (2011). Reconceptualising assessment feedback: A key to improving student learning? *Studies in Higher Education*, *36*(6), 671-687. doi:10.1080/03075071003731135

Bennett, R. E. (2011). Formative assessment: A critical review. *Assessment in Education: Principles, Policy & Practice*, *18*(1), 5-25. doi:10.1080/0969594X.2010.513678

Bibbo, T., & D'Erizans, R. (2014). Professional development that works. *Principal Leadership*, *14*(7), 28-32. doi:10.1007/978-94-017-9433-6_5

Bilbro, J., Iluzada, C., & Clark, D. (2013). Responding effectively to composition students: Comparing student perceptions of written and audio feedback. *Journal on Excellence in College Teaching*, *24*(1), 47-83. doi:10.5539/elt.v9n8p73

Black, P. (2015). Formative assessment – an optimistic but incomplete vision. *Assessment in Education: Principles, Policy & Practice*, *22*(1), 161-177. doi:10.1080/0969594X.2014.999643

Black, P., & Wiliam, D. (1998a). Assessment and classroom learning. *Assessment in Education*, *5*(1), 7-74. doi:10.4135/9781446250808.n2

Black, P. & Wiliam, D. (1998b). *Inside the black box: Raising standards through classroom assessment*. London, England: School of Education King's College.

Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation & Accountability*, *21*(1), 5-31. doi:10.1007/s11092-008-9068-5

Box, C., Skoog, G., & Dabbs, J. M. (2015). A case study of teacher personal practice assessment theories and complexities of implementing formative assessment. *American Educational Research Journal*, *52*(5), 956-983. doi:10.3102/0002831215587754

Bradley, J. (2015). *Designing schools for meaningful professional learning: A guidebook for educators.* Thousand Oaks, CA: Corwin and Learning Forward.

Brookhart, S. M. (2012). Preventing feedback fizzle. *Educational Leadership*, *70*(1), 24-29.

Brown, C., & Militello, M. (2016). Principal's perceptions of effective professional development in schools. *Journal of Educational Administration*, *54*(6), 703-726. doi:10.1108/JEA-09-2014-0109

Carless, D., Salter, D., Yang, M., & Lam, J. (2011). Developing sustainable feedback practices. *Studies in Higher Education*, *36*(4), 395-407. doi:10.1080/03075071003642449

Chan, P. E., Konrad, M., Gonzalez, V., Peters, M. T., & Ressa, V. A. (2014). The critical

role of feedback in formative instructional practices. *Intervention in School and Clinic*, *50*(2), 96–104. doi:10.1177/1053451214536044

Chappuis, J. (2012). How am I doing? *Educational Leadership*, *70*(1), 36-40.

Chappuis, J. (2015). *Seven strategies of assessment for learning.* Boston, MA: Pearson.

Chappuis, J., Stiggins, R., Chappuis, S., & Arter, J. (2012). *Classroom assessment for student learning: Doing it right— using it well.* Boston, MA: Pearson.

Clark, I. (2012). Formative assessment: Assessment is for self-regulated learning. *Educational Psychology Review*, *24*(2), 205-249.

Coe, R., Aloisi, C., Higgins, S., & Major, L. E. (2014). *What makes great teaching? Review of the underpinning research*. Project Report. London, England: Sutton Trust.

Collopy, R. (2015). Investing in effective professional development for educators. *School Business Affairs*, *81*(6), 12-15. doi:10.1111/1467-9604.12030

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (Laureate custom ed.). Boston, MA: Pearson Education.

Dixon, H., & Haigh, M. (2009). Changing mathematics teachers' conceptions of assessment and feedback. *Teacher Development*, *13*(2), 173-186. doi:10.1080/13664530903044002

Dorn, S. (2010). The political dilemmas of formative assessment. *Exceptional Children*, *76*(3), 325-337. doi:10.1177/001440291007600305

Dueck, M. (2014). *Grading smarter, not harder: Assessment strategies that motivate kids*

*and help them learn.* Alexandria, VA: ASCD.

Dukor, B., & Holmberg, C. (2013). Helping beginning students uncover the art and science of formative feedback. *California English*, *18*(4), 8-10. doi:10.1016/B978-1-84334-655-5.50008-8

Earley, P., & Porritt, V. (2014). Evaluating the impact of professional development: the need for a student-focused approach. *Professional Development in Education*, *40*(1), 112-129. doi:10.1080/19415257.2013.798741

ESSA (2015). Every student succeeds act of 2015, Pub. L. No. 114-95 Stat. 1177 (2015-2016). Retrieved from https://www.congress.gov/114/plaws/publ95/PLAW-114publ95.pdf

Fisher, D., & Frey, N. (2012). Making time for feedback. *Educational Leadership*, *70*(1), 42-47.

Fisher, D., & Frey, N. (2013). Implementing RTI in a High School: A Case Study. *Journal of Learning Disabilities*, *46*(2), 99–114. doi:10.1177/0022219411407923

Fyfe, E. R., & Rittle-Johnson, B. (2016). Feedback both helps and hinders learning: The causal role of prior knowledge. *Journal of Educational Psychology*, *108*(1), 82-97. doi:10.1037/edu0000053

Fyfe, E. R., Rittle-Johnson, B., & DeCaro, M. S. (2012). The effects of feedback during exploratory mathematics problem solving: Prior knowledge matters. *Journal of Educational Psychology*, *104*(4), 1094-1108. doi:10.1037/a0028389

Gamlem, S. M. (2015). Feedback to support learning: Changes in teachers' practice and beliefs. *Teacher Development*, *19*(4), 461-482.

doi:10.1080/13664530.2015.1060254

Gamlem, S. M., & Munthe, E. (2014). Mapping the quality of feedback to support students' learning in lower secondary classrooms. *Cambridge Journal of Education*, *44*(1), 75-92. doi:10.1080/0305764X.2013.855171

Gaumer Erickson, A. S., Noonan, P. M., Brussow, J., & Supon Carter, K. (2017). Measuring the quality of professional development training. Professional Development in Education, 43(4), 685-688. doi:10.1080/19415257.2016.1179665

Gillham, B. (2000). *Case study research methods*. London: Continuum.

Goodwin, B., & Miller, K. (2012). Research says good feedback is targeted, specific, timely. *Educational Leadership*, *70*(1), 82-83.

Gotwals, A., Philhower, J., Cisterna, D., & Bennett, S. (2015). Using video to examine formative assessment practices as measures of expertise for mathematics and science teachers. *International Journal of Science & Mathematics Education*, *13*(2), 405-423. doi:10.1007/s10763-015-9623-8

Guskey, T. R. (2014). Evaluating professional learning. In S. Billett (Ed.), *International Handbook of Research in Professional and Practice-based Learning*, (pp. 1215–1235). New York, NY: Springer International.

Hargreaves, E. (2012). Teachers' classroom feedback: Still trying to get it right. *Pedagogies*, *7*(1), 1-15. doi:10.1080/1554480X.2012.630454

Hattie, J. (2012). Know thy impact. *Educational Leadership*, *70*(1), 18-23.

Hattie, J., Fischer, D., & Frey, N. (2016). Do they hear you? *Educational Leadership*, *73*(7), 16-21.

Hattie, J., & Gan, M. (2011). Instruction based on feedback. In R. Mayer & P. Alexander (Eds.), *Handbook of research on learning and instruction* (pp. 249–271). New York, NY: Routledge.

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*(1), 81-112. doi:10.3102/003465430298487

Havnes, A., Smith, K., Dysthe, O., & Ludvigsen, K. (2012). Formative assessment and feedback: Making learning visible. *Studies in Educational Evaluation*, *38*(1), 21-27. doi:10.1016/j.stueduc.2012.04.001

Heitink, M., Van der Kleij, F., Veldkamp, B., Schildkamp, K., & Kippers, W. (2016). A systematic review of prerequisites for implementing assessment for learning in classroom practice. *Educational Research Review*, *17,* 50-62. doi:10.1016/j.edurev.2015.12.002

Hodgen, J., & Wiliam, D. (2006). *Mathematics inside the black box: Assessment for learning in the mathematics classroom*. Granada Learning.

Hudesman, J., Crosby, S., Flugman, B., Issac, S., Everson, H., & Clay, D. B. (2013). Using formative assessment and metacognition to improve student achievement. *Journal of Developmental Education*, *37*(1), 2-13.

Hudesman, J., Crosby, S., Ziehmke, N., Everson, H., Isaac, S., Flugman, B., Zimmerman, B., & Moylan, A. (2014). Using formative assessment and self-regulated learning to help developmental mathematics students achieve: A multi-campus program. *Journal on Excellence in College Teaching*, *25*(2), 107-121. doi:10.4135/9781526401861.n9

Jenkins, J. O. (2010). A multi-faceted formative assessment approach: Better recognising the learning needs of students. *Assessment & Evaluation in Higher Education*, *35*(5), 565-576. doi:10.1080/02602930903243059

Jiang, Y. (2014). Exploring teacher questioning as a formative assessment strategy. *RELC Journal*, *45*(3), 287–304. doi:10.1177/0033688214546962

Jonsson, A., Lundahl, C., & Holmgren, A. (2015). Evaluating a large-scale implementation of assessment for learning in Sweden. *Assessment in Education: Principles, Policy & Practice*, *22*(1), 104-121. doi:10.1080/0969594X.2014.970612

Kearney, W. S., Webb, M., Goldhorn, J., & Peters, M. L. (2013). Examining the impact of critical feedback on learner engagement in secondary mathematics classrooms: A multi-level analysis. *AASA Journal of Scholarship & Practice*, *10*(1), 23-38. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.673.8634&rep=rep1&type=pdf#page=23

Kelly, A. M., Gningue, S. M., & Qian, G. (2015). First-year urban mathematics and science middle school teachers: Classroom challenges and reflective solutions. *Education and Urban Society*, *47*(2), 132–159. doi:10.1177/0013124513489147

Ketsman, O. (2012). Expectations in the foreign language classrooms: A case study. *The Qualitative Report, 17*(53), 1-21. Retrieved from https://nsuworks.nova.edu/tqr/vol17/iss53/2

Killion, J. (2018). *Assessing impact: Evaluating professional learning.* Thousand Oaks,

CA: Corwin.

Killion, J., & Roy, P. (2009). *Becoming a learning school.* Oxford, OH: National Staff Development Council.

Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance. *Psychological Bulletin*, *119*(2), 254-284. doi:10.1037/0033-2909.119.2.254

Kobrin, J. L. (2016). Learning progressions in action in a middle school: A case study. *Professional Development in Education*, *42*(1), 171-173. doi:10.1080/19415257.2014.963885

Kohn, A. (2011). The case against grades. *Educational Leadership*, *69(3)*, 28-33.

Kutaka, T. S., Smith, W. M., Albano, A. D., Edwards, C. P., Ren, L., Beattie, H. L., & Stroup, W. W. (2017). Connecting Teacher Professional Development and Student Mathematics Achievement. *Journal of Teacher Education*, *68*(2), 140-154. doi:10.1177/0022487116687551

Lalor, A. (2012). Keeping the destination in mind. *Educational Leadership*, *70*(1), 75-78.

Lauer, P. A., Christopher, D. E., Firpo-Triplett, R., & Buchting, F. (2014). The impact of short-term professional development on participant outcomes: A review of the literature. *Professional Development in Education*, *40*(2), 207-227. doi:10.1080/19415257.2013.776619

Learning Forward. (2011). *Standards for professional learning*. Oxford, OH: Author.

Lee, I. (2011). Feedback revolution: What gets in the way? *ELT Journal: English Language Teachers Journal*, *65*(1), 1-12. doi:10.1093/elt/ccp028

Lee, I., Mak, P., & Burns, A. (2016). EFL teachers' attempts at feedback innovation in the writing classroom. *Language Teaching Research*, *20*(2), 248-269. doi:10.1177/1362168815581007

Liljedahl, P. l. (2014). Approaching Professional Learning: What teachers want. *Mathematics Enthusiast*, *11*(1), 109-122. Retrieved from https://scholarworks.umt.edu/tme/vol11/iss1/7

Lindvall, J., Helenius, O., & Wiberg, M. (2018). Critical features of professional development programs: Comparing content focus and impact of two large-scale programs. *Teaching & Teacher Education*, *70*121-131. doi:10.1016/j.tate.2017.11.013

Lodico, M., Spaulding, D., & Voegtle, K. (2010). *Methods in educational research: From theory to practice.* San Francisco, CA: John Wiley & Sons.

Lopes, J. b., & Cunha, A. E. (2017). Self-directed professional development to improve effective teaching: Key points for a model. *Teaching & Teacher Education*, *68*262-274. doi:10.1016/j.tate.2017.09.009

Mahfoodh, O. A., & Pandian, A. (2011). A qualitative case study of EFL students' affective reactions to and perceptions of their teachers' written feedback. *English Language Teaching*, *4*(3), 14-25. doi:10.5539/elt.v4n3p14

Marzano, R., & Heflebower, T. (2011). Grades that show what students know. *Educational Leadership*, *69(3)*, 34-39.

Maxfield, L. (2013). Improve Your Students' Learning by Improving Your Feedback. *Journal of Singing*, *69*(4), 471-478. Retrieved from

https://search.proquest.com/openview/8b559c88f30fe6ac0a626a9b06712fe2/1?pq-origsite=gscholar&cbl=41612

Merchie, E., Tuytens, M., Devos, G., & Vanderlinde, R. (2018). Evaluating teachers' professional development initiatives: towards an extended evaluative framework. *Research Papers In Education*, *33*(2), 143-168. doi:10.1080/02671522.2016.1271003

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation.* San Francisco, CA: Jossey-Bass.

Miles, M., & Huberman, A. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: Sage.

Moss, C. M. (2015). *Formative classroom walkthroughs: How principals and teachers collaborate to raise student achievement.* Alexandria, VA: ASCD.

National Center for Education Statistics. (2016). NCES Statement on PISA 2015 Results. Retrieved from http://nces.ed.gov/whatsnew/commissioner/remarks2016/12_06_2016.asp

National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. (1978). *The Belmont report: Ethical principles and guidelines for the protection of human subjects of research*. Bethesda, MD: The Commission. Retrieved from https://www.hhs.gov/ohrp/regulations-and-policy/belmont-report/read-the-belmont-report/index.html

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (2013). *Formative assessment*. Retrieved from http://www.nctm.org/uploadedFiles/Standards_and_Positions/Position_Statements/Formative%20Assessment1.pdf

National Council of Teachers of Mathematics. (2014). *Principles to action: Ensuring mathematical success for all.* Reston, VA: National Council of Teachers of Mathematics.

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common core state standards*. Washington, DC: Authors. Retreived from http://www.corestandards.org/assets/CCSSI_ELA%20Standards.pdf

Ni Shuilleabhain, A., & Seery, A. (2018). Enacting curriculum reform through lesson study: a case study of mathematics teacher learning. *Professional Development In Education*, *44*(2), 222-236. doi:10.1080/19415257.2017.1280521

Nichols, T. P. (2012). Feedback in the age of efficiency. *Educational Leadership*, *70*(1), 71-74.

Nicol, D. J., & Macfarlane-Dick, D. (2006). Formative assessment and self-regulated learning: A model and seven principles of good feedback practice. *Studies in Higher Education*, *31*(2), 199-218. doi:10.1080/03075070600572090

No Child Left Behind (NCLB) Act of 2001, Pub. L. No. 107-110, § 115, Stat. 1425 (2002). Retrieved from https://www2.ed.gov/nclb/landing.jhtml

Olsen, B., & Buchanan, R. (2017). "Everyone wants you to do everything": Investigating the professional identity development of teacher educators. *Teacher Education*

*Quarterly*, *44*(1), 9-34. Retrieved from https://www.researchgate.net/profile/Brad_Olsen/publication/312989962_Everybody_Wants_You_to_Do_Everything_Investigating_the_Professional_Identity_Development_of_Teacher_Educators/links/588bd6aea6fdcc8e63c809be/Everybody-Wants-You-to-Do-Everything-Investigating-the-Professional-Identity-Development-of-Teacher-Educators.pdf

Opfer, V. D., & Pedder, D. (2011). Conceptualizing teacher professional learning. *Review of Educational Research*, *81*(3), 376-407. doi:10.3102/0034654311413609

Owen, L. (2016). The impact of feedback as formative assessment on student performance. *International Journal of Teaching & Learning in Higher Education*, *28*(2), 168-175. Retrieved from https://files.eric.ed.gov/fulltext/EJ1111131.pdf

Peshek, S. (2012). Assessment and grading in a differentiated mathematics classroom. *Ohio Journal of School Mathematics*, *65*, 45-50. Retrieved from https://kb.osu.edu/bitstream/handle/1811/78208/OJSM_65_Spring2012_45.pdf?sequence=1

Poskitt, J. (2014). Transforming professional learning and practice in assessment for learning. Curriculum Journal, 25(4), 542-566. doi:10.1080/09585176.2014.981557

Price, M., Handley, K., Millar, J., & O'Donovan, B. (2010). Feedback: All that effort, but what is the effect? *Assessment & Evaluation in Higher Education*, *35*(3), 277-289. doi:10.1080/02602930903541007

Ramaprasad, A. (1983). On the definition of feedback. *Behavioral Science*, *28*(1), 4-13.

Retrieved from https://www.researchgate.net/profile/Arkalgud_Ramaprasad/publication/227634769_On_the_Definition_of_Feedback/links/59fa08ceaca272026f6ed416/On-the-Definition-of-Feedback.pdf

Randel, B., Apthorp, H., Beesley, A. D., Clark, T. F., & Wang, X. (2016). Impacts of professional development in classroom assessment on teacher and student outcomes. *Journal of Educational Research*, 109(5), 491-502. doi:10.1080/00220671.2014.992581

Saldana, J. (2013). *The coding manual for qualitative researchers* (2nd ed.). Thousand Oaks, CA: Sage.

Sadler, D.R. (1989). Formative assessment and the design of instructional systems. *Instructional Science, 18*(2), 119–41. Retrieved from http://pdf.truni.sk/e-ucebnice/iktv/data/media/iktvv/Symposium_LTML_Royce%20Sadler_BFormative_Assessment_and_the_design_of_instructional_systems.pdf

Sadler, D. (2010). Fidelity as a precondition for integrity in grading academic achievement. *Assessment & Evaluation in Higher Education*, *35*(6), 727-743. doi:10.1080/02602930902977756

Santos, L., & Semana, S. (2015). Developing mathematics written communication through expository writing supported by assessment strategies. *Educational Studies In Mathematics*, *88*(1), 65-87. doi:10.1007/s10649-014-9557-z

See, B. H., Gorard, S., & Siddiqui, N. (2016). Teachers' use of research evidence in practice: A pilot study of feedback to enhance learning. *Educational Research*,

*58*(1), 56-72. doi:10.1080/00131881.2015.1117798

See Ling, S., & Saw Lan, O. (2012). Investigating assessment practices of in-service teachers. *International Online Journal of Educational Sciences*, *4*(1), 91-106. Retrieved from https://www.researchgate.net/profile/Saw_Lan_Ong/publication/268015768_Investigating_Assessment_Practices_of_In-service_Teachers/links/5580057d08aeb61eae273b9f/Investigating-Assessment-Practices-of-In-service-Teachers.pdf

Shepard, L. A. (2018). Learning progressions as tools for assessment and learning. *Applied Measurement in Education*, *31*(2), 165-174. doi:10.1080/08957347.2017.1408628

Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research*, *78*(1), 153-189. doi:10.3102/0034654307313795

Siewert, L. (2010). The effects of written teacher feedback on the academic achievement of fifth-grade students with learning challenges. *Preventing School Failure*, *55*(1), 17-27. doi:10.1080/10459880903286771

Simons, H. (2009). *Case study research in practice.* London: Sage Publications, Ltd. doi:10.4135/9781446268322

Stake, R. (1995). *The art of case study research.* Thousand Oaks, CA: Sage.

Superfine, A., & Wenjuan Li. (2014). Developing mathematical knowledge for teaching teachers: A model for the professional development of teacher educators. *Issues in Teacher Education*, *23*(1), 113-132. doi:10.1177/0022487114534265

Suurtamm, C., Koch, M., & Arden, A. (2010). Teachers' assessment practices in mathematics: Classrooms in the context of reform. *Assessment In Education: Principles, Policy & Practice*, *17*(4), 399-417. doi:10.1080/0969594X.2010.497469

Tack, H., Valcke, M., Rots, I., Struyven, K., & Vanderlinde, R. (2018). Uncovering a hidden professional agenda for teacher educators: A mixed method study on Flemish teacher educators and their professional development. *European Journal of Teacher Education*, *41*(1), 86-104. doi:10.1080/02619768.2017.1393514

Tay, H. (2015). Setting formative assessments in real-world contexts to facilitate self-regulated learning. *Educational Research for Policy & Practice*, *14*(2), 169-187. doi:10.1007/s10671-015-9172-5

Tovani, C. (2012). Feedback is a two-way street. *Educational Leadership*, *70*(1), 48-51.

Thurlings, M., & den Brok, P. (2017). Learning outcomes of teacher professional development activities: a meta-study. *Educational Review*, *69*(5), 554-576. doi:10.1080/00131911.2017.1281226

van den Bergh, L., Ros, A., & Beijaard, D. (2013). Feedback during active learning: Elementary school teachers' beliefs and perceived problems. *Educational Studies*, *39*(4), 418-430. doi:10.1080/03055698.2013.767188

Vatterott, C. (2015). *Rethinking grading: Meaningful assessment for standards-based learning.* Alexandria, VA: ASCD.

Voerman, L., Meijer, P., Korthagen, F., & Simons, R. (2012). Types and frequencies of feedback interventions in classroom interaction in secondary education. *Teaching*

*and Teacher Education*, *28*(8), 1107-1115. doi:10.1016/j.tate.2012.06006

Westerberg, T. (2016). *Charting a course to standards-based grading: What to stop, what to start, and why it matters*. Alexandria, VA: ASCD.

Wiggins, G. (2012). 7 keys to effective feedback. *Educational Leadership*, *70*(1), 10-16.

Wiliam, D. (2011a). *Embedded formative assessment*. Bloomington, IN: Solution Tree Press.

Wiliam, D. (2011b). What is assessment for learning? *Studies in Educational Evaluation*, *37*(1), 3-14. doi:10.1016/j.stueduc.2011.03.001

Wiliam, D. (2012). Feedback: Part of a system. *Educational Leadership*, *70*(1), 31-34.

Wiliam, D. (2016a). *Leadership for teacher learning.* West Palm Beach, FL: Learning Sciences International.

Wiliam, D. (2016b). The secret to effective feedback. *Educational Leadership*, *73*(7), 10-15.

Wiliam, D., & Leahy, S. (2015). *Embedding formative assessment: Practical techniques for K-12 classrooms*. West Palm Beach, FL: Learning Sciences International.

Wilson, M. (2012). What do we say when a child says …: "Look at my drawing!" *Educational Leadership*, *70*(1), 52-56.

Wilson, S. M. (2013). Professional development for science teachers. *Science, 340*(6130), 310-313. doi:10.1126/science.1230725

Wingate, U. (2010). The impact of formative feedback on the development of academic writing. *Assessment & Evaluation in Higher Education*, *35*(5), 519-533. doi:10.1080/02602930903512909

Wylie, E. C., & Lyon, C. J. (2015). The fidelity of formative assessment implementation: issues of breadth and quality. *Assessment in Education: Principles, Policy & Practice*, 22(1), 140-160. doi:10.1080/0969594X.2014.990416

Yang, M. & Carless, D. (2013). The feedback triangle and the enhancement of dialogic feedback processes. *Teaching in Higher Education*, *18*(3), 285-297. doi:10.1080/13562517.2012.719154

Appendix A: Project

## Professional Development 3-Day Formative Assessment Training Session

### Purpose

The purpose of this 3-day professional development training session is to reduce the gap of the current classroom practice of mathematics teachers in comparison to what research suggests is effective formative assessment and feedback practice. Through this training session the participants will learn the aspects of formative assessment and how to integrate them into classroom practice.

### Goals

- Provide mathematics teachers with the foundational knowledge to integrate the first three aspects of the formative assessment process into their classroom practice.
- Provide mathematics teachers the opportunity to work together collaboratively and to analyze student learning data.

### Outcomes

- Mathematics teachers will understand and integrate the first three aspects of the formative assessments process into their classroom practice.
- Mathematics teachers will clearly identify the learning targets for students and align curriculum assessments to the learning targets.
- Mathematics teachers will use student assessment data to provide feedback to students and make adjustments for the next stages of learning.
- Mathematics teachers will work collaboratively as a department to promote collective improvement and accountability while promoting increasing student learning.

### Target Audience

Mathematics teachers in the school

### Timeline

The 3-day Formative Assessment Training should take place at the beginning of the school year. The first two days should take place in August prior to the start of the 2018 school year, with the last day taking place one month after the school year has started in order to use actual classroom assessment information and data.

### Materials Needed

Presenter needs:

- Audio-visual projection equipment
- Presentation files
- Copies of handouts

Participant needs:

- Writing instrument
- Curricular materials (teacher's manual, syllabi, assessments, etc.)
- Student completed assessments

**Formative Assessment Training Agenda**

**Day 1**

| | |
|---|---|
| 9:00-9:30 | Welcome/Introductions/Icebreaker Activity |
| 9:30-12:00 | Presentation: Introduction to Formative Assessment |
| 12:00-1:00 | Lunch Break |
| 1:00-1:30 | Formative Assessment Question and Answer |
| 1:30-3:00 | Presentation: Introduction to Curriculum Mapping |

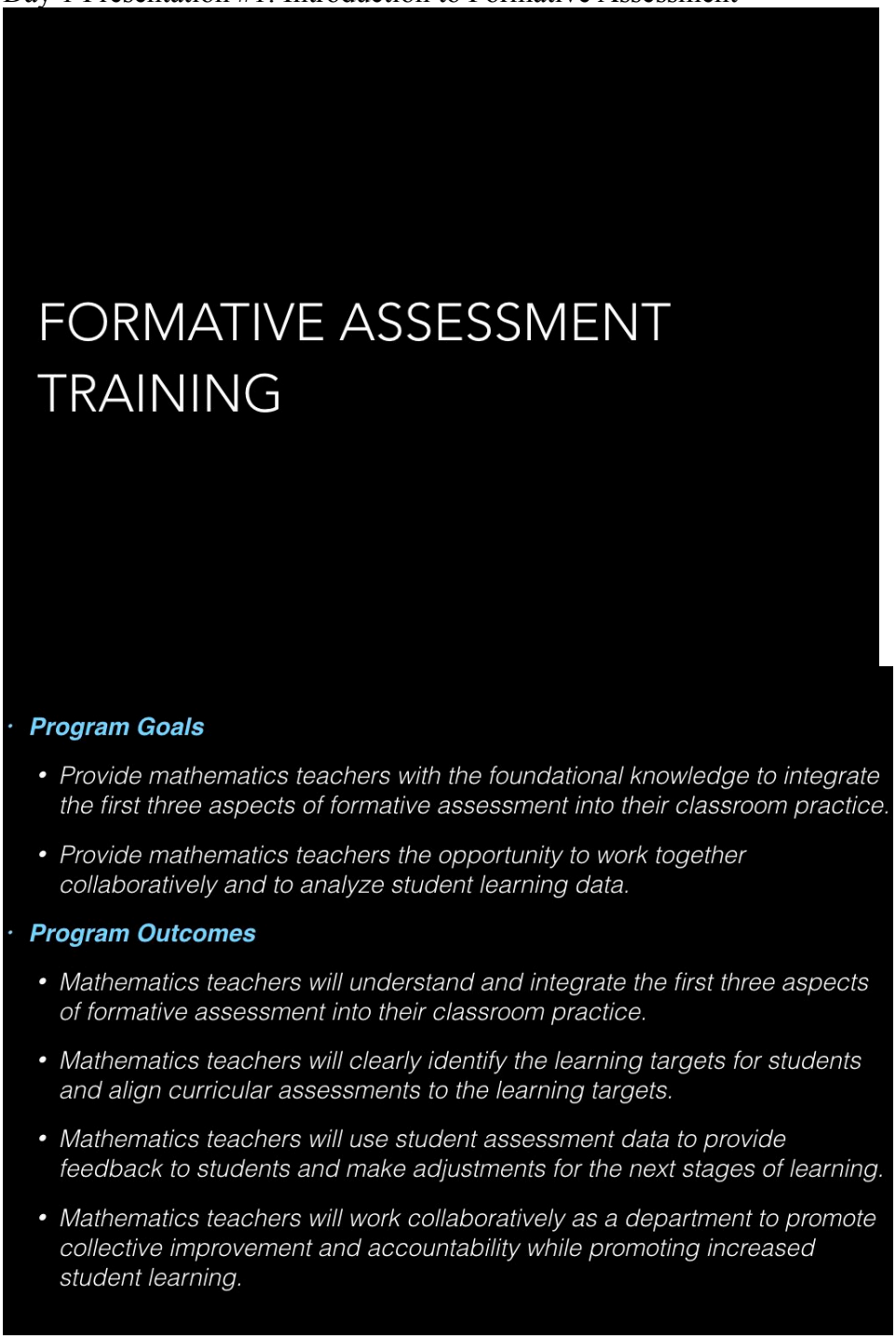
**Day 2**

| | |
|---|---|
| 9:00-9:30 | Icebreaker Activity; Question and Answer from Day 1 |
| 9:30-12:30 | Collaborative Curriculum Mapping Work |
| 12:30-1:30 | Lunch Break |
| 1:30-2:00 | Presentation: Alignment of Significant Assessments |
| 2:00-3:00 | Collaborative Alignment of Significant Assessments Work |

**Day 3** (One month later)

| | |
|---|---|
| 9:00-9:30 | Icebreaker Activity; Question and Answer from previous training sessions |
| 9:30-10:30 | Presentation: Assessment Breakdown |
| 10:30-12:30 | Individual Assessment Breakdown Work |
| 12:30-1:30 | Lunch Break |
| 1:30-1:45 | Question and Answer on Assessment Breakdown |
| 1:45-3:00 | Individual Presentations of Assessment Breakdown/Peer Review Activity |
| 3:00-3:30 | Wrap up and Training Evaluation |

Day 1 Presentation #1: Introduction to Formative Assessment

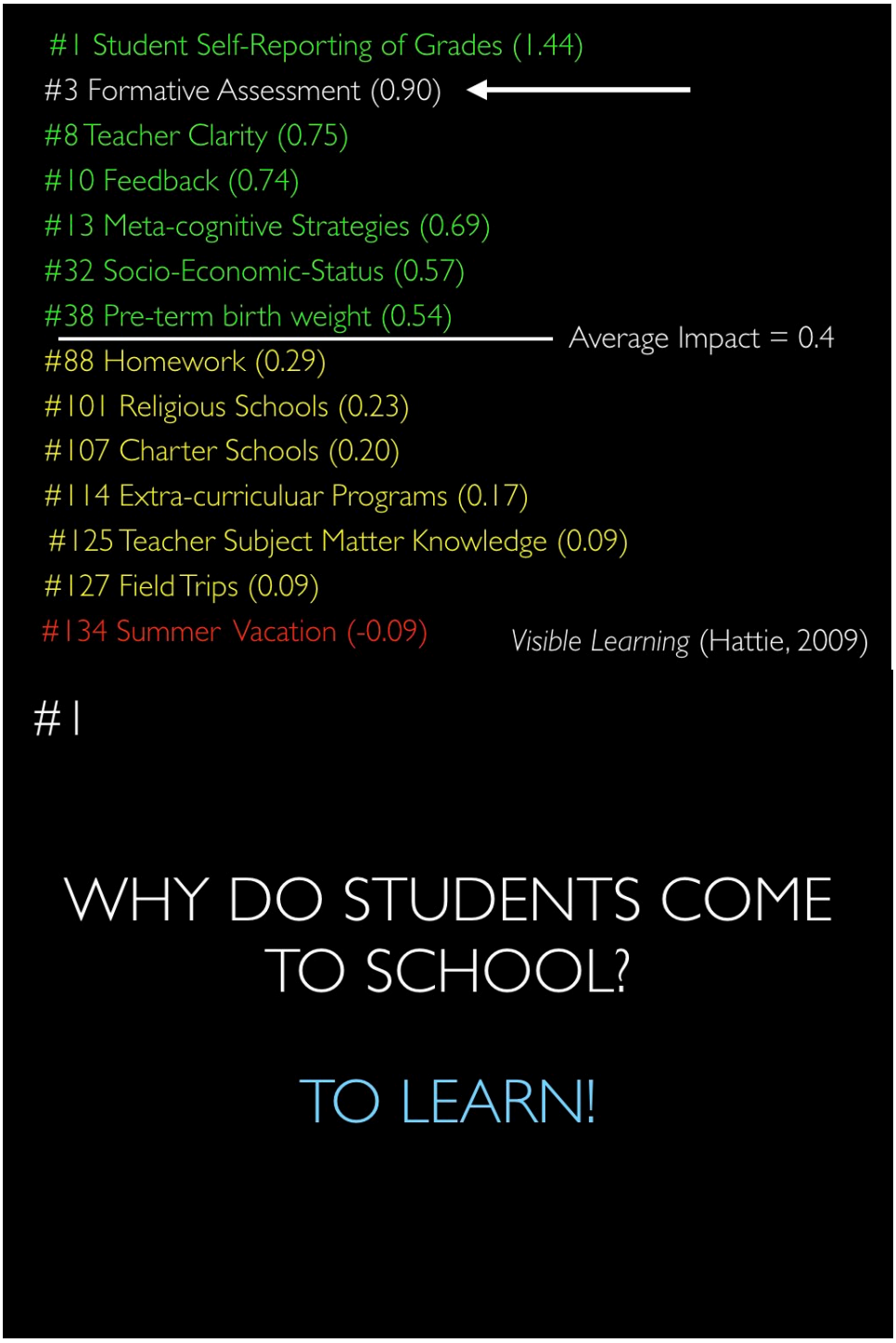


# Basic Agenda

- *Day 1*
  - *Introduction to Formative Assessment*
  - *Introduction to Curriculum Mapping*
- *Day 2*
  - *Curriculum Mapping Work*
  - *Assessment Alignment Work*
- *Day 3*
  - *Assessment Breakdown Activity*

DAY 1

# INTRODUCTION TO FORMATIVE ASSESSMENT


#1 Student Self-Reporting of Grades (1.44)
#3 Formative Assessment (0.90)
#8 Teacher Clarity (0.75)
#10 Feedback (0.74)
#13 Meta-cognitive Strategies (0.69)
#32 Socio-Economic-Status (0.57)
#38 Pre-term birth weight (0.54)
Average Impact = 0.4
#88 Homework (0.29)
#101 Religious Schools (0.23)
#107 Charter Schools (0.20)
#114 Extra-curriculuar Programs (0.17)
#125 Teacher Subject Matter Knowledge (0.09)
#127 Field Trips (0.09)
#134 Summer Vacation (-0.09)
*Visible Learning* (Hattie, 2009)
#1
WHY DO STUDENTS COME TO SCHOOL?
TO LEARN!

## #2 WHAT IS A TEACHER'S JOB?

*Sage on the stage?*
*or*
*Guide on the side?*

## #2 WHAT IS A TEACHER'S JOB?

"The teacher's job is not to transmit knowledge, nor to facilitate learning. It is to engineer effective learning environments for the students.

"Sometimes a teacher does her best teaching before the students arrive in the classroom."

(Wiliam, 2011, p. 49-50)

## Summative vs. Formative

- ***Summative*** (SA): Assessment of Learning
  - **Verifies Learning:** Certifies, ranks, accountability
- ***Formative*** (FA): Assessment for Learning
  - **Supports Learning:** Creates decision-making moments to generate feedback to move learning forward
- What determines SA/FA is TIMING and PURPOSE
  - SA: End of learning cycle
  - FA: During the learning cycle

## Formative Assessment

- There is no such thing as a "Formative Assessment tool"! (Analogies)
- Formative Assessment is a **systematic process** designed to generate actionable feedback for decisions

## 5 Key Aspects of Formative Assessment

| | Where the learner is going | Where the learner is now | How to get there |
|---|---|---|---|
| Teacher | **1.** Clarifying, sharing, and understanding learning intentions and success criteria | **2.** Engineering effective discussions and other learning tasks that elicit evidence of student understanding | **3.** Providing feedback that moves learners forward |
| Peer | | **4.** Activating students as instructional resources for one another | |
| Learner | | **5.** Activating students as the owners of their own learning | |

(Black & Wiliam, 2009, p.8)

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(Black & Wiliam, 2009, p.8)

## 1. CLARIFYING, SHARING, & UNDERSTANDING LEARNING INTENTIONS AND SUCCESS CRITERIA

"You've got to be very careful if you don't know where you are going, because you might not get there."

–Yogi Berra

## 1. CLARIFYING, SHARING, & UNDERSTANDING LEARNING INTENTIONS AND SUCCESS CRITERIA

- **Clear learning targets are essential!**
- 4 types of targets
  - *Knowledge-level:* factual, procedural, conceptual
  - *Reasoning-level:* predict, compare, evaluate
  - *Skill-level:* real-time or physical demo
  - *Product-level:* creation of a product

## 5 Key Aspects of Formative Assessment

| | Where the learner is going | Where the learner is now | How to get there |
|---|---|---|---|
| **Teacher** | **1.** Clarifying, sharing, and understanding learning intentions and success criteria | **2.** Engineering effective discussions and other learning tasks that elicit evidence of student understanding | **3.** Providing feedback that moves learners forward |
| **Peer** | | **4.** Activating students as instructional resources for one another | |
| **Learner** | | **5.** Activating students as the owners of their own learning | |

(Black & Wiliam, 2009, p.8)

## 2. Engineering effective discussions, tasks, and activities that elicit evidence of learning

"... assessment is THE central process in instruction. Students do not learn what we teach. If they did, we would not need to keep gradebooks. We could, instead, simply record what we taught."

(Wiliam, 2011, p. 47-48)

## 2. Engineering effective discussions, tasks, and activities that elicit evidence of learning

- Why do we need evidence?
  - Because student do not learn exactly what they are "taught"
- Listening to students
  - Evaluative
  - Interpretive

17

## 2. Engineering effective discussions, tasks, and activities that elicit evidence of learning

- Quality classroom assessment:
  - Designed to give specific information to the intended user.
  - Based on clearly articulated learning targets.
  - Accurately measure student achievement
  - Yield results that are effectively communicated to intended user
  - Involve students in self-assessment and further learning.

## 2. Engineering effective discussions, tasks, and activities that elicit evidence of learning

- Problems occur when the method of assessment doesn't align with the target type.
  - Demonstrate . . .
  - Essays
  - Compare and contrast
- To promote learning you must separate the intention from the context!

React to the "engineering" of the learning tasks in this clip.

Wargames (1983)

## 5 Key Aspects of Formative Assessment

| | Where the learner is going | Where the learner is now | How to get there |
|---|---|---|---|
| Teacher | **1.** Clarifying, sharing, and understanding learning intentions and success criteria | **2.** Engineering effective discussions and other learning tasks that elicit evidence of student understanding | **3.** Providing feedback that moves learners forward |
| Peer | | **4.** Activating students as instructional resources for one another | |
| Learner | | **5.** Activating students as the owners of their own learning | |

(Black & Wiliam, 2009, p.8)

## 3. Providing feedback that moves learning forward

"information . . . regarding aspects of one's performance or understanding that **reduces the discrepancy** between what is understood and what is aimed to be understood."

(Hattie & Gan, 2011, p. 258)

## Feedback is the critical aspect that supports formative assessment

## 3. Providing feedback that moves learning forward

"Much of the feedback that students get has little to no effect on their learning, and some kinds of feedback are actually counterproductive."

(Wiliam, 2011, p. 107)

## Possible Responses to Feedback

***Positive impact on learning**

| *Response Type* | *Performance Exceeds Goal* | *Performance Falls Short of Goal* |
|---|---|---|
| ***Change Behavior*** | Exert less effort | **Increase effort** |
| ***Change Goal*** | **Increase aspiration** | Reduce aspiration |
| ***Abandon Goal*** | Decide if goal is too easy | Decide goal is too hard |
| ***Reject Feedback*** | Feedback is ignored | Feedback is ignored |

(Wiliam, 2011, p. 115)

# Feedback

- Effective Feedback Answers 3 Questions
  - Where am I going?
  - How am I going?
  - Where to next?
- Four Levels of Feedback
  - Task Level
  - Process Level
  - Self-Regulation Level
  - Self Level

# Task Level Feedback

*How well a task is being performed*

- Often called corrective feedback or knowledge of results
- 90% of classroom feedback is directed at this level.
- Addresses surface learning (acquisition, storing, reproduction)
- Too much FT leads to trial & error strategies and less cognitive effort
- Powerful when addressing faulty interpretations, but doesn't generalize
- Short written comments > grades

## Process Level Feedback

*Processes needed to understand & perform the tasks*

- More effective than task-level for deeper learning
- Generalizes to other tasks/situations
- A necessary pre-req for student self-regulation

## Self-regulation Level Feedback

*Self-monitoring, directing, guiding of actions*

- Capacity to self-assess and create internal feedback
- Willingness to invest effort in seeking feedback
- Degree of confidence in response
- Can make accurate attributions about success or failure

## Self Level Feedback

*Personal evaluations about the learner*

- FS is very common, welcomed, and expected
- Does not improve learning
  - Counterproductive and leads to self-handicapping, hopelessness, difficulty in self-assessment, social comparison, rejection of effective feedback, setting of low goals
- Often combined with FT; reduces effectiveness & directs attention away form learning
- Used often to mitigate critical comments (the ineffective sandwich method)
- Research has found that no feedback has a higher positive effect on learning than giving praise

## Feedback Research

- Teachers often give "poor" students more praise.
- Feedback to boys is more related to lack of effort.
  - Dangers
- Feedback to girls is more related to ability.
  - Dangers
- Teachers often use assessment information as feedback about students— not their teaching.

# Feedback Timing

"The optimal timing of feedback seems to depend on the nature of the learning task. When students are acquiring new, complex knowledge or skills, real-time checks for understanding and tips can prevent them from developing misconceptions or incorrect practices. But when they are extending and applying knowledge (for example, writing an essay or solving a complex theorem), delaying feedback somewhat can enable them to self-correct, develop perseverance, and take responsibility for their own learning objectives."

(Goodwin & Miller, 2012, p. 83)

# Feedback Timing

"However, feedback that's too immediate may cause students to rely on teachers for answers rather than persevering and figuring out problems on their own."

(Goodwin & Miller, 2012, p. 83)

## Feedback Timing

- Feedback should be "timely"
- **Immediate Feedback:** During the initial learning about the task (do not use during the fluency stage).
- **Delayed Feedback:** For things that require more mental cognitive processing.

## Ineffective Feedback

- Not directed at the learning target
- Grades
- Praise
- In a format that is not accessible to students (in word or deed)
- Highly prescriptive comments
- Untimely feedback

## Remember the purpose!

To reduce the discrepancy between the current performance and the goal.

# Effective Feedback

- Directs attention to the learning
- Occurs during the learning so there is time to act
- Addresses partial understanding in the progression
- Is a recipe for future action
- Does not do the thinking for the student— it causes it!
- Limits corrective information to the amount of advice that can be acted on
- Focus on self-efficacy, not self-esteem

React to the feedback given in this clip.

Hoosiers (1986)

## 3. Providing feedback that moves learning forward

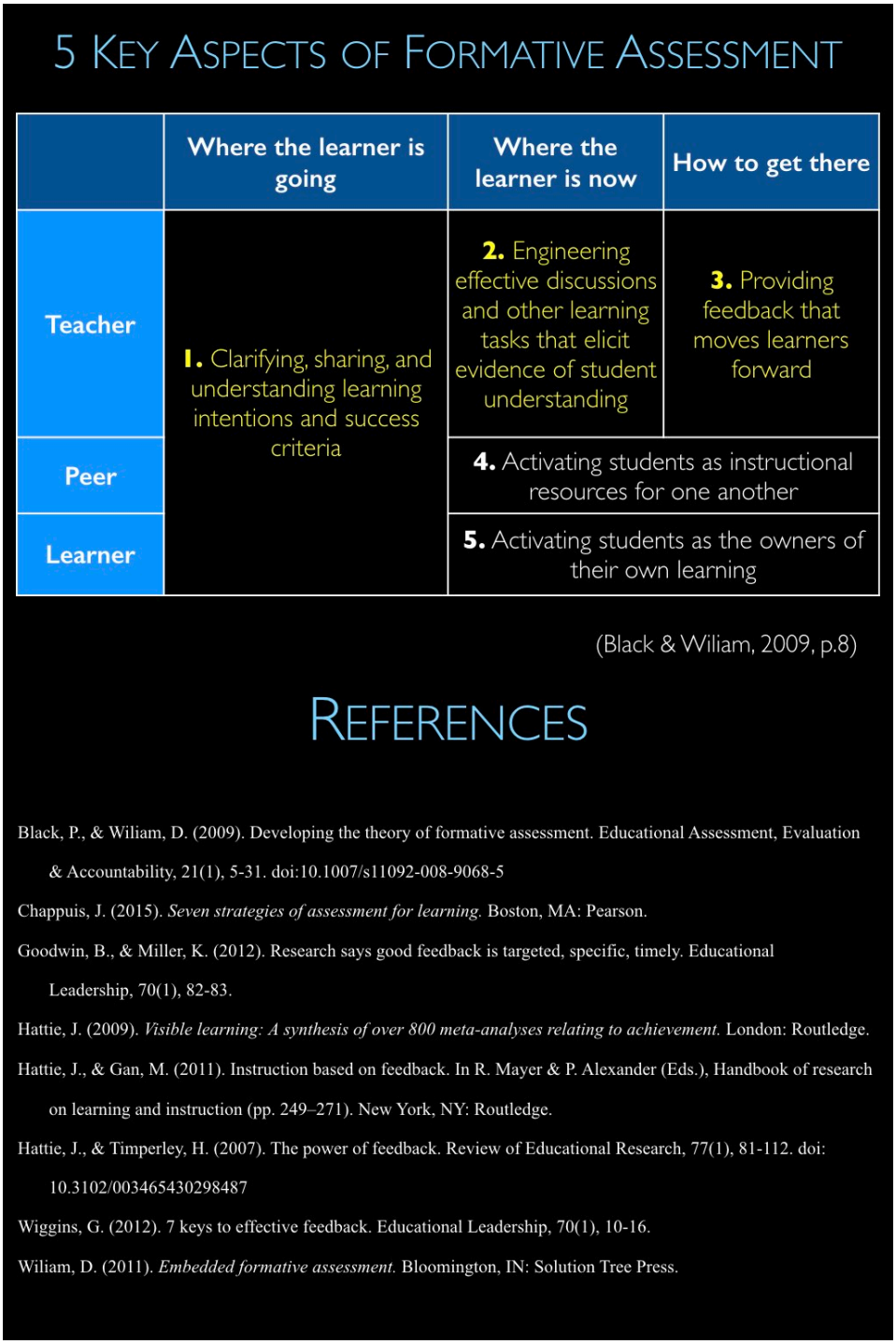
"information . . . regarding aspects of one's performance or understanding that **reduces the discrepancy** between what is understood and what is aimed to be understood."

(Hattie & Gan, 2011, p. 258)

Intentionally engineer your learning tasks so you get the information you want for feedback

"remember that 'no time to give and use feedback' actually means 'no time to cause learning.'"

(Wiggins, 2012, p.16)



## 5 Key Aspects of Formative Assessment

| | Where the learner is going | Where the learner is now | How to get there |
|---|---|---|---|
| Teacher | **1.** Clarifying, sharing, and understanding learning intentions and success criteria | **2.** Engineering effective discussions and other learning tasks that elicit evidence of student understanding | **3.** Providing feedback that moves learners forward |
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(Black & Wiliam, 2009, p.8)

## References


Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. Educational Assessment, Evaluation & Accountability, 21(1), 5-31. doi:10.1007/s11092-008-9068-5

Chappuis, J. (2015). *Seven strategies of assessment for learning.* Boston, MA: Pearson.

Goodwin, B., & Miller, K. (2012). Research says good feedback is targeted, specific, timely. Educational Leadership, 70(1), 82-83.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement.* London: Routledge.

Hattie, J., & Gan, M. (2011). Instruction based on feedback. In R. Mayer & P. Alexander (Eds.), Handbook of research on learning and instruction (pp. 249–271). New York, NY: Routledge.

Hattie, J., & Timperley, H. (2007). The power of feedback. Review of Educational Research, 77(1), 81-112. doi: 10.3102/003465430298487

Wiggins, G. (2012). 7 keys to effective feedback. Educational Leadership, 70(1), 10-16.

Wiliam, D. (2011). *Embedded formative assessment.* Bloomington, IN: Solution Tree Press.


Day 1 Presentation #2: Introduction to Curriculum Mapping

DAY 1

# FORMATIVE ASSESSMENT TRAINING

1

## 5 KEY ASPECTS OF FORMATIVE ASSESSMENT

| | Where the learner is going | Where the learner is now | How to get there |
|---|---|---|---|
| Teacher | **1.** Clarifying, sharing, and understanding learning intentions and success criteria | **2.** Engineering effective discussions and other learning tasks that elicit evidence of student understanding | **3.** Providing feedback that moves learners forward |
| Peer | | **4.** Activating students as instructional resources for one another | |
| Learner | | **5.** Activating students as the owners of their own learning | |

2

(Black & Wiliam, 2009, p.8)

## 1. CLARIFYING, SHARING, & UNDERSTANDING LEARNING INTENTIONS AND SUCCESS CRITERIA

What are your targets?

Where are they organized?

"Curriculum mapping is the process where each teacher records the content and skills taught and how they are assessed and aligned to standards."

(Udelhofen, 2005, p. xviii)

3

FORMATIVE ASSESSMENT ASPECT #1

# CURRICULUM MAPPING INTRODUCTION

4

## WHAT IS CURRICULUM?

"Curriculum represents a set of desired goals or values that are activated through a development process and culminate in successful learning experiences for students."

(Wiles & Bondi, 2007, p. 5)

**CURRICULUM IS WHAT WE INTEND FOR STUDENTS TO EXPERIENCE.**

5

"Until and unless we rethink from the ground up what an effective and engaging curriculum is and therefore what kinds of instruction and tools best support it, no cool new tool invented by outsiders to schools will likely make a dent in our medieval model of learning."

–GRANT WIGGINS (2013)

6

## THE EMPTY CHAIR

**What will this student learn?**

How will we know?

7

"Curriculum mapping is the process where each teacher records the content and skills taught and how they are assessed and aligned to academic standards." (xviii)

"Mapping the curriculum brings teachers out of isolation and provides a focused, reflective, and collaborative process that has a positive impact on all stakeholders—most important, on students, but also on teachers who benefit from the new collegiality and shared purpose, support, and responsibility." (xix)

–SUSAN UDELHOFEN (2005)

8

"If the teaching staff has not been involved in developing the curriculum they are to teach, of if it violates their values concerning teaching, the teacher may just shut the classroom door and follow his or her own dictates. For this reason, classroom teachers are the key to all curriculum work and must be fully and openly involved in the development of school programs."

(UDELHOFEN, 2005, P.10)

9

## WHY MAP?

- Real, living data on what happens in the classroom.
- True collaboration
- Locates gaps & redundancies; identifies opportunities for curricular integration
- Forces alignment of assessments
- Real alignment to standards
- Leave a Legacy
- **For you: It will be the foundation & structure of the formative assessment process.**

10

## WHAT IS ON A MAP?

- **Content**: What is taught
- **Skills**: What the student will do (Action verb)
- **Assessment**: How you find out if they really know (Noun)
- + Other Stuff (Standards, Essential ?s, etc)

11

## WHAT IS CONTENT?

- It describes the subject matter and can be a topic, theme, specific unit of study, concept. (Big bucket)

| Music: | Math: | Soc. Studies: |
|---|---|---|
| Note Value | Estimation | Citizenship |
| Baroque-era music | Probability | Manifest Destiny |

| Science: | Lang Arts: |
|---|---|
| Photosynthesis | Narrative Writing |
| Atomic Structure | Type of Poetry |

12

## WHAT ARE SKILLS?

- Precise expectations or outcomes students are expected to know (i.e. learning targets).
- Must be assessable!
- They must begin with an action verb! (See verb list)
  - Use an accurate verb; the choice of verb will often imply what assessment is appropriate.

Sing a song using soft/loud voice.

Identify the climax of a story.

Compare/contrast various parallelograms.

13

***Skill Verbs***

| | | | |
|---|---|---|---|
| adapt | deduce | infer | pursue |
| adjust | defend | inquire | rate |
| analyze | define | inspect | reason |
| apply | demonstrate | instruct | recite |
| appraise | derive | integrate | recognize |
| argue | design | interact | record |
| articulate | develop | interpret | reflect |
| ask | differentiate | invent | report |
| assess | discuss | investigate | represent |
| build | display | judge | research |
| calculate | distinguish | justify | respond |
| challenge | document | label | retrieve |
| check | dramatize | list | revise |
| choose | engage | locate | search |
| clarify | establish | manipulate | seek |
| classify | estimate | match | select |
| collect | evaluate | model | show |
| combine | examine | modify | sketch |
| compare | exhibit | monitor | solve |
| complete | experiment | name | state |
| compute | explain | order | structure |
| conclude | explore | organize | summarize |

## *Examples of Skills*

**Religion**

- Compare and contrast the invisible and visible church.
- Differentiate between reason and faith in regard to the doctrine of election.
- Apply the 4th commandment to a citizen's relationship to the government.

**Lang Arts**

- Evaluate the arguments and specific claims of a text.
- Determine the author's point of view in a text.
- Utilize a colon to introduce a list in a writing piece.

**Social Studies**

- Compare and contrast various examples of good government and citizenship in the Old Testament.
- Explain the effect that environment can have on an individual's beliefs and actions.
- Explain how different theories of government are implemented in various Asian counties.

**Science**

- Identify the layers of the Earth.
- Explain and differentiate meiosis and mitosis.
- Compare and contrast different regions of the electromagnetic spectrum.

**Music**

- Define and demonstrate syncopated rhythms.

- Explain the effect that environment can have on an individual's beliefs and actions.
- Explain how different theories of government are implemented in various Asian counties.

**Science**

- Identify the layers of the Earth.
- Explain and differentiate meiosis and mitosis.
- Compare and contrast different regions of the electromagnetic spectrum.

**Music**

- Define and demonstrate syncopated rhythms.
- Create and perform a piece in AABA form.
- Interpret various note and rest durations in simple, compound, and mixed meter.

**Phys Ed**

- Perform various stretching exercises (static, dynamic, PNF) and can explain the benefits of each.
- Construct a sample fitness plan for a young working adult that contains all components of health-related fitness.
- Describe the relationship between poor nutrition and health risk factors.

**Math**

- Extend the definition of sine and cosine for any angle of rotation.
- Identify and write equivalent fractions.
- Calculate a weighted mean given a grouped data set in a distribution table using a spreadsheet.

" . . . assessment is THE central process in instruction. Students do not learn what we teach. If they did, we would not need to keep gradebooks. We could, instead, simply record what we taught."

(Wiliam, 2011, p. 47-48)

17

## WHAT ARE ASSESSMENTS?

- Must include concrete evidence of achievement of skills.
- 3 Types of Assessments:
  - Obtrusive
  - Unobtrusive
  - Student Generated
- Can be any type, but it **must be documented.**
  - Should have the same name in Planbook and gradebook.

18

# MAP TEMPLATE & FORMAT

19

***Curriculum Map Template***

| Month | Content | Skills | Assessment (SA) |
|---|---|---|---|
| September | A: Content1 | A1: Explain blah , blah, blah<br>A2: Solve blah , blah, blah<br>A3: Compare/Contrast blah , blah, blah<br>A4: Apply blah , blah, blah<br>A5: Investigate blah , blah, blah | A1, A2: Quiz1<br>A2, A3, A5: Project 1<br>A1-A5: Test |
| | B: Content2 | B1: Model . . . . .<br>B2: Solve . . . . .<br>B3: Solve . . . . . | B1-B6: Quiz |
| October | B: Content2 (cont) | B4: Predict . . . .<br>B5: Recognize . . . .<br>B6: Identify . . . | B1-B6: Test |
| | C: Content3 | C1: Model . . . . .<br>C2: Solve . . . . .<br>C3: Demonstrate . . . . .<br>C4: Predict . . . . | C1: Quiz1<br>C1, C2: Quiz2<br>C4: Quiz3<br>C1, C2, C4: Test |
| | ***Noun Descriptor*** | ***Measureable Verb Target*** | ***Defined Noun; Documented*** |

## ORGANIZATIONAL ISSUES/THOUGHTS

- Difference between Lesson Plans & Curriculum Maps
  - CM: Focus on "what" students will learn (blue print)
  - LP: Focus on "how" the learning will be attacked (your furnishing plan)

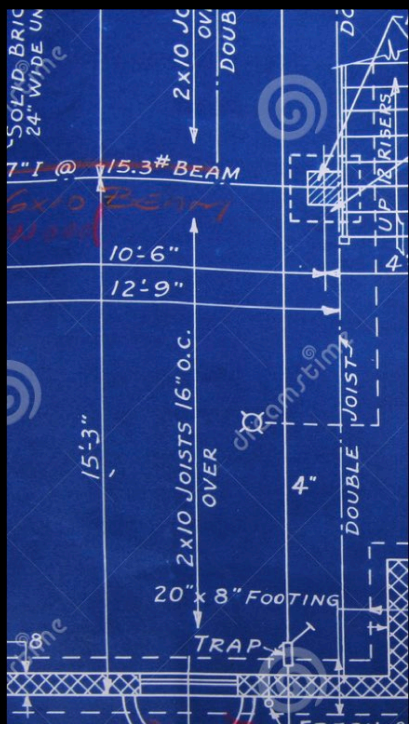
21

## BLUE-PRINT ANALOGY

A blue-print is a specific overview, but doesn't include all the details like: shingle style, paint colors, molding, fixtures, flooring, etc.

Maps are our "blueprints", but the "furnishing" is largely based on teacher discretion based on talents, interests, and abilities.

22



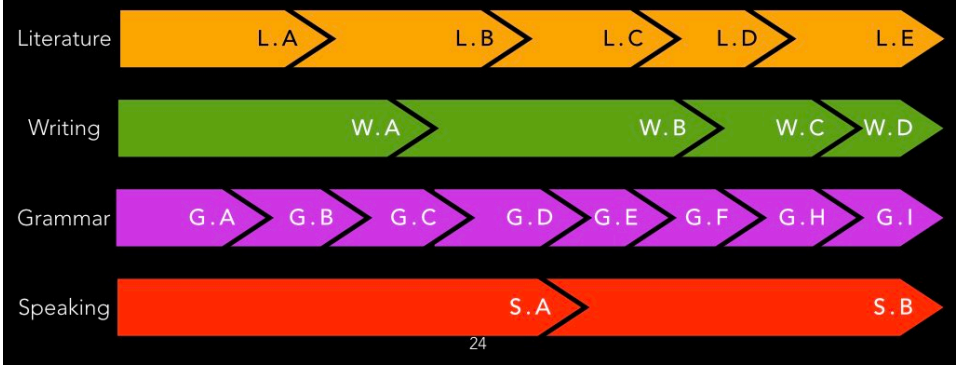
## ORGANIZATIONAL ISSUES/THOUGHTS

- Skills are not lesson objectives. Skills are specific, but the "grain size" is larger than lesson objectives. It might take 3 or 4 (or more!) lesson objectives that lead to the attainment of a skill.
- Non-linear or multi-track curriculum

23

Linear


Multi-track Lang Arts Example

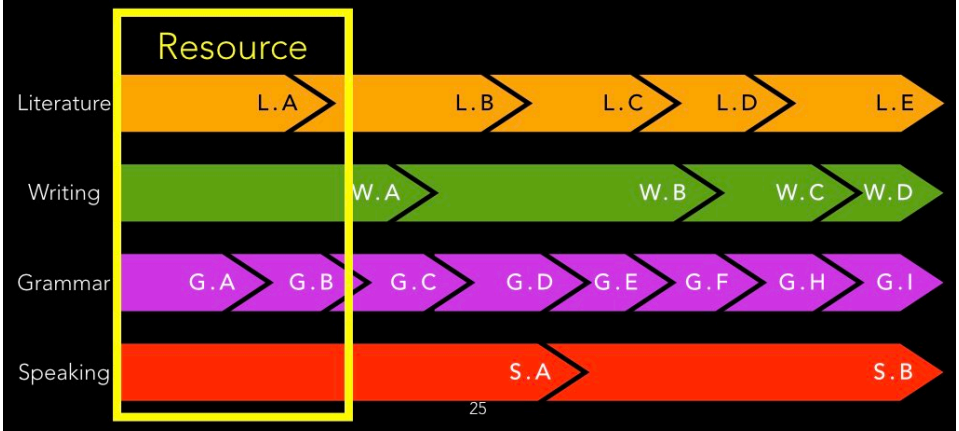



24

## A SHIFT IN THINKING. . .

From: "I teach *Number the Stars.*" ← Resource!

To: "I use *Number the Stars* to teach . . . ."

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## A SHIFT IN THINKING. . .

From: "I teach the book of Genesis."
To: "I use Genesis to teach . . . ."

From: "I teach Shakespeare."
To: "I use Shakespeare to teach . . . ."

From: "I teach Microsoft Word."
To: "I use Microsoft Word to teach . . . ."

. . .FROM TEACHING THE RESOURCE
TO TEACHING THE LEARNING TARGET

26

## TYPES OF CURRICULUM MAPS

- Diary Maps:
  - Advantages: Not as time intensive initially; more accurate
  - Disadvantages: slower; have to wait until end of year for action
- Projection Maps:
  - Advantages: Allows better planning, instruction, assessment
  - Disadvantages: time intensive upfront; requires planning

27

## GUIDELINES FOR CREATING MAPS

- Every teacher collects and records curriculum data independently.
  - However, use your colleagues as sounding board for the articulation of skills.
- Content, Skills & Assessments are recorded by month in a diary map method.
- To assist in creating the maps, use any curricular materials that guide instruction (lesson plans, texts, standards, lessons)
  - **An accurate Planbook is one of your best resources!**
- Maps are drafts! They are constantly revised & never "complete"

28

## CURRICULUM MAPPING CYCLE

- Completing Individual Maps

End of Year Tasks

- Individual Review of Maps
- Small Group Review
- Report Results to Department/Faculty
- Develop an Action Plan

29

## GUIDELINES

- Start with the course that is your strength and/or has the most students.
- Grain size (generally) for full year course:
  - Content for course: 10ish
  - Skills for course: 100ish
  - A rule of thumb: # of skills should be 60%-70% of instructional days
- Physically align significant assessments
- Be real, accurate, and honest

30

# Examples

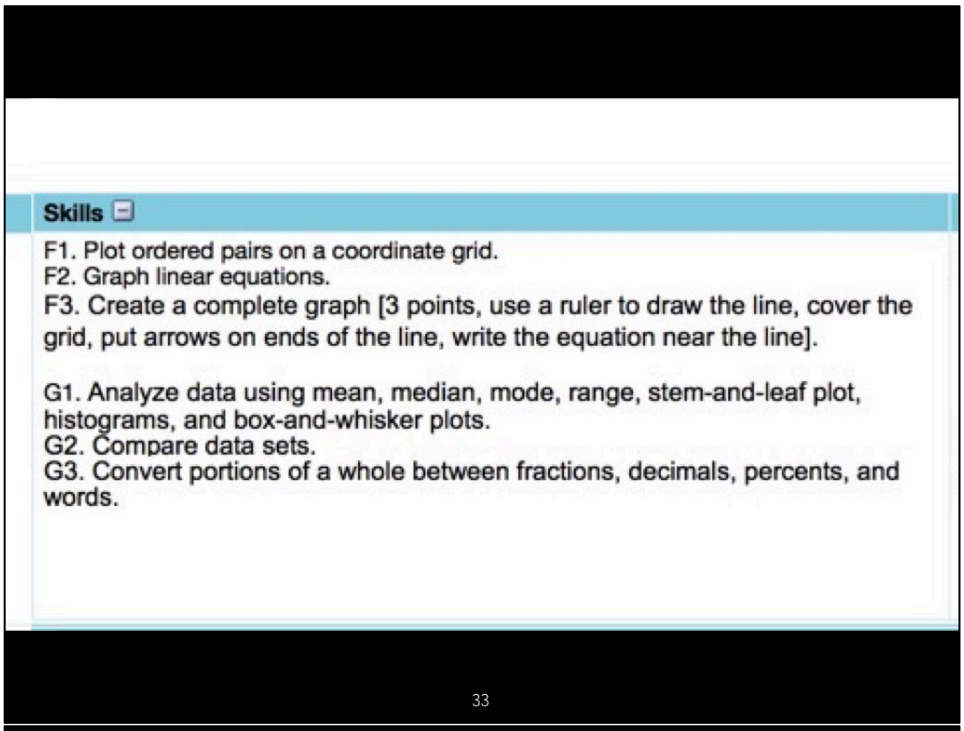
**January 2018**

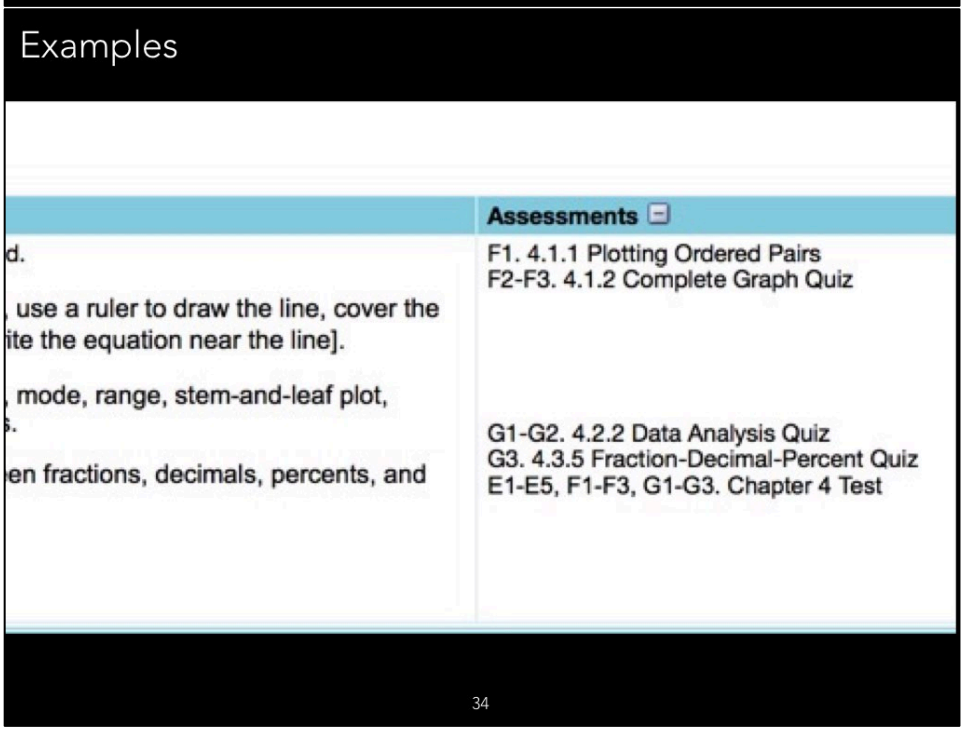
| Content | Skills | Assessments |
|---|---|---|
| F. Graphing | F1. Plot ordered pairs on a coordinate grid.<br>F2. Graph linear equations.<br>F3. Create a complete graph [3 points, use a ruler to draw the line, cover the grid, put arrows on ends of the line, write the equation near the line]. | F1. 4.1.1 Plotting Ordered Pairs<br>F2-F3. 4.1.2 Complete Graph Quiz |
| G. Data Analysis & Percents | G1. Analyze data using mean, median, mode, range, stem-and-leaf plot, histograms, and box-and-whisker plots.<br>G2. Compare data sets.<br>G3. Convert portions of a whole between fractions, decimals, percents, and words. | G1-G2. 4.2.2 Data Analysis Quiz<br>G3. 4.3.5 Fraction-Decimal-Percent Quiz<br>E1-E5, F1-F3, G1-G3. Chapter 4 Test |

31

**January 2018**

| Content | Skills |
|---|---|
| F. Graphing | F1. Plot ordered pairs on a coordi<br>F2. Graph linear equations.<br>F3. Create a complete graph [3<br>grid, put arrows on ends of the |
| G. Data Analysis & Percents | G1. Analyze data using mean, r<br>histograms, and box-and-whisk<br>G2. Compare data sets.<br>G3. Convert portions of a whole<br>words. |


Skills
F1. Plot ordered pairs on a coordinate grid.
F2. Graph linear equations.
F3. Create a complete graph [3 points, use a ruler to draw the line, cover the grid, put arrows on ends of the line, write the equation near the line].
G1. Analyze data using mean, median, mode, range, stem-and-leaf plot, histograms, and box-and-whisker plots.
G2. Compare data sets.
G3. Convert portions of a whole between fractions, decimals, percents, and words.
33


Examples
Assessments
d.
use a ruler to draw the line, cover the
ite the equation near the line].
mode, range, stem-and-leaf plot,
en fractions, decimals, percents, and
F1. 4.1.1 Plotting Ordered Pairs
F2-F3. 4.1.2 Complete Graph Quiz
G1-G2. 4.2.2 Data Analysis Quiz
G3. 4.3.5 Fraction-Decimal-Percent Quiz
E1-E5, F1-F3, G1-G3. Chapter 4 Test
34

**December 2017**

| Content | Skills |
|---|---|
| V(E) - Chapter 3 Argument Terms | V(E) - identify argument VOCAB |
| S(B) - Essay Presentation | W(F) - 2- Create a well-thought out argument essay based off of a prompt |
| L(A) - Rhetorical situation | S(B) - 1- Present to the class on an essay of choice |
| L(H) - Synthesizing sources | S(B) - 2 - Display appropriate public speaking skills (eye contact, volume, delivery) |
| | L(A) - 1,2,3 - Analyze essay of choice for rhetorical situation |
| | L(G) - dissect Vietnam political cartoons in the light of argument |
| | L(H) - 1- Use sources to inform an argument |
| | L(H) - 2- Use sources to appeal to an audience |
| | L(H) - 3- synthesize given sources to create a well-thought out argument essay - based off of a given prompt |

**January 2018**

| Content | Skills |
|---|---|
| L(I) - Novel reading "Catcher in the Rye" (CIR) | L(I) - 1- Discover theme in CIR- loss of innocence, death, psychological trauma, authentic vs. artificial, dealing with change, l of communication, depression. |
| L(A) - Rhetorical Analysis | L(I) - 2 - Identify the qualities of an "unreliable narrator" |
| W(J) - They Say/I Say "The Art of Summarizing" | L(I) - 3- Recognize parallelism in chapters of CIR |
| V(E) - Vocab Studies | L(I) - 4 - connect symbolism to items in CIR |
| W(K) - They Say/I Say "The Art of Quoting" | |

| Skills | Assessments |
|---|---|
| V(E) - identify argument VOCAB | V(E) - Vocab Quiz on argument terms |
| W(F) - 2- Create a well-thought out argument essay based off of a prompt | W(F) - 2 - Argument Essay Prompt |
| S(B) - 1- Present to the class on an essay of choice | S(B) - 1,2 - L(A) - Essay Presentation |
| S(B) - 2 - Display appropriate public speaking skills (eye contact, volume, delivery) | S(A) - 3rd Columnist Reaction |
| L(A) - 1,2,3 - Analyze essay of choice for rhetorical situation | L(H) - 3- Synthesis Prompt |
| L(G) - dissect Vietnam political cartoons in the light of argument | W(F) - Final Argument Paper |
| L(H) - 1- Use sources to inform an argument | L(A) - 5 - Full length multiple choice practice (semester "exam") |
| L(H) - 2- Use sources to appeal to an audience | |
| L(H) - 3- synthesize given sources to create a well-thought out argument essay - based off of a given prompt | |

| Skills | Assessments |
|---|---|
| L(I) - 1- Discover theme in CIR- loss of innocence, death, psychological trauma, authentic vs. artificial, dealing with change, loss of communication, depression. | L(A) - 1 - "On the Duty of Civil Disobedience" reaction |
| L(I) - 2 - Identify the qualities of an "unreliable narrator" | S(A) - Columnist reaction # 4 |
| L(I) - 3- Recognize parallelism in chapters of CIR | V(E) - VOCAB Quiz |
| L(I) - 4 - connect symbolism to items in CIR | L(A) - 2 Compare/Contrast Rhetorical Analysis Essay on African American Writings read/discussed in class |

**November 2017**

| Content | Skills |
|---|---|
| B: Ephesians and Philippians | B6: Compare<br><br>B7: Different husband/wife<br><br>B8: Analyze<br><br>B9: Examine appropriate re<br><br>B10: Reflect experienced a with those sit<br><br>B11: Identify and explore v<br><br>B12: Write a take with you |

37

| | Skills | Assess |
|---|---|---|
| | B6: Compare and contrast the old self vs. the new self in daily living.<br><br>B7: Differentiate between role and responsibility in our relationships - husband/wife; parent/child; employer/employe<br><br>B8: Analyze spiritual battles and apply the armor of God<br><br>B9: Examine who Christ is and what he has done for us, and consider appropriate responses to his goodness in your life<br><br>B10: Reflect on hardships and heartaches you or friends have experienced and apply God's words and promises that help us cope with those situations<br><br>B11: Identify specific methods of encouragement found in Philippians and explore ways to apply those methods to help a hurting friend<br><br>B12: Write and apply at least 4 verses from these letters that you can take with you in your life. | B6-11: Ephesia<br><br>B12: W the valu<br><br>B1-12: open Bi |

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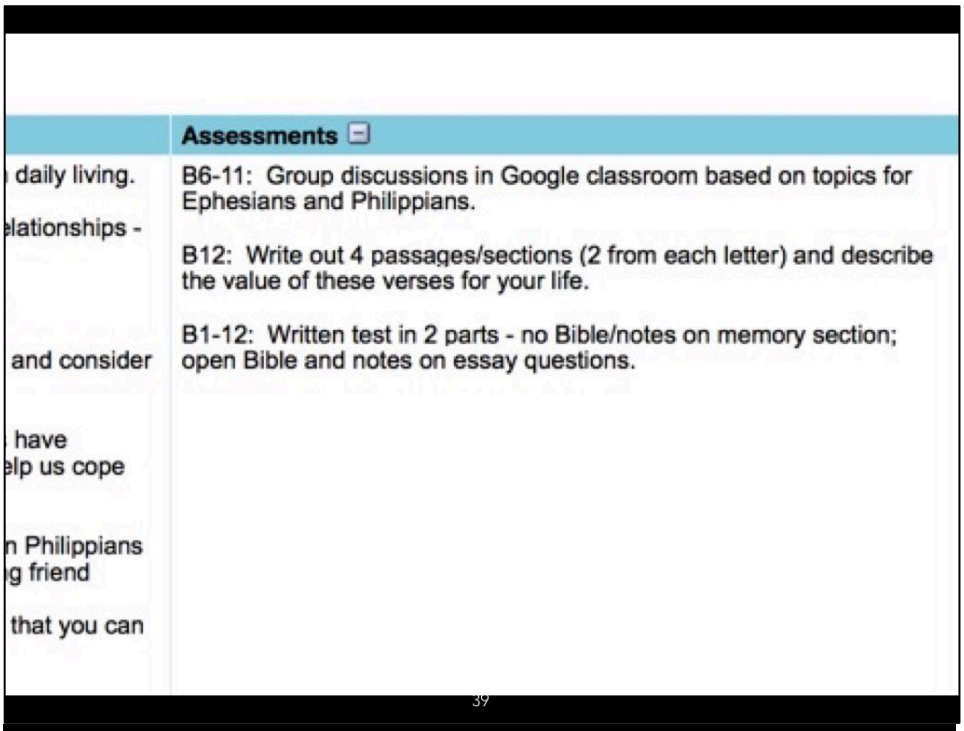

| | Assessments |
|---|---|
| daily living. | B6-11: Group discussions in Google classroom based on topics for Ephesians and Philippians. |
| lationships - | B12: Write out 4 passages/sections (2 from each letter) and describe the value of these verses for your life. |
| and consider | B1-12: Written test in 2 parts - no Bible/notes on memory section; open Bible and notes on essay questions. |
| have<br>lp us cope | |
| n Philippians<br>g friend | |
| that you can | |

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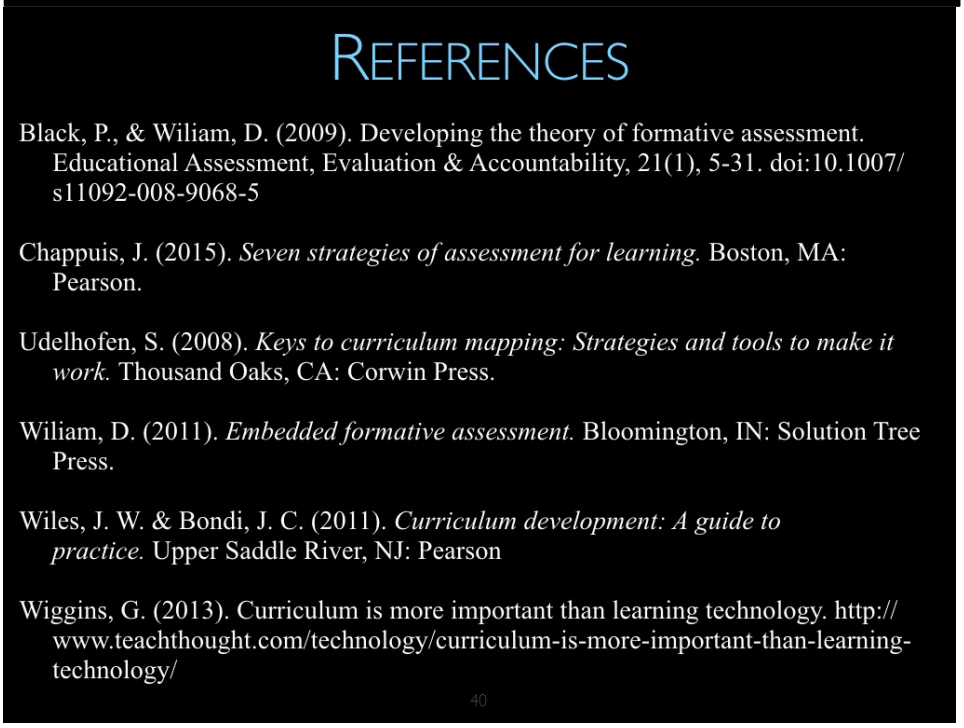


# REFERENCES


Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. Educational Assessment, Evaluation & Accountability, 21(1), 5-31. doi:10.1007/s11092-008-9068-5

Chappuis, J. (2015). *Seven strategies of assessment for learning.* Boston, MA: Pearson.

Udelhofen, S. (2008). *Keys to curriculum mapping: Strategies and tools to make it work.* Thousand Oaks, CA: Corwin Press.

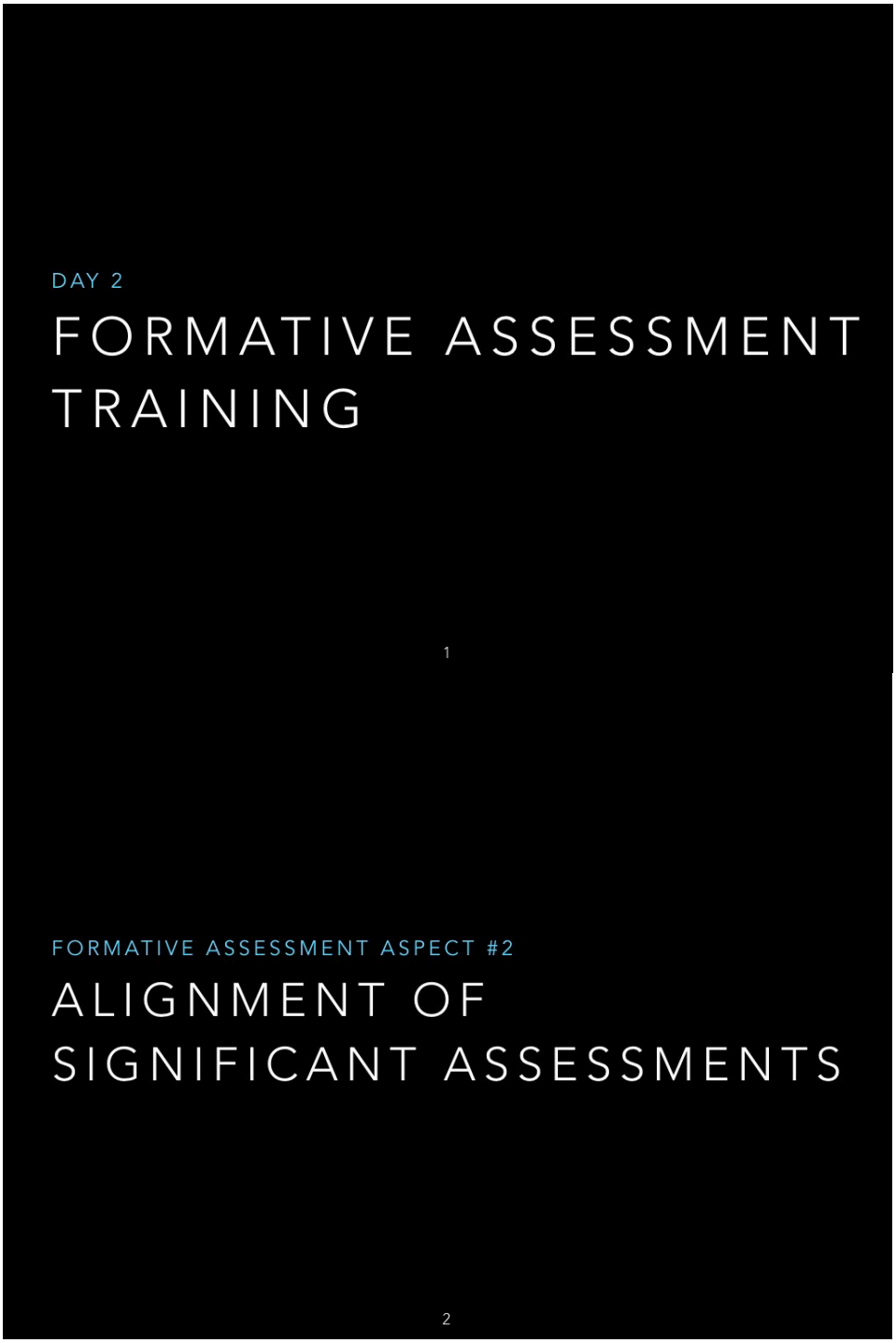
Wiliam, D. (2011). *Embedded formative assessment.* Bloomington, IN: Solution Tree Press.

Wiles, J. W. & Bondi, J. C. (2011). *Curriculum development: A guide to practice.* Upper Saddle River, NJ: Pearson

Wiggins, G. (2013). Curriculum is more important than learning technology. http://www.teachthought.com/technology/curriculum-is-more-important-than-learning-technology/


40

Day 2 Presentation: Alignment of Significant Assessments


DAY 2
FORMATIVE ASSESSMENT TRAINING
1
FORMATIVE ASSESSMENT ASPECT #2
ALIGNMENT OF SIGNIFICANT ASSESSMENTS
2

## 5 Key Aspects of Formative Assessment

| | Where the learner is going | Where the learner is now | How to get there |
|---|---|---|---|
| Teacher | **1.** Clarifying, sharing, and understanding learning intentions and success criteria | **2.** Engineering effective discussions and other learning tasks that elicit evidence of student understanding | **3.** Providing feedback that moves learners forward |
| Peer | | **4.** Activating students as instructional resources for one another | |
| Learner | | **5.** Activating students as the owners of their own learning | |

(Black & Wiliam, 2009, p.8)

3

## The Empty Chair

What will this student learn?

**How will we know?**

4

# ASSESSMENT

*(Purpose: Elicit evidence of student learning)*

- Observed Score = True Score + Error Score
  - Admit/realize limitations of assessment
- Eliminate non-learning "contaminants" from assessment
- Assessment of learning targets
  - Make sure the assessment item matches the target type

5

# TARGET-ITEM ALIGNMENT

- 4 types of targets
  - *Knowledge-level:* factual, procedural, conceptual
  - *Reasoning-level:* predict, compare, evaluate
  - *Skill-level:* real-time or physical demo
  - *Product-level:* creation of a product
- Examples of Misalignment
  - Hatchet; Essay; Picture Frame; Compare/Contrast

6

# ASSESSMENT

*(Purpose: Elicit evidence of student learning)*

- Why is target-item alignment important?
  - Validity/reliability of the data are impacted
  - Because adjustments can be made on everything except the learning target!
- Difference between assessing learning and the strategies for learning.
- Use assessment evidence to make adjustments to serve to student learning needs!

7

# ASSESSMENT

*(Purpose: Elicit evidence of student learning)*

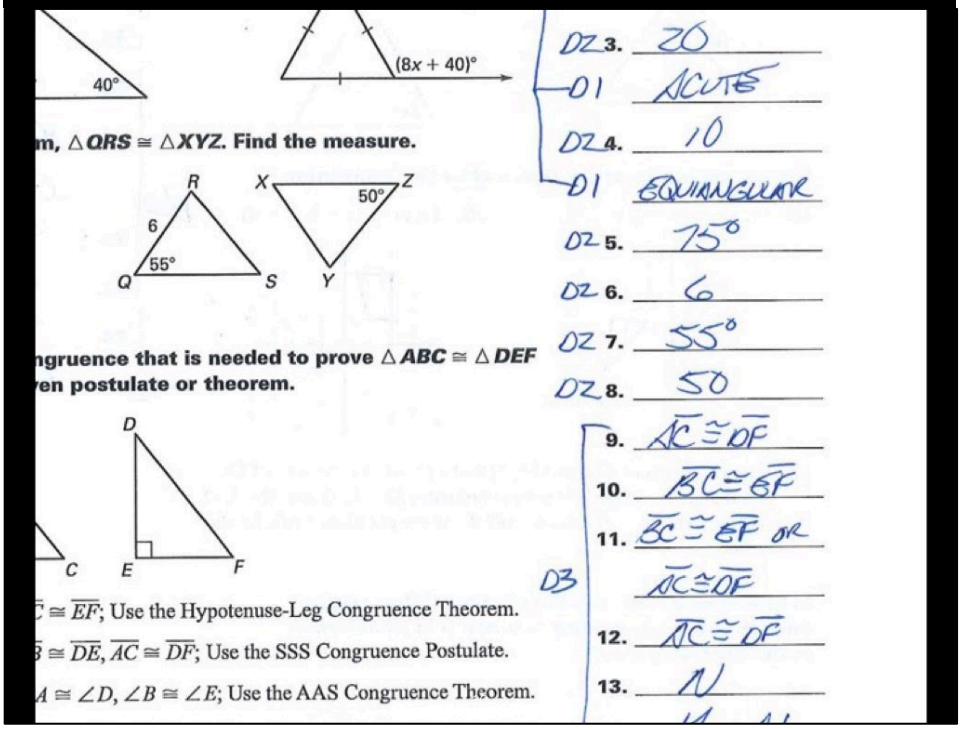
- Remember that quality classroom assessment is:
  - Designed to give specific information to the intended user.
  - Based on clearly articulated learning targets.
  - Accurately measures student achievement
  - Yield results that are effectively communicated to intended user
  - Involve students in self-assessment and further learning.
  - In a formative manner, assessment also must provide information that can be used for feedback to move learning forward.

8

# ALIGNMENT OF SIGNIFICANT ASSESSMENTS (SA)

- "Significant" is defined by the teacher, but *must* include tests, exams, & major projects.
- No need to create something new, use a current/past assessment.
- Indicate these in Planbook with an (SA) after the title of the assessment.
- Each item on the SA is **physically** (write on the copy) aligned with the mapped skill.
  - Write the Skill identifier (i.e. D4, F2, etc.) next to the item.
- Save a paper copy of the all aligned SAs

9



## ALIGNMENT OF SIGNIFICANT ASSESSMENTS (SA)

- You may find:
  - items are not grouped together logically or by skill
  - assessments that don't cover some skills
  - you are unhappy with the amount of items per skill
  - items on your assessments that do not fit a skill on your map. If so, determine:
    - Is this item covering something that should be a skill?
    - Is this a necessary item on the assessment?
- You may have to mentally wrestle with this— and that means you are on the right track!

11

## 5 KEY ASPECTS OF FORMATIVE ASSESSMENT

<table>
<tr><th></th><th>Where the learner is going</th><th>Where the learner is now</th><th>How to get there</th></tr>
<tr><td>Teacher</td><td rowspan="3">1. Clarifying, sharing, and understanding learning intentions and success criteria</td><td>2. Engineering effective discussions and other learning tasks that elicit evidence of student understanding</td><td>3. Providing feedback that moves learners forward</td></tr>
<tr><td>Peer</td><td colspan="2">4. Activating students as instructional resources for one another</td></tr>
<tr><td>Learner</td><td colspan="2">5. Activating students as the owners of their own learning</td></tr>
</table>

12

(Black & Wiliam, 2009, p.8)

"The journey of a thousand miles begins with a single step."

— LAOZI, CHINESE PHILOSOPHER

13

# REFERENCES

Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. Educational Assessment, Evaluation & Accountability, 21(1), 5-31. doi:10.1007/s11092-008-9068-5

14

Day 3 Presentation: Assessment Breakdown

DAY 3

# FORMATIVE ASSESSMENT TRAINING

1

## 5 KEY ASPECTS OF FORMATIVE ASSESSMENT

| | Where the learner is going | Where the learner is now | How to get there |
|---|---|---|---|
| Teacher | **1.** Clarifying, sharing, and understanding learning intentions and success criteria | **2.** Engineering effective discussions and other learning tasks that elicit evidence of student understanding | **3.** Providing feedback that moves learners forward |
| Peer | | **4.** Activating students as instructional resources for one another | |
| Learner | | **5.** Activating students as the owners of their own learning | |

2

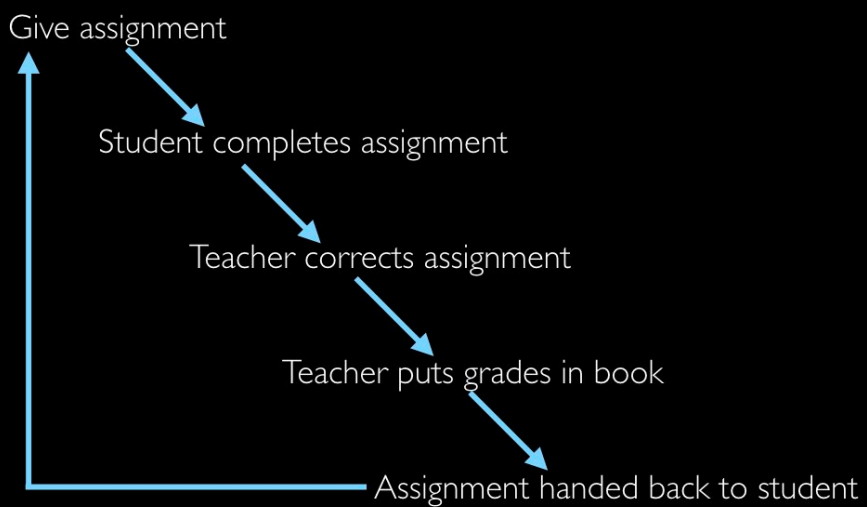
(Black & Wiliam, 2009, p.8)

FORMATIVE ASSESSMENT ASPECTS #2&3

# ASSESSMENT BREAKDOWN

3

## TYPICAL CYCLE




4

# ELIMINATE "CORRECTING" FROM YOUR TEACHING PRACTICE

- Listen to Students!
  - Evaluative = Correcting
  - Interpretive = Assessing

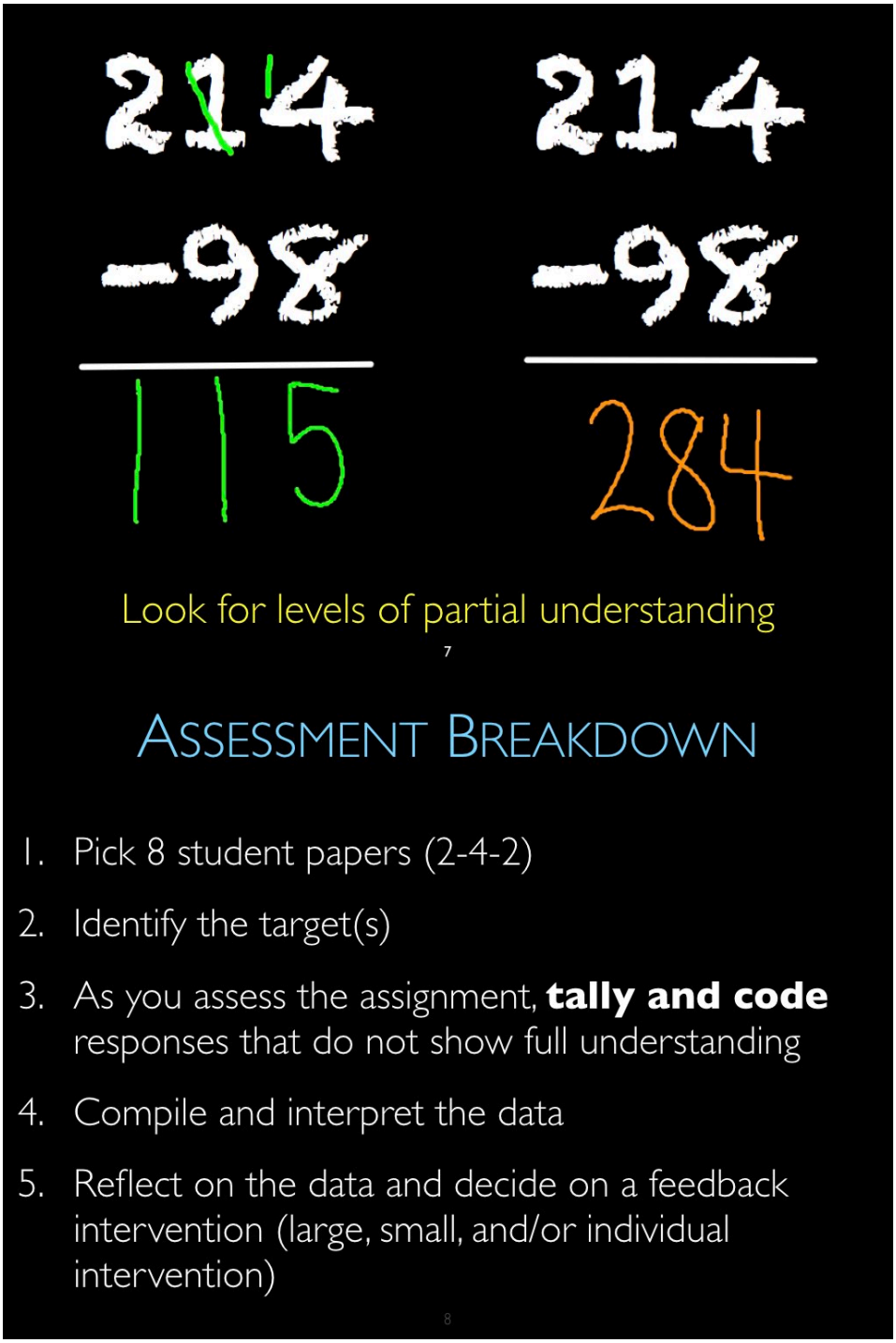
## TO SERVE STUDENT NEEDS, WE MUST LISTEN INTERPRETIVELY!

5

"when we don't look at the work, we can't use it as evidence to guide further instruction. We close our eyes to information about learning needs and shut more students out."

(Chappius, 2015, p.18)

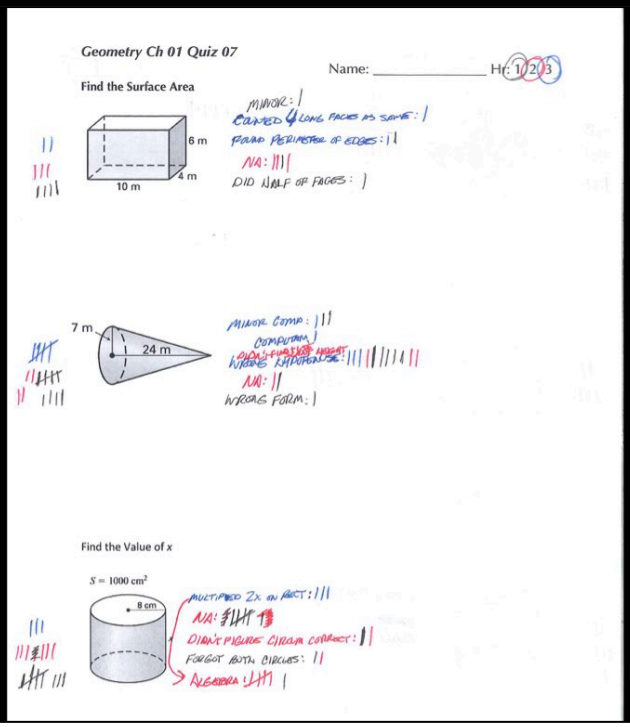
6


214
-98
115
214
-98
284
Look for levels of partial understanding
7
ASSESSMENT BREAKDOWN
1. Pick 8 student papers (2-4-2)
2. Identify the target(s)
3. As you assess the assignment, **tally and code** responses that do not show full understanding
4. Compile and interpret the data
5. Reflect on the data and decide on a feedback intervention (large, small, and/or individual intervention)
8

# Tally and Code

- Patterns in students responses will undoubtedly occur
- Keep a tally on how many times each item is "wrong"
- When "wrong", identify what the student did wrong and give a reason (code)
- Group similar codes/reasons together
- If you can't figure out a reason for the answer, use "Unknown"
- ***LISTEN INTERPRETIVELY!***





Geometry Ch 01 Quiz 07

Name: _____ Hr: 1 2 3

Find the Surface Area

6 m
4 m
10 m

MINOR: |
CAUSED 4 LONG FACES AS SAME: |
FOUND PERIMETER OF EDGES: ||
N/A: |||
DID HALF OF FACES: |

7 m
24 m

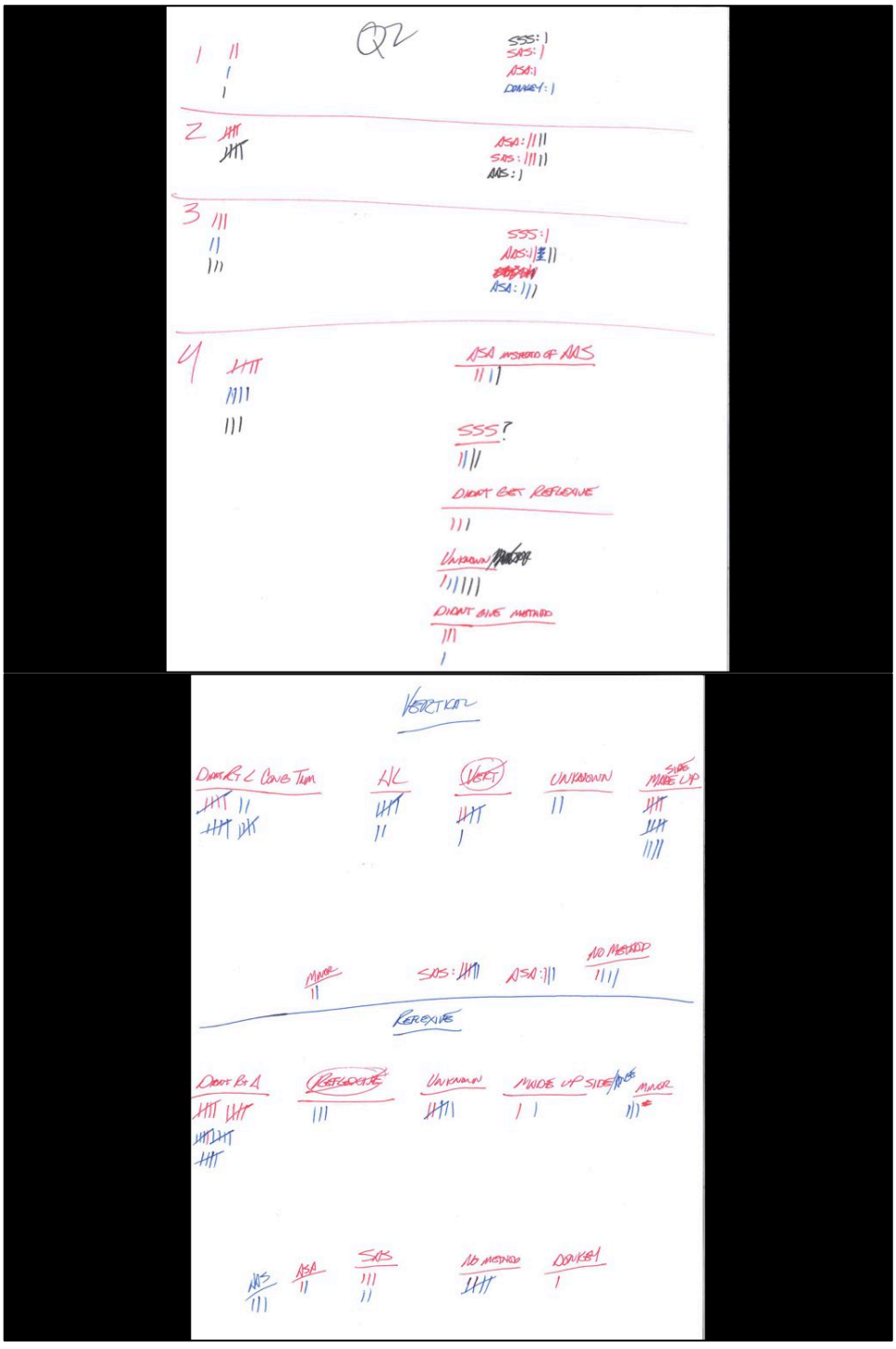
MINOR COMP: |||
COMPUTATION
WRONG RADIUS/DIAM: |||| |||| ||
N/A: ||
WRONG FORM: |

Find the Value of x

$S = 1000\ cm^2$

8 cm

MULTIPLIED 2x ON RECT: |||
N/A: |||| |
DIAM'S FIGURES CIRCUM CORRECT: ||
FORGOT BOTH CIRCLES: ||
ALGEBRA |||| |


Q2
SSS: 1
SAS: 1
ASA: 1
DIDN'T GET: 1
2
ASA: ||||
SAS: ||||1
AAS: 1
3
SSS: 1
ASA: |||
4
ASA INSTEAD OF AAS
SSS?
DIDN'T GET REFLEXIVE
UNKNOWN
DIDN'T GIVE METHOD
VERTICAL
DIDN'T GET CAVES TURN
HC
VERT
UNKNOWN
SIDES MADE UP
MAJOR
SAS: |||
ASA: ||
NO METHOD
REFLEXIVE
DIDN'T GET
REFLEXIVE
UNKNOWN
MADE UP SIDES
MINOR
AAS
ASA
SAS
NO METHOD
DIDN'T GET

# Tally and Code

- Keep a tally on how many times each item is "wrong"
- When "wrong", identify what the student did wrong and give a reason (code)
- ***LISTEN INTERPRETIVELY!***
- ***Ask:***
  - What did I learn?
  - How do I respond?
  - What would I change about this assessment?

13

# *Example: Geometry Quiz Evaluation*

*Skills Assessed:*

J3: Multiply matrices of various dimensions

J4: Perform reflections and rotations using coordinate rules/multiplication

14

Teacher created

3

$$\begin{bmatrix} 5 & -1 \\ 0 & -2 \\ 2 & 6 \end{bmatrix}\begin{bmatrix} -2 \\ 2 \end{bmatrix}$$

$$\begin{bmatrix} 4 & -3 \\ 4 & 5 \end{bmatrix}\begin{bmatrix} x & y \\ -3 & 2 \end{bmatrix}=\begin{bmatrix} 13 & 14 \\ -11 & 30 \end{bmatrix}$$

$$\begin{bmatrix} -3 & -5 \\ y & -2 \end{bmatrix}\begin{bmatrix} -1 & -2 \\ -5 & x \end{bmatrix}=\begin{bmatrix} 28 & 6 \\ 12 & 4 \end{bmatrix}$$

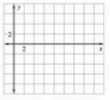
Textbook resource

Name _____ Date _____

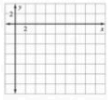
CHAPTER 9 **Quiz 2** *For use after Lessons 9.3–9.5*

**The vertices of △*ABC* are *A*(6, 2), *B*(4, 3), and *C*(9, 8). Graph the reflection in the line.**

1. $x$-axis



2. $y = -2$



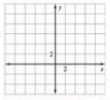
**Find the coordinates of the image of *P*(3, −4) after the rotation about the origin.**

3. 90° rotation 4. 180° rotation 5. 270° rotation

**The vertices of △*LMN* are *L*(−9, 7), *M*(−6, −1), and *N*(−2, 2). Graph the image of △*LMN* after a composition of the transformations in the order they are listed.**

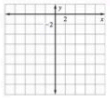
6. Translation: $(x, y) \rightarrow (x + 8, y)$

   Reflection: in the $y$-axis



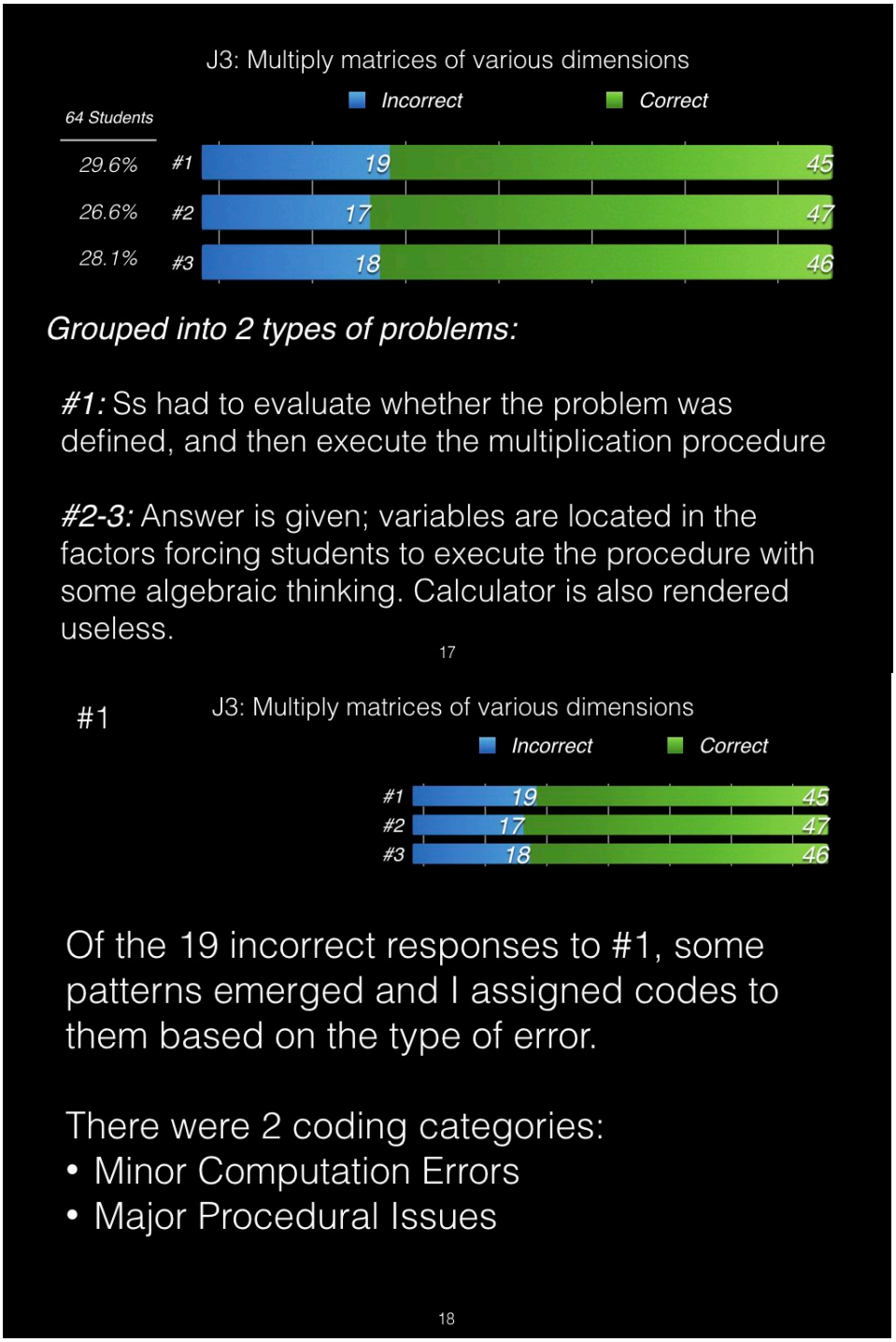
7. Rotation: 90° about the origin

   Translation: $(x, y) \rightarrow (x + 3, y - 4)$



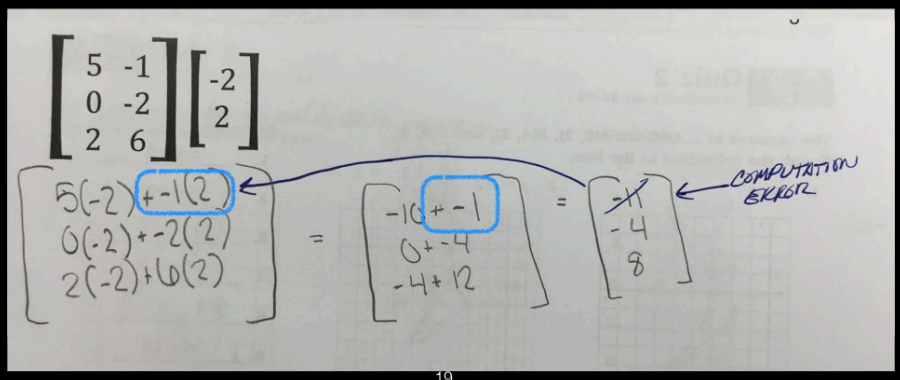
***Answers***

1. See left.
2. See left.
3. _____
4. _____
5. _____
6. See left.
7. See left.


J3: Multiply matrices of various dimensions
Incorrect
Correct
64 Students
29.6% #1 19 45
26.6% #2 17 47
28.1% #3 18 46
Grouped into 2 types of problems:
#1: Ss had to evaluate whether the problem was defined, and then execute the multiplication procedure
#2-3: Answer is given; variables are located in the factors forcing students to execute the procedure with some algebraic thinking. Calculator is also rendered useless.
17
#1
J3: Multiply matrices of various dimensions
Incorrect
Correct
#1 19 45
#2 17 47
#3 18 46
Of the 19 incorrect responses to #1, some patterns emerged and I assigned codes to them based on the type of error.
There were 2 coding categories:
• Minor Computation Errors
• Major Procedural Issues
18

#1 J3: Multiply matrices of various dimensions

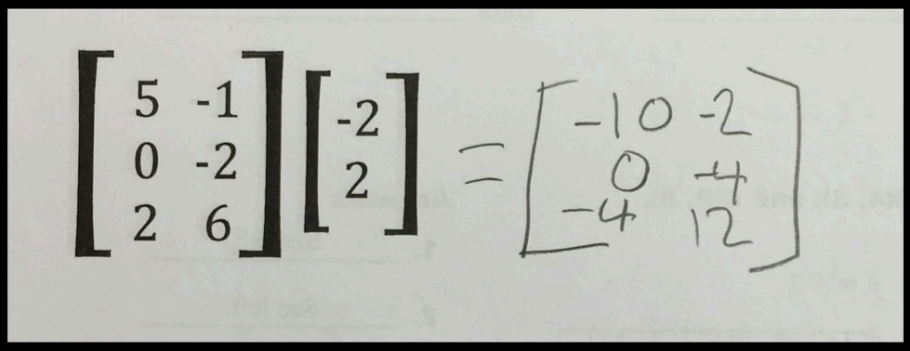

*Minor Computation Error*




19

#1 J3: Multiply matrices of various dimensions

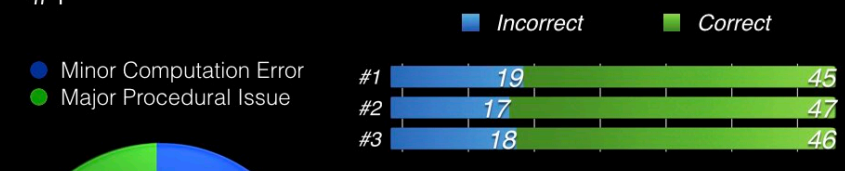

*Major Procedural Issue*

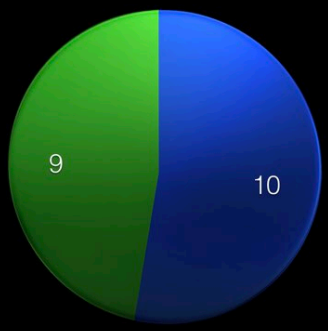


20

#1

J3: Multiply matrices of various dimensions




What Did I Learn?

- Students make computation errors with negative numbers
- About 15% of students do not have the procedure for matrix multiplication down

21

J3: Multiply matrices of various dimensions


#2

$$\begin{bmatrix} 4 & -3 \\ 4 & 5 \end{bmatrix}\begin{bmatrix} x & y \\ -3 & 2 \end{bmatrix} = \begin{bmatrix} 13 & 14 \\ -11 & 30 \end{bmatrix}$$

#3

$$\begin{bmatrix} -3 & -5 \\ y & -2 \end{bmatrix}\begin{bmatrix} -1 & -2 \\ -5 & x \end{bmatrix} = \begin{bmatrix} 28 & 6 \\ 12 & 4 \end{bmatrix}$$

22

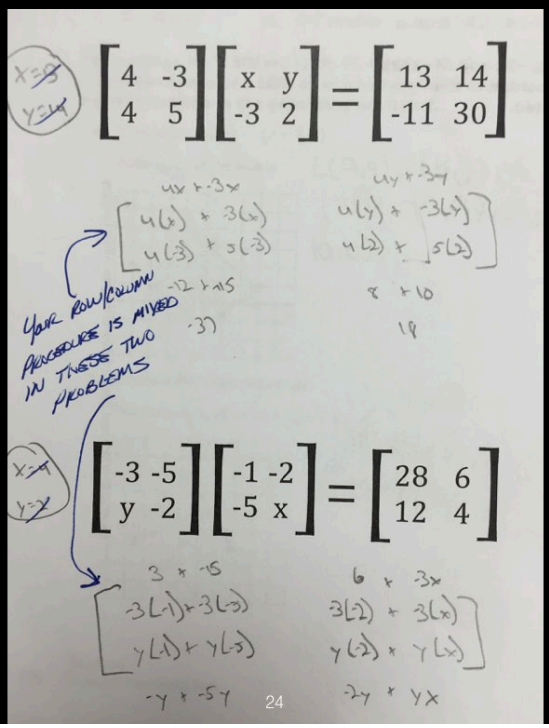
J3: Multiply matrices of various dimensions


*Numbers 2-3*

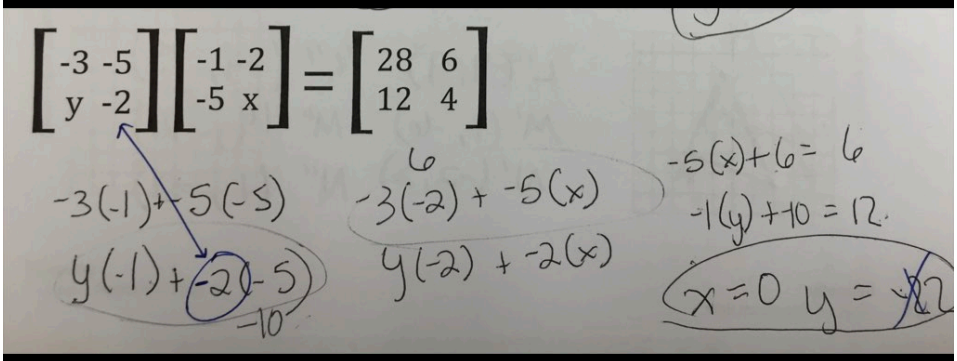
There were 4 coding categories:

- Wrong Row/Column Procedure
- Minor Computation/Negative # Error
- Major Procedural Issue
- Unknown/NA

23

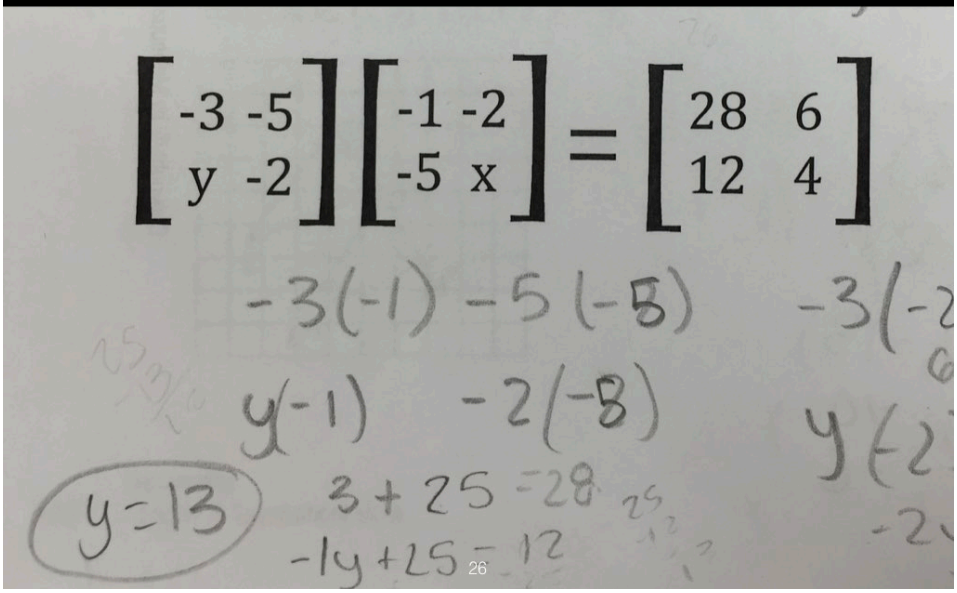


## *Minor Computation/Negative # Error*



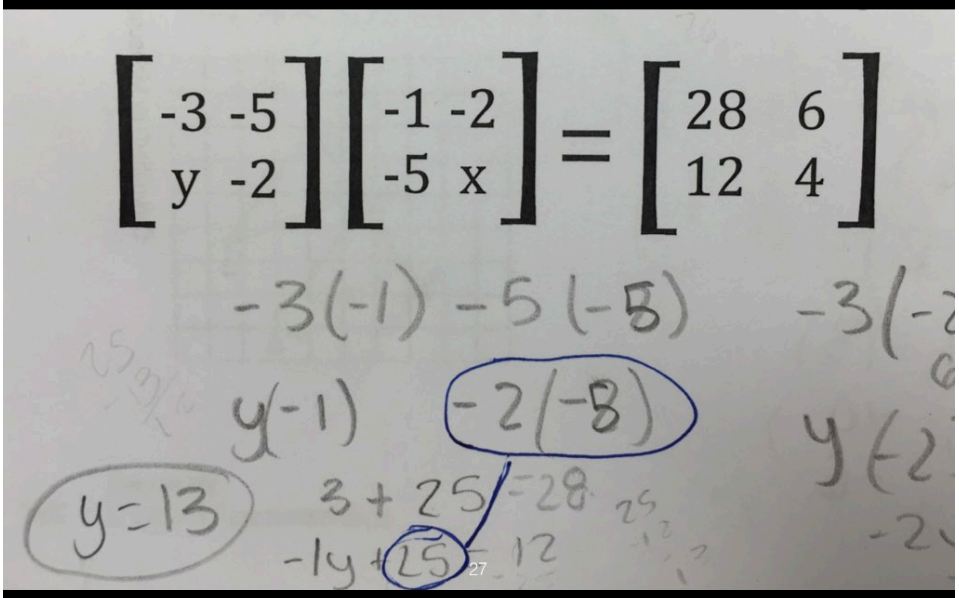

25

## *Minor Computation/Negative # Error*

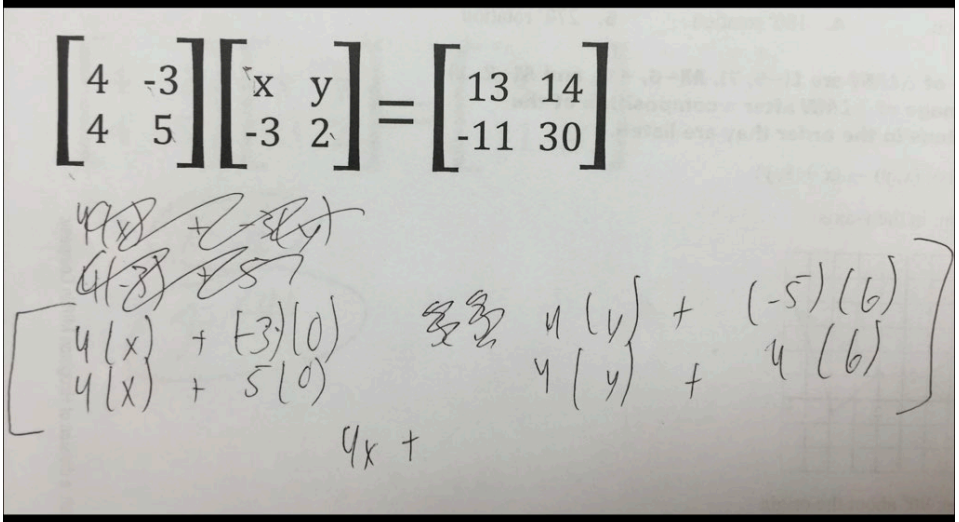



26

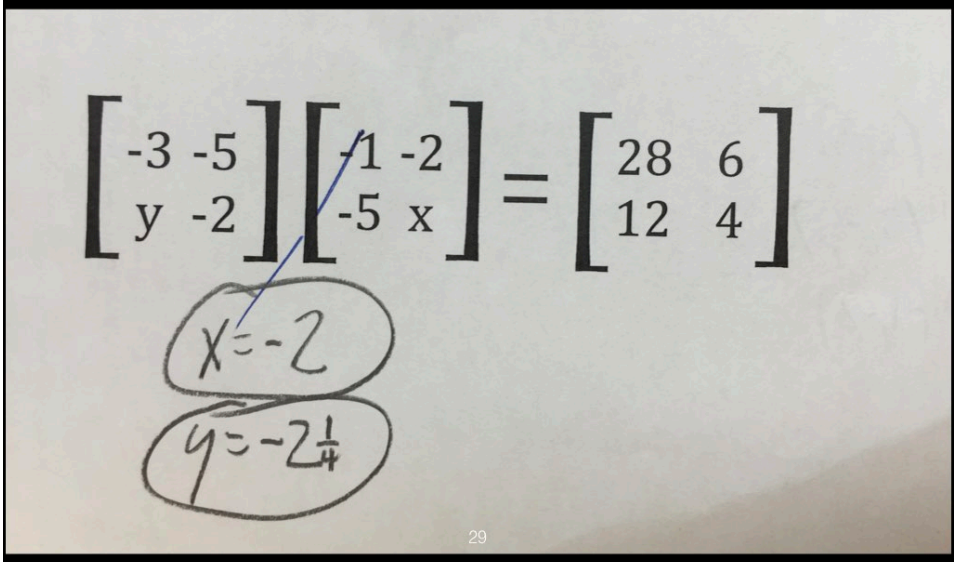
*Minor Computation/Negative # Error*




*Major Procedural Issue*

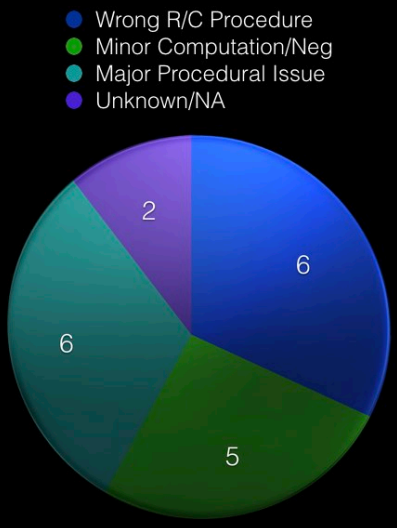


## *Unknown/NA*

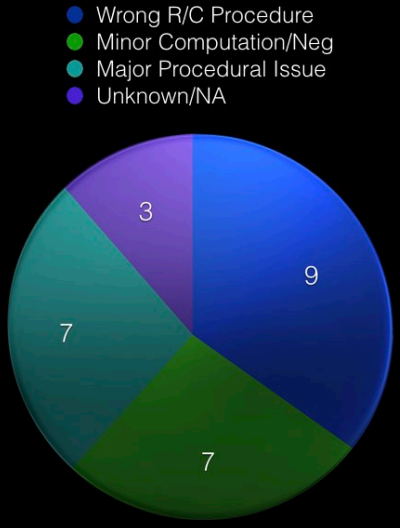



J3: Multiply matrices of various dimensions

#2




#3




30

J3: Multiply matrices of various dimensions


*What Did I Learn?*

- Students make computation errors with negative numbers
- Significant number of students do not have the procedure for matrix multiplication down

*How Did I Respond?*

- Addressed "tricky" negative computation to whole class
- Reviewed Matrix Multiplication procedure slide to whole class;
- Gave individual process feedback for major offenders

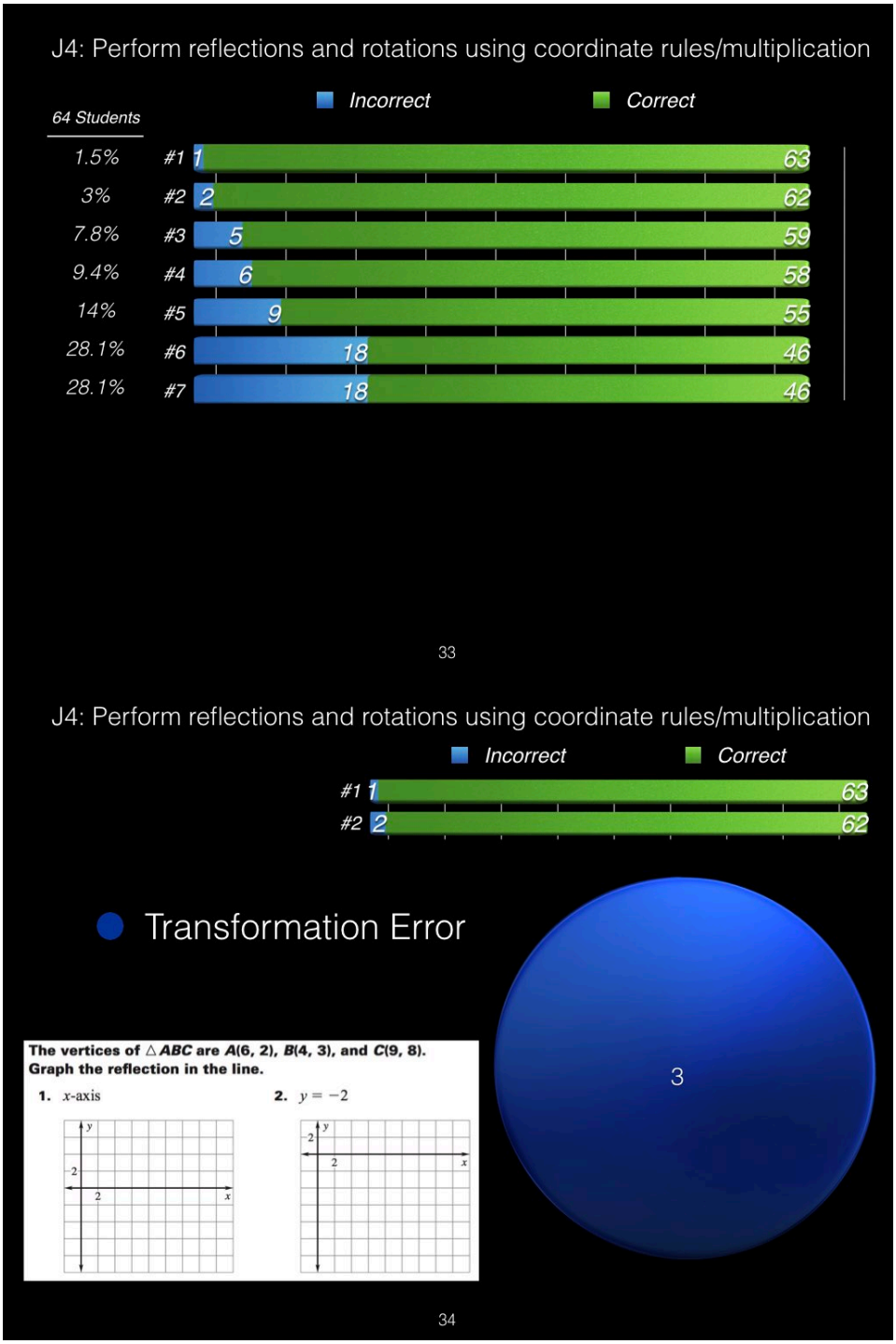
31

J3: Multiply matrices of various dimensions


*Anything I would change about the assessment?*

- I don't think so. I added #2-3 this year as a way to get to the nitty-gritty of the procedure and as a way to make sure students do not rely on the calculator. I feel the problems gave me specific information on student thinking to help me move the learning forward.

32


J4: Perform reflections and rotations using coordinate rules/multiplication
Incorrect
Correct
64 Students
1.5% #1 1 63
3% #2 2 62
7.8% #3 5 59
9.4% #4 6 58
14% #5 9 55
28.1% #6 18 46
28.1% #7 18 46
33
J4: Perform reflections and rotations using coordinate rules/multiplication
Incorrect
Correct
#1 1 63
#2 2 62
Transformation Error
3
The vertices of △ABC are A(6, 2), B(4, 3), and C(9, 8). Graph the reflection in the line.
1. x-axis
2. y = −2
34

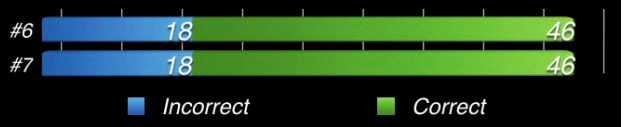
J4: Perform reflections and rotations using coordinate rules/multiplication


**Find the coordinates of the image of $P(3, -4)$ after the rotation about the origin.**

**3.** 90° rotation $(-b, a)$ **4.** 180° rotation $(-a, -b)$ **5.** 270° rotation $(b, -a)$


35

J4: Perform reflections and rotations using coordinate rules/multiplication



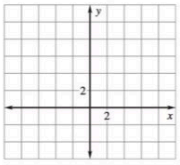

#6-7 dealt with compositions of transformations and two types of errors were revealed:

- Transformation Error
- Incomplete Composition

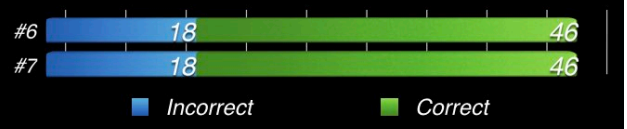
**The vertices of $\triangle LMN$ are $L(-9, 7)$, $M(-6, -1)$, and $N(-2, 2)$. Graph the image of $\triangle LMN$ after a composition of the transformations in the order they are listed.**

**6.** Translation: $(x, y) \rightarrow (x + 8, y)$

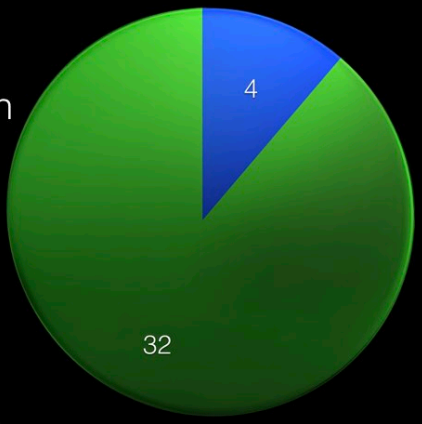
Reflection: in the $y$-axis



J4: Perform reflections and rotations using coordinate rules/multiplication

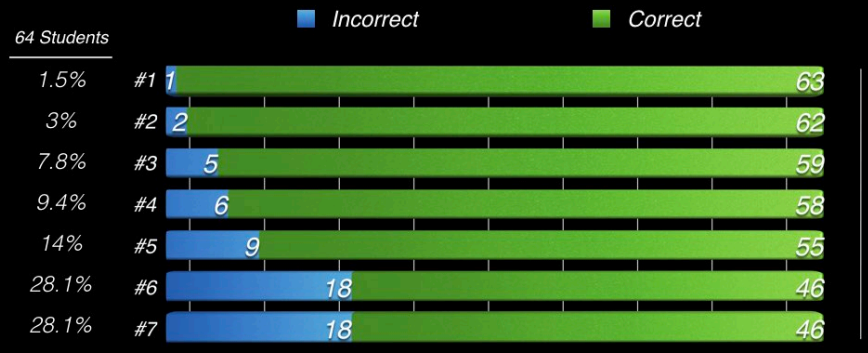



Translation Error
Incomplete Composition




37

J4: Perform reflections and rotations using coordinate rules/multiplication

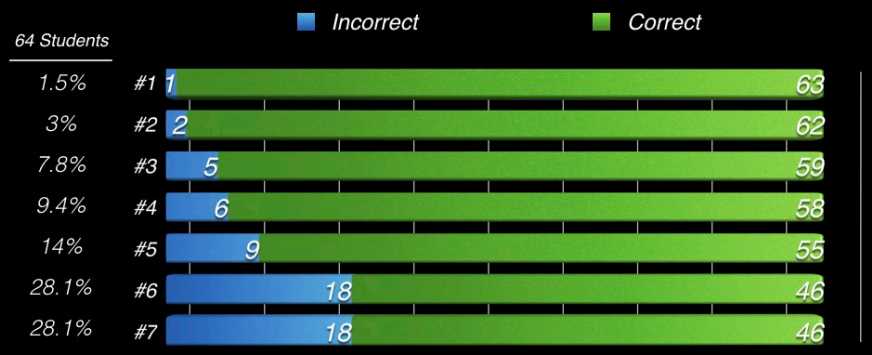



*What Did I Learn?*

- #1-2: Appears that this type of problem is mastered.
- #3-5: Majority of incorrect answers were due to application of wrong coordinate rule
- #6-7: Most errors were due to students not doing both steps of the composition

38

J4: Perform reflections and rotations using coordinate rules/multiplication

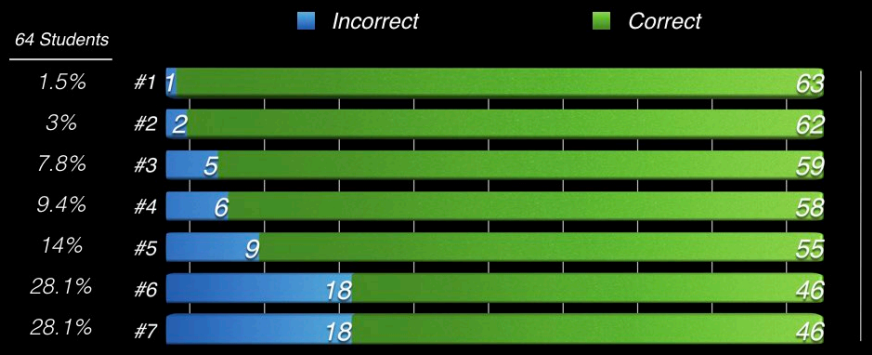



*How Did I Respond?*

- Addressed wrong coordinate rule with a small group of students individually
- Reviewed the process with #6-7 to whole class emphasizing compositions are more than one transformation.

39

J4: Perform reflections and rotations using coordinate rules/multiplication




*Anything I would change about the assessment?*

- I don't think so. The combination of #1-2 & #6-7 are almost the exact skill, but did expose and pinpoint a misconception regarding compositions giving a good opportunity to give feedback.

40

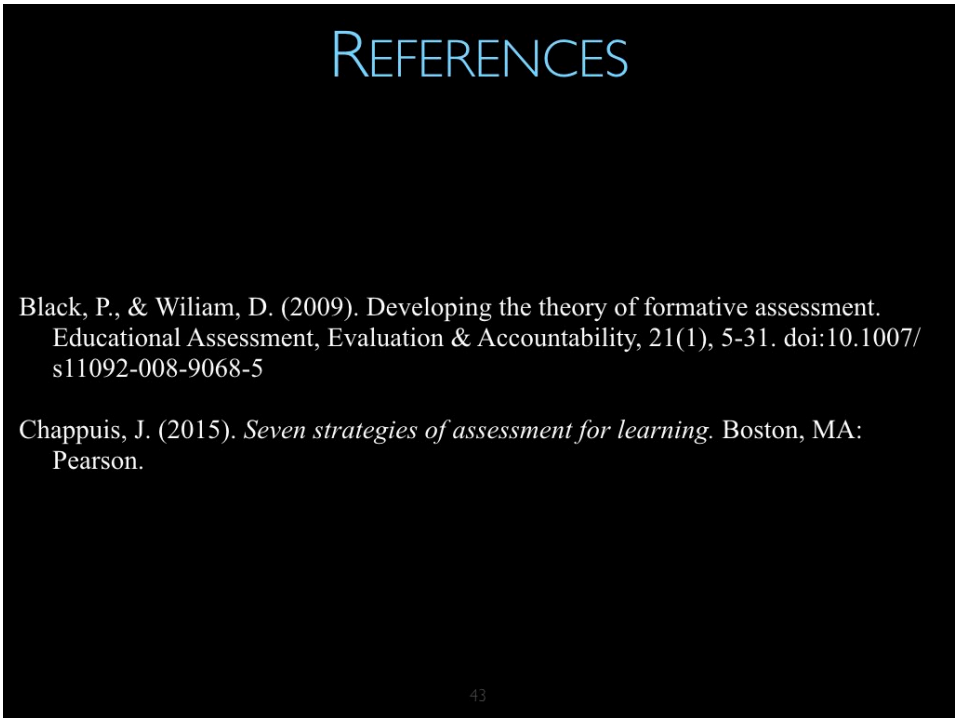
If an assessment item does not provide insight to the teacher on the level of student mastery of the target and provide specific information to be used for feedback, it needs to be exchanged for one that does.

41

## SUMMARY

- Remember the big picture:
  - Why do students come to school?
  - What is your job?
  - Have an attitude of service in your assessment practice. (What can I learn that will help me serve the student's learning needs?)
- Assess, don't correct.
  - Listen interpretively for information to be used for feedback.
- Use assessments to figure out how best to serve student learning needs, provide feedback information, and to adjust your practice to move learning forward.

42




Day 3 Handout: Assessment Breakdown Instructions

### *Assessment Breakdown*

***GOAL: Use assessments to elicit information to provide feedback and respond to student-learning needs.***

- Select or design an assessment for the expressed purpose of eliciting information in order to provide feedback and adjust your instruction DURING THE LEARNING PROCESS.
    - Do not use a test.
    - Do not use Matching/Multiple Choice unless you have carefully designed the items to give you information on student thinking and misconceptions (this is an advanced skill).
    - Do not use computer/automatic-grading software.
        - We will evaluate and analyze student work for insight on student thinking and misconceptions in order that we can help move learning forward. Understanding common student "symptoms" and partial understanding takes time and practice, so we need to do it manually for a while and get good at it before we can leverage technology to help take it to the next level.
- Identify the learning targets/map skills being assessed.
- Evaluate the assessment for each of those skills.
- Select 8 student samples from:
    - 2 students who typically do well
    - 4 students who are middle of the road or unpredictable
    - 2 students who typically do poorly
- Evaluate the 8 student assessment samples.
    - Make notes about the types of errors
    - Categorize/code student errors/misconceptions
- Ask Questions:
    - What can you learn about student understanding?
    - What misconceptions are present?
    - How will you respond to this information?
        - Feedback Intervention (individual/small group/whole class)
    - Anything you would change about the assessment?

<u>Submit:</u>

1. Copies of the 8 student assessments
2. Your Assessment Breakdown Report (See example) which details:
    - **Learning Target/Skill(s)**
    - **Results of Assessment Data**
    - Your **Discussion** of the data
        - Include student understanding/misconceptions
        - Include what you learned about the students
    - Your planned **Next Steps** to deliver feedback and to move learning forward.
    - **Reflection**
        - Any changes to the assessment for the future?

Day 3 Handout: Assessment Breakdown Peer Activity

## *Assessment Breakdown Peer Review*

Teacher:_____ Class:_____

Peer Reviewer:_____

Directions:

- Compare the Assessment Breakdown Guidelines with the teacher's submission.
- Feedback should be directed toward the task only. You are not to make comments that are:
  - non-specific ("Good job!"),
  - do not address specific aspects of the task ("I like this assessment"), or
  - are personal in nature ("You are a great teacher!").
- Keep the following goals of the Breakdown in mind as you review:
  - Use assessments to serve and respond to student learning needs.
  - Insight into student thinking and misconceptions is gained.
  - Data support the adjustments that are made during the learning process.

- **Learning Target/Skill:** Comment on the alignment of the questions with the stated skill. Suggestions for improvement?

- Look at the design of the questions carefully. Comment on the ability of the questions to elicit the level of student understanding and/or misconceptions. Suggestions for improvement?

## *Assessment Breakdown Peer Review*

- **Results/Discussion:** Compare the student responses with the conclusions on the report. Comment on the conclusions made by the teacher and the evidence from the student responses. Suggestions for improvement?

- **Next Steps:** Comment on the teacher's implementation of an appropriate intervention response based on student needs. Suggestions for improvement?

- **Reflection:** Comment on the teacher's suggestions for improvement of the assessment. Were they able to identify weaknesses and limitations of the assessment?

- Other comments/questions:

Day 3 Handout: Evaluation

**Formative Assessment Training**
**Evaluation Form**

Thank you for your participation. Please take a few minutes to provide feedback and complete the following evaluation questions.

The goals of the training sessions were:

- Provide mathematics teachers with the foundational knowledge to integrate the first three aspects of the formative assessment process into their classroom practice.
- Provide mathematics teachers the opportunity to work together collaboratively and to analyze student learning data.

1. The training increased your knowledge of the formative assessment process.
*Strongly Disagree* *Disagree* *Neutral* *Agree* *Strongly Agree*

Comment (optional):

2. As a result of the training, you can more clearly identify the learning targets for students and align curriculum assessments to the learning targets.
*Strongly Disagree* *Disagree* *Neutral* *Agree* *Strongly Agree*

Comment (optional):

3. As a result of the training, you are more equipped to use student assessment data to provide feedback to students and make adjustments for the next stages of learning.
*Strongly Disagree* *Disagree* *Neutral* *Agree* *Strongly Agree*

Comment (optional):

4. It was helpful to work through this process with my department colleagues.
*Strongly Disagree* *Disagree* *Neutral* *Agree* *Strongly Agree*

Comment (optional):

5. As a result of the training, our department is more equipped to integrate the formative assessment process into our practice.
*Strongly Disagree* *Disagree* *Neutral* *Agree* *Strongly Agree*

Comment (optional):

6. I believe that this training will help me to improve my students' learning.
*Strongly Disagree* *Disagree* *Neutral* *Agree* *Strongly Agree*

Comment (optional):

**Formative Assessment Training**
**Evaluation Form**

Please answer:

6. Please identify the aspects of the training had the most benefit for you.

7. Please identify any recommendations you may have to make this training more effective.

8. What questions or struggles about the formative assessment process do you still have?

Appendix B: Document Summary/Analysis Form

| | | | |
|---|---|---|---|
| Document ID Code: | | | |
| Document Owner: | | Date Received: | |
| Document Name/Description: | | | |
| Summary of Contents: | Assessment:<br><br>Feedback: | | |
| Significant/Important Datapoints Yielded | Assessment:<br><br>Feedback: | | |

Appendix C: Interview Protocol

***Title of Study:*** *High School Mathematics Teachers' Formative Feedback: A Qualitative Case Study*

Date:

Time of Interview:

Interviewer: Ryan Rathje

Interviewee:

Location of Interview:

***Welcome & Thank You Script:***

"Hello, my name is Ryan Rathje, and welcome. Thank you so much for agreeing to participate in this study. I appreciate and respect the time you're willing to give to this project, and hope that you will find the experience to be valuable."

***Qualifications & Informed Consent Check:***

Informed Consent Check:

"I had previously sent you an Informed Consent Form that you already returned to me. Did you have any additional questions about the study, or the information contained on the Informed Consent Form that I can answer for you before we proceed?

"Your name and identifying information will not be made public and any comments or answers you share will be kept confidential. The responses of all participants will be compared and evaluated to identify common themes. This information may be helpful in determining how best to serve teachers as they work to improve student learning in mathematics."

***Ground Rules:***

"Ok, thank you (for consent to participate)."

"During this interview, please speak for yourself and your own perspectives, and to avoid speaking for others. We need to respect privacy of students, parents, families, as

well as colleagues and others where there's no need to disclose specific names of individuals. If you do speak about other teachers, building administrators, students or parents, please do so only as they relate to understanding the topic we're exploring today and how interactions with these people shape your own experiences."

"Do you have any questions?"

***Purpose / Tone Set***

"The purpose of this study is to explore and understand the use of assessment and feedback in high school mathematics classrooms. The purpose of the interview is for you to share your perspectives, beliefs, and practices with me regarding assessment and feedback in your teaching practice. I invite you to feel free to relate your experience in a free-flowing and open manner. The more details you share, the better. Since the interview will be recorded, you don't need to worry that I'll miss something or that you are providing too much detail. These questions are intended to assist you in talking about your beliefs and perspectives. I might provide questions that seek clarification about you've described or ask you to provide examples or elaborate on certain aspects of your comments.

"Do you have any questions at this point?"

**QUESTIONS:**

**Phase 1: Background – Rapport Building**

"Ok, let's begin: Tell me a little about yourself"

Needed Demographic Information –

Name, age

What is your education background? Any post-graduate work? What area?

How long have you been teaching? How long at XXX? How long have you taught mathematics courses?

TIME CHECK:

**Phase 2: The Experience**

"Let's talk about assessment. Tell me what you believe about the primary purpose of assessing students." [RQ2]

"Describe for me your philosophy of assessment in your classroom." [RQ2]

"Walk me though what assessment looks like in your classroom. Imagine you've just finished a topic—how are you assessing a student's knowledge or skills?" [RQ1.2]

"How do students know what they will be assessed on?" [RQ1.1]

"Describe the timing and in what manner you communicate learning intentions to students" [RQ1.1]

"How often do you assess student learning and in what forms does it take?" [RQ1.2]

"How do you design, or where do you get the tools to assess your students? [RQ1.2]

"Where did you learn how to assess students?" [RQ3][2]

"What training have you received (either formally or informally) that has influenced your assessment practices?" [RQ3]

"Would you elaborate more on where or how you developed your system or philosophy of assessment?" [RQ3]

TIME CHECK:

"I'd like to transition into your thoughts about feedback."

"How would you define the term 'feedback'?" [RQ2]

"What purpose does feedback serve in a mathematics classroom?" [RQ2]

"Would you describe what you think "good" feedback looks like?" [RQ2]

"Would you describe what you think "poor" feedback looks like?" [RQ2]

"How would you describe the timing of feedback you give to students?" [RQ1.3]

"How would you describe the typical amount of feedback you give to students?" [RQ1.3]

"How would you describe the manner or format in which you deliver feedback to students?" [RQ1.3]

"Describe the types of information you provide to typically provide to students." [RQ1.3]

"Can you give a few examples of how you typically give feedback to students in your classroom practice?" [RQ1.3]

"Where did you learn how to give feedback to students?" [RQ3]

"What training have you received (either formally or informally) that has influenced your feedback practices?" [RQ3]

TIME CHECK:

**Phase 3: Reflections**

"What you've shared with me up to this point is very helpful in capturing your perspective about this topic. I'm wondering . . ."

"In what ways have your beliefs or practices about assessment changed over the course of your teaching career?" [RQ2]

"In a perfect world, how would you ideally assess student learning?" [RQ2]

"How would you describe the gap between the perfect world you just described and your current practice?" [RQ1]

"What do you hope to achieve in providing feedback?" [RQ2]

"What do you think your feedback achieves?" [RQ2]

"What do you think students typically do with the feedback you give them?" [RQ2]

"What is your greatest challenge in giving students feedback?" [RQ2]

"Are there any closing comments you would like to share?"

TIME CHECK:

"Wow…what a fascinating and powerful experience…thank you so much…"

"In conclusion, I would like to thank you and express my sincere appreciation for your participation in this study and taking time to share your experiences / perspective / ideas…. I want to assure you again that your responses are confidential. And just as a reminder, if needed, do I have your permission to contact you for follow up information? Also, I will provide you with a draft of my preliminary findings. I would like you to read the draft to verify or provide feedback to increase the accuracy of my interpretation of

your thoughts and perspectives on assessment and feedback form the interview. Thank you again for participating in my study."

# Appendix D: Observation Field Notes Form

Class:_____ **Observation Field Notes Form** Date/Time:_____

| Hattie & Timperley Model of Feedback | | | | |
|---|---|---|---|---|
| | **Task Level Feedback**<br>*How well tasks are understood and performed* | **Process Level Feedback**<br>*the main process needed to understand and perform tasks* | **Self-Regulation Feedback**<br>*Self-monitoring, directing, and regulating of actions* | **Self Level Feedback**<br>*Personal evaluations and affect (usually positive) about the learner* |
| | *Misc. Observations/Timing/Amount/Audience/etc.* | | | |
| *Black/Wiliam FA Theory* | *Assessment Notes:*<br>*1. Learning Intentions*<br>*2. Effective learning tasks*<br>*4. Using peers as resources*<br>*5. Student learning ownership* | | | |