A STUDY OF MIDDLE SCHOOL MATHEMATICS TEACHERS’ IMPLEMENTATION OF FORMATIVE ASSESSMENT

by

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An executive position paper submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Doctor of Education in Educational Leadership

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ABSTRACT

The purpose of this study was to determine how middle school math teachers implemented formative assessment in their mathematics classrooms, including whether and how they used technology to do so. There were three key questions that guided this study: 1) How do middle school teachers plan for and collect data for formative assessment during a mathematics lesson? 2) In what ways do teachers use evidence gained from formative assessment to change their instruction, if at all? and, 3) To what degree do middle school mathematics teachers use technology when engaging in formative assessment during a mathematics lesson? I used a qualitative research design in this study, which included document analysis, observations, and teacher interviews, to collect data from five middle school mathematics teachers. The research revealed three significant findings: 1) Formative assessment activities in these middle school mathematics lessons fell into one of three categories; Purposefully Planned for, Not Planned for but Used, and Missed Opportunities. 2) When teachers did include formative assessments in their Acquisition Lesson Plans, it was rare that the plans also included the exact interventions they would use if the data showed that some or all of the students held some misunderstanding. While teachers did frequently add new math problems to their instruction or modify the mode of instruction, those changes often came the next day in a multi-day lesson as opposed to in the exact moment that the formative assessment
activity occurred. 3) Although teachers embedded formative assessments into lessons that were delivered through the use of technology and a learning management system, Schoology, they did not use technology solely for the purpose of formative assessment.

*Keywords:* formative assessment, Learning-Focused Strategies, LFS, Acquisition Lesson Plans, ALPs, Schoology, mathematics, professional learning communities, PLCs.
Chapter 1

INTRODUCTION

Formative assessment has been part of the education process even before 1967 when Michael Scriven used the terms “formative” and “summative” to label the different ways and reasons for collecting data on student thinking and understanding (Greenstein, 2010). Although those two different types of assessments were labeled in the late sixties, most of the assessments done with students were summative assessments, often in the form of high stakes tests. While summative assessment can show both teachers and students how well the concepts and skills were mastered, they do not allow for in the moment adjustments to instruction so that teaching can be responsive to students’ thinking to support students’ ongoing learning. Formative assessments do allow for just that. Because it allows for a change in instruction based on data, formative assessment has substantial impact on raising student achievement (Black & Wiliam, 1998). The purpose of this study was to see whether and how middle school mathematics teachers incorporate formative assessment into their instruction. Understanding the extent of teachers’ application of formative assessment in instruction can provide insights regarding the district’s guidance and support for teachers.
Background

In the early part of the new century, the Bush administration enacted the No Child Left Behind Act (NCLB), which had a profound impact on education (No Child Left Behind, 2011). The federal government became more involved in education with the hopes of improving the system so that all students met “the standards.” While each individual state was allowed to set its own standards of proficiency, NCLB introduced a focus on accountability. All states were required to bring every student up to the proficient level by the 2013-2014 school year. In addition, all core content teachers were required to be “highly qualified.” In Delaware, this act meant that every student in grades two through ten would take the Delaware State Testing Program (DSTP) every spring for five days – two days each for reading and math and one day for writing. Scores from grades 3, 5, 8 and 10 would be published in the spring and used to rank each school. Each year the benchmark score for determining if a school was “successful” was increased in an effort to get continuously closer to the 100 percent proficiency by spring of 2014.

When Barack Obama became president, education reform was also part of his agenda. Like his predecessor, George W. Bush, Obama believed that American students were not achieving at the same level as their foreign counterparts. The Secretary of Education, Arnie Duncan, and the Obama administration enacted Race to the Top (RTTT). States were invited to submit an application to apply for part of the 4.35 billion dollars set aside for this “race.” Delaware applied for, and was awarded, 100 million dollars in the first round of RTTT. Delaware’s application included the continuation of high stakes testing. However, in 2011 the DSTP test was replaced with a new high stakes
state test, Delaware Comprehensive Assessment System (DCAS). The DCAS test in reading and mathematics was administered three times a year and was designed to not only show whether or not students are “proficient” but also to show growth over the course of the academic school year. In 2013, the DCAS scores also became a measure used in the teacher evaluation process. As part of RTTT, Delaware was required to adopt the Common Core Standards. This required the adoption of a new assessment, Smarter Balanced, which was developed by a consortium of states to address the new standards. Even though the development of these tools was to improve accountability, at that point schools, students and teachers were not held accountable for scores on the Smarter Balanced test. The results from the test administered during the 2015-2016 year was used as the benchmark data. After the 2015 - 2016 year, teachers’ and schools’ ratings were based on student scores.

In one district, Polk¹, teachers and administrators were focused on these high stakes tests concerned with how to help the students improve their scores so that the school's rating based on the students’ scores could “meet the standards.” Despite six years of reorganization and restructuring efforts, specifically at the high school, students continue to perform below the state average on the state test. (See Table 1)

---

¹ All proper nouns in this paper are pseudonyms.
Table 1  School Rating

<table>
<thead>
<tr>
<th>Year</th>
<th>Growth model</th>
<th>AYP</th>
<th>Rating</th>
<th>Under improvement</th>
<th>Under improvement status</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>Meets Target</td>
<td>Meets Target</td>
<td>Academic Progress</td>
<td>Yes</td>
<td>Improvement Year 2</td>
</tr>
<tr>
<td>2007</td>
<td>Not Yet Determined</td>
<td>Below Target</td>
<td>Academic Watch</td>
<td>Yes</td>
<td>Corrective Action</td>
</tr>
<tr>
<td>2008</td>
<td>Not Yet Determined</td>
<td>Below Target</td>
<td>Academic Watch</td>
<td>Yes</td>
<td>Restructure Year 1</td>
</tr>
<tr>
<td>2009</td>
<td>Below Target</td>
<td>Below Target</td>
<td>Academic Watch</td>
<td>Yes</td>
<td>Restructure Year 2</td>
</tr>
<tr>
<td>2010</td>
<td>Below Target</td>
<td>Below Target</td>
<td>Academic Watch</td>
<td>Yes</td>
<td>Restructure Year 3</td>
</tr>
<tr>
<td>2011</td>
<td>Below Target</td>
<td>Below Target</td>
<td>Academic Watch</td>
<td>Yes</td>
<td>Improvement Year 2</td>
</tr>
</tbody>
</table>

Until the 2009-2010 school year, most of the efforts to improve student achievement had revolved around: reorganization of staff, scheduling, and new program additions such as a freshman seminar, a class in which students learned note taking, studying and organizational skills. At Rydell High—as was the case at many schools—this resulted in an environment that focused on student testing and not student learning. All of the students’ experiences revolved around the high-stakes testing program. The environment at the school was what John Dewey might call a mis-educative experience; an experience that “has the effect of arresting or distorting the growth of further experience” (Dewey, 1938).
As part of the restructuring plan in 2009, the school adapted Learning-Focused Strategies (LFS)\(^2\) as the framework for planning and instruction. To ease teachers into this new initiative, a three-year professional development plan was put into place in order to train all staff in this framework and related instructional strategies. In 2010, the rest of the district schools began professional development and implementation of LFS.

The LFS model includes a Know-Understand-Do (KUD) chart for a unit, in which the standards are unpacked and the important concepts and vocabulary are recorded to help focus teachers when planning assessments for the unit. Using a KUD, teachers organized into Professional Learning Communities (PLCs) developed Student Learning Map (SLM) that contains all the essential questions that they will be exploring during the unit. These essential questions push teachers to no longer plan a lesson to fit a period of time, but to create an Acquisition Lesson Plan (ALP) that is focused on the essential question. An ALP could, and often does take more than one typical fifty-minute class period. The LFS framework requires teachers to constantly determine student understanding throughout an ALP so that they do not get to the end of the lesson only to find out that their students are unable to answer the lesson essential question. Including opportunities for formative assessment throughout an ALP is a key component of LFS-based instruction. Each ALP must contain multiple Assessment Prompts (APs) that help the help the teacher purposefully plan for formative assessment throughout the lesson (See Appendix A for an example of an ALP). Understanding what students already know,

\(^2\) Learning Focused Strategies is a framework that connects the most effective strategies and practices. It is a model where all students’ progress through all three levels of learning. The levels are acquisition, extending thinking, and authentic and meaningful learning.
as well as how they process new information, is key to knowing the students and helping
them learn the material being taught. Using formative assessment multiple times within
every lesson, as required in the LFS framework, should help the teacher to make
instructional decisions that will create a bridge from knowledge that students already
have to future knowledge that students will construct when provided with appropriate
opportunities for learning (Wennergren, 2011).

After the three years of professional development and instructional support
provided by administration and LFS consultants, formative assessment practices should
have been consistent and pervasive throughout the school. In the fall of 2012, Rydell
High School brought in Max Thompson, Project Director of the Learning-Focused
Schools Model, to analyze implementation of all aspects of the LSF frameworks. The
main concern after completing the observations and interviews and after analyzing survey
results was that there was a lack of consistency and quality for implementing the
expected strategies delivered through professional development and on-site coaching.
While many of the components of LFS were observed, the implementation of the
practices reflected compliance to the expectations, but not meaningful use. For example,
teachers used learning maps and word walls (recommended strategies), but never once
referred them during the course of their lessons. In other rooms, teachers would lecture
or plan activities for the entire class period, never once stopping to check for student
understanding. One of the primary instructional challenges identified through the LFS
visit was that teachers were not utilizing formative assessment strategies resulting in
instruction and assignments that were below the level of rigor the students required.
Rydell High School was failing to create an educational experience that focused on student learning.

The same results also occurred in middle schools. Middle schools had received three years of LFS professional development, yet many of the same key components were not being fully implemented. In 2014, two of the middle schools, which continuously scored low on accountability measures, were identified by Delaware Department of Education (DEDOE) as needing intervention. One of the schools, Bayside Middle, was labeled as an Action School. The state defines an Action School as a Title 1 school that presents significant academic achievement gaps in their subgroup(s) or overall low student achievement as specified through ESEA Flexibility. As an Action School, Bayside had to work with district officials to create a plan that would help improve the achievement level of the subgroup. Hickory, the second middle school was labeled a Focus School. A Focus school is one identified by the Secretary of Education from a list of the bottom 10 percent of Title 1 schools in the academic achievement gaps of one or more student subgroups pursuant to ESEA Flexibility. Focus schools have a three year planning, implementation and evaluation cycle they must go through under the guidance of the Department of Education. If, over time improvement did not occur, the state could impart further actions and requirements on both schools.

The district has put in place various supports for teachers and students in order to help increase student achievement in reaction to the labels recently assigned to them by the DEDOE. One support provided for all teachers in both schools is Observation Feedback. The entire teaching staff of a school was divided among the leadership team
made up of administrators and instructional coaches. Each week, a member of the leadership team conducts a 10 minute walkthrough for each of their teachers. During the walkthrough they complete a walkthrough form that is sent electronically to the teacher immediately after the walkthrough is conducted. During planning time, the teacher and leadership team member sit and discuss what was observed during those 10 minutes and come up with a manageable action step for the teacher to work on during the next week. This meeting takes about 10 to 15 minutes and is conducted once a week. The district, realizing that formative assessment was crucial for student achievement, included formative assessment as a “look for” on the walkthrough form. (See Appendix B)

For this study, I focused on the use of formative assessment in middle school, specifically eighth grade mathematics classes. Even with all the professional development and supports put into place, our math students were still failing to meet the standards on accountability assessments. Due to the lack of improvement on those tests, neither school has been able to remove the label assigned to them by DEDOE.

While formative assessment is important at all grade levels, I focused on eighth grade for two reasons. First two-thirds of the middle schools in the district have been labeled as a Focus or Action School. Secondly, it was based on my current job status. As a middle school math instructional coach, while I had access to all the math teachers at the three schools, it was the eighth grade teachers that I had worked closely with as we began to implement the new curriculum. Teachers picked lessons from the two units they had taught during the pilot year. I believed that would increase the chances of technology being incorporated in to the lesson this year, which was import since I was also interested
Teachers have seen the material and how students respond to the lesson the previous year, but they now had the opportunity to work together to “tweak” them and incorporate technology, yet they were not so familiar with the lessons that they will just “do what they have always done.”

**Purpose**

The purpose of this study was to determine how middle school math teachers, who have received professional development in both Learning-Focused Strategies and instructional technology, were implementing formative assessment in their mathematics classrooms, including whether and how they were using technology to do so. Both the LFS PD and the PD on instructional technology gave the teachers opportunities to develop formative assessment strategies. It is my hope that a better understanding of how these teachers conducted formative assessments as well as how the data from the assessments impacted instruction will serve to provide insight for how to support all middle school math teachers as the district navigates its way into 21st Century learning.

A key component of LFS is assessment prompts. Assessment prompts are formative assessments that are strategically placed throughout the lesson to help teachers gather data and make instructional decisions so that students will be successful in understanding and answering the lesson essential question by the end of the lesson. In this project, I examined, in part, the frequency with which five teachers use the data gained from these assessments to improve their instruction.
While teachers have had an opportunity to receive professional development in LFS and know that implementing formative assessment is an expectation of the district, I anticipated that the data gained from formative assessment did not often manifest in instruction. And if it did, it was likely not to be immediately visible in instructional practice. As a mathematics instructional coach, part of my job is to do observation feedback walkthroughs in the classrooms. Based on my previous observations of teachers, I had seen a need for a study that looks at how teachers can implement formative assessment and how the data gained from that assessment can inform immediate decisions in instruction.

Over the past few years there has been an infusion of technology in the Polk School District. The professional development for instructional technology emphasized tools for immediate feedback like Socrative, Kahoot and Zaption that allows teachers to provide engaging quizzes and share results in real-time. Other tools like the social media platforms, can have students create a “backchannel” that allows for an easy flow of questions and responses between the teacher and students or students and students. There are other resources and learning management systems such as Schoology and Edmodo that allow teachers to provide feedback to students continuously and to individualize instruction. Using technology effectively allows for “real-time feedback to students and allows teachers to see which students need extra help and which ones need more challenging assignments” (West, 2013, pg. 14).

Through the instructional technology PD, teachers had been exposed to different sites and apps available to them that will allow them to assess student understanding.
Many of these applications allow for results to be visible to both the teacher and the students immediately without revealing which student provided which response. And while teachers who have received PD and have technology available to them daily are incorporating it into their lessons, I anticipated that very few are using it for formative assessment that will lead to immediate results.

This study explored how teachers used formative assessment data to tailor instruction in a timely manner. With our district incorporating a change in mathematics curriculum and teachers planning new lessons collaboratively across the three middle school and with the help of the math coaches, I was able to study the process of planning for and implementing formative assessment in the mathematics classroom. The research aimed to inform the district in determining whether there is a need to provide professional development or classroom support that focuses on how to effectively plan for and implement formative assessment.
Chapter 2

LITERATURE REVIEW

This literature review focuses on defining and discussing formative assessment. It also makes a case for how technology, in particular Classroom Response Systems, can be used to assess student understanding. The purpose of this literature review, then, is to provide an understanding of formative assessment as well as show a benefit in using technology to determine student understanding.

Formative Assessment

Formative assessment is defined as assessment for learning, a point in the instructional sequence where instruction can change in light of evidence about the students’ achievement (Wiliam, 2011). Swan and Mazur (2011) define formative assessment as “just in time” assessment that allows a teacher to make decisions about classroom instruction with time left to adjust in future instruction. These decisions about instruction should be based on what will help to improve and accelerate student learning (Sadler, 1998). This “just in time” assessment should occur in the zone of proximal development (ZPD) as seen in figure 1 below (Vygotsky, 1987). This will help the teacher make instructional decisions that will create a bridge to take the student from knowledge that they already have to future knowledge that they will construct when provided with appropriate opportunities for learning (Wennergren, 2011).
This process contrasts with assessment of learning (Wiliam, 2011). Assessment of learning is often used at the end of a lesson or unit to determine the level to which the students have learned the content. This type of assessment is referred to as summative assessment. It is often a way to provide students and observers with an evaluation of their overall performance and rank them against their peers in the course (Stiggins, 2005). Assessment for learning begins with the students knowing what will be expected of them throughout the learning process while the teacher monitors progress throughout the lessons to determine if the learning goals are being met (Stiggins, 2005). Paul Black illustrated the difference between assessment for learning and assessment of learning this way: “When the cook tastes the soup, that’s formative assessment; when the customer tastes the soup, that’s summative assessment” (Stanley & Alig, 2013, p.1). If that soup does not taste the way the cook wants it to taste, he can add the necessary spices or ingredients until it reaches the desired taste. Similarly, when both the student and teacher know what the end product is supposed to be and the teacher is constantly formatively assessing student progress, he or she is able to change or add to the instruction in order for the student to reach the desired results. For the purposes of this study formative assessment is defined as that “just in time” assessment that is used to inform instruction.
Classrooms where attention is paid to assessment for learning see improvements in student achievement (Leahy, Lyon, Thompson & Wiliam, D., 2005; Phelan, J., et al., 2001). Paul Black and Dylan Wiliam found that students in classrooms where teachers formatively assessed student learning achieved in six or seven months what would otherwise take a year (Leahy et al., 2005). These results were consistent across multiple countries as well as age groups and content areas. In studying how teachers implemented formative assessment in their own classrooms, Leahy et al. (2005), determined that every teacher and classroom is different but there are some broad strategies that work across all content and grade areas.

- Clarifying and sharing learning intentions and criteria for success.
- Engineering effective classroom discussions, questions, and learning tasks.
- Providing feedback that moves learning forward.
- Activating students as the owners of their own learning.
- Activating students as instructional resources for one another.

Using formative assessment reduces the achievement gap by helping the low achievers the most. Black and Wiliam (1998) reviewed research where learning gains were measured by comparing: the average improvements in pupils’ scores on test with the range scores that are found for typical groups of pupils on these same tests. One of those studies looked at the effects of formative assessment on low attaining students and students with learning disabilities. That study showed that providing both groups of students with frequent feedback from the formative assessment could help enhance learning.
Often teachers rely on the summative assessment for determining how a student is progressing in the content. However, it is the formative assessment that is more informative and will help produce greater gains in student achievement. Leahy, Lyon, Thompson, & William (2005), claim that we need to shift from the tradition of quality control (summative assessment) in learning to quality assurance. Quality assurance (formative assessment) is the point in a lesson where the teacher can change instruction based on evidence of student achievement (William, 2011). This type of assessment is more useful than summative assessment for determining where a student is and how to move them forward (Wiliam, 2011).

Formative assessment is most effective when the feedback is not attached to a grade. When teachers try to combine formative and summative assessments the positive effects of formative assessment are often nullified by placing a grade on the student work. An increase in student achievement was seen when feedback given on student work consisted of comments intended to help the students move forward, whereas there was no increase (and some decrease) in student achievement when a grade was attached to the formative assessment comments (Black & Wiliam, 1998; Volante, & Beckett, 2011).

**Formative Assessment in the Mathematics Classroom**

Formative assessment should be placed strategically throughout a math lesson so that teachers can determine student understanding and make decisions about the next steps of instruction based on student need. As Cathy Seeley, past president of the National Counsel of Mathematics (NCTM) states, “If we can catch students’
misunderstandings and confusion before they become habits, we can help students improve both now and in the future” (Seeley, 2014). It is much easier to correct the misconception in the moment then to try to reteach inaccurate mathematics that students have taken as mathematical truths. Jeane Joyner and George Bright, in their book *INFORMative Assessment*, put it this way; “When we as teachers are able to intervene before incomplete understands or inaccurate ideas coalesce into inappropriate ‘rules,’ we are more likely to have students who become competent and confident mathematicians” (Joyner & Bright, 2016, p. 130).

Teachers must acknowledge that what their students learn is not necessarily what they intended, and this is inevitable because of the unpredictability of teaching. Thus, it is essential that teachers explore students’ thinking before assuming that students have understood something (Wiliam, 2011). Posing good questions, listening to students, response and classroom discussions can help teachers begin to understand student thinking. In Japan, teachers spend a majority of their PLC time creating good questions that can be used during a lesson to help them determine whether or not their teaching has been successful (Wiliam, 1999). When we planned for a new curriculum, our PLCs needed to make it a priority to purposely plan questions that allowed us to determine whether or not our teaching was translating into successful student learning.

**Using Technology for Formative Assessment**

Formative assessment of student understanding is very important to planning and implementing lessons in the classroom. Technology can aid a teacher in formatively assessing students and providing critical feedback. Classroom Response Systems (CRS)
have been introduced into many classrooms to formatively assess student understanding throughout a lesson. These devices can be used to elicit information from all students and quickly display student responses in a graphical representation. Classroom response systems come in various forms and are referred to in the literature by different names (Audience Response System, Classroom Communication System, Classroom Response System, Classroom Voting System, and Clickers). In this review, the devices will be referred to as the Classroom Response System (CRS).

There are many benefits to using a CRS in the classroom. A teacher can elicit responses from all students quickly, increase student participation and engagement, and produce a graphical display of results driving a more productive classroom discourse (Barber & Njus, 2007; Beatty & Gerace, 2009). For example, when the teacher poses a question and the students respond using a CRS, a graphical representation, such as a bar graph showing how many students picked a particular response, is immediately generated. The teacher can use that graph to quickly see what percent of the class responded correctly. Based on the graph of responses, the teacher may determine if the students have a good understanding of the concept and continue with the lesson as planned. However, if the student responses reveal some gaps in understanding then the teacher must find a way to adjust. Students can also provide feedback for each other, discuss possible misconceptions that would lead to an incorrect answer, and create a process that could be used to determine the correct answers. The teacher intervention, and/or the classroom discourse among the students stemming from the results, can help the teacher shape instruction (Dufresne et al., 1996).
Well placed questions, to which students respond using CRS throughout a class, may help students maintain attention and stay motivated to learn (Cain, Black, Rohr, 2009). In a study at the University of Kentucky (Cain et al., 2009), instructors inserted six to seven questions that utilized the CRS into each of their lectures. Results from the surveys completed by the students at the end of the semester showed that 110 out of 111 students surveyed said periodic use of CRS helped them stay focused. Ninety-eight percent of the students felt that the use of data from the CRS led to better class discussions (Cain et al., 2009). Researchers found significant differences in mean course grades over three years from 2006 to 2008 and a Game-Howell post-hoc analysis showed a significant difference in 2008 to both 2007 and 2006. In each of the three years, all expectations and grading structures remained constant; the only change was the instructor’s effectiveness in using the CRS (Cain et al., 2009).

Formative assessment may play a major role in both teaching and learning in middle and high school. Utilizing the CRS as a tool for formative assessment should increase student engagement and aid teachers in make decisions about instruction quickly as it does in the post-secondary settings discussed above. Many of the studies included had been done using higher education instructors and classes. The purpose of this study is to determine how middle school math teachers, who have received professional development in both Learning-Focused Strategies and instructional technology, are implementing formative assessment in their mathematics classrooms, including whether and how they use technology to do so.
Key Questions

1. How do middle school teachers plan for formative assessment and collect data during a mathematics lesson?
   a. What classifications of formative assessment were observed during a mathematics lesson?
   b. When during the class period and lesson (if a lesson is longer than a class period) were students formatively assessed?
   c. How do middle school math teachers decide on the form of the formative assessment?
   d. What type of evidence are the teachers able to collect from the formative assessment?

2. In what ways did teachers use evidence gained from formative assessment to change their instruction, if at all?

3. How do middle school mathematics teachers use technology when engaging in formative assessment during a mathematics lesson?

One of Polk’s district supervisors often asks teachers, “What do you want the students to know and how do you know that they know it?” To frame the formative assessment process, it is important to expand upon the supervisor’s question so that it becomes, “What do you want the students to know, how do you know that they know it, and what will you do if they don’t?” The key questions are designed to investigate how teachers
are incorporating formative assessment and the new technology that has been brought into the mathematics classroom to answer these question.
In order to address my key questions, I used a qualitative design. Qualitative designs are used when the purpose of the study is to answer the “how” and “why” question (Baxter & Jack, 2008). The purpose of this study was to determine how five middle school math teachers are implementing formative assessment in their mathematics classrooms. In order to do this, I observed classes, interviewed the teachers and analyzed lesson plans. Using triangulation of sources, I was able to examine the consistency of different data sources within the same method. Having multiple qualitative data sources allowed me to observe how the formative assessment was being implemented in the classroom as well as discuss the “why” with the teachers.

Data Collection

Participants. This study, which took place during the 2016 – 2017 school year, included five eighth-grade teachers from three different middle schools in the district. During that school year, all three of the middle schools were in the first year of implementing a new curriculum. I wanted to use teachers from just one grade level so that I could observe the same lessons in each classroom. During the 2015 – 2016 school year, in my role as an instructional math coach, I spent the most time with the eighth-
grade math teachers during professional development as well as professional learning communities. The targeted teachers spent most of their professional development time taking a look at the mathematics and planning lessons for two pilot units in the CMP3 curriculum. Being in their classrooms on a regular basis made classroom observations more comfortable for both the teachers and the students. This is one of the reasons that I choose eighth grade teachers for this study. All teachers in this study will be referred to by a pseudonym. The teachers that were part of the study are listed in Table 2 below.

Table 2  *Teachers in Study*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>School label</th>
<th>Type of math class</th>
<th>PD experience</th>
<th>Access to technology</th>
<th>Researcher’s coaching role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher 1</td>
<td>Action</td>
<td>Regular &amp; Special Ed</td>
<td>LFS &amp; Technology</td>
<td>Yes</td>
<td>Grade level focus &amp; School focus</td>
</tr>
<tr>
<td>Teacher 2</td>
<td>Action</td>
<td>Regular Ed</td>
<td>LFS</td>
<td>No</td>
<td>Grade level focus &amp; School focus</td>
</tr>
<tr>
<td>Teacher 3</td>
<td>Focus</td>
<td>Regular Ed</td>
<td>LFS &amp; Technology</td>
<td>Yes</td>
<td>Grade level focus</td>
</tr>
<tr>
<td>Teacher 4</td>
<td>Focus</td>
<td>Regular Ed</td>
<td>LFS &amp; Technology</td>
<td>Yes</td>
<td>Grade level focus</td>
</tr>
<tr>
<td>Teacher 5</td>
<td>None</td>
<td>Regular &amp; Special Ed</td>
<td>LFS</td>
<td>No</td>
<td>Grade level focus</td>
</tr>
</tbody>
</table>

Since I believed that technology would benefit teachers in formally assessing students, it was initially important that the teachers have technology available to them
along with having received some training on ways to integrate the technology into the mathematics classroom. Eighth grade was selected because three of the nine teachers in the district had access to technology daily in their classrooms, a higher proportion than in sixth or seventh grade. Those three teachers were Teacher 1 from one of the middle schools and Teacher 3 and Teacher 4 from a second middle school. Each of these teachers were assigned class set of iPads or a class set of Chromebooks, and students were able to connect to the internet to access Schoology as well as programs and applications that can be used as a CRS. The remaining teachers who did not have access to technology, but who were piloting the same core curriculum, allowed for comparison.

Another variance of note between the participants would be the current status of the school based on prior performance. Teacher 1 and Teacher 2 are both from an “action school”, Teacher 3 and Teacher 4 are from a “focus school” while Teacher 5 is from a school that has not been labeled by the Department of Education for low scores on a high stakes test. This contrast could lend itself to see if teachers working in schools where students continually score low on the state test formatively assess differently or less often than those at a school whose students consistently meet the standards.

A third contrast between the teachers is the amount of professional development on instructional technology that the five teachers have received. All teachers in the district, including the five that were part of this study, have received professional development over the past two or more years on Schoology, the learning management system adopted by the district and the state. On Schoology teachers can build lessons by embedding links to websites and videos where students can gain information around the
concept being taught at the time. Teachers can also incorporate quizzes and assessments in these lessons. Three teachers had also received extension PD through two different two-year continuous trainings, while the last two have received no PD on technology. The three teachers who have had extensive training in technology spent time experiencing different ways to create websites, using tools such as Symbaloo to organize websites for student use, and experimenting with web based programs such as Socrative that could be used as a formative assessment tool.

Lastly, there is a contrast between the labels the three schools have received (or not received) from the Department of Education. One of the three schools’ students had consistently scored well on the high stakes state test and therefore has not received a label. Was this school implementing formative assessment more often than the two schools that are labeled as a “focus” or “action” school? Was there a difference between the three schools as to how they used the data from formative assessment? Did one use it to inform instruction of the current lesson while the others use the data to inform future lessons? Did any of the schools use it to inform instruction for the same lesson but for the following year?

Data sources. According to Creswell (2007), a characteristic of qualitative research is the use of multiple sources for collecting data such as observations, interviews, and artifacts. This study includes all three of those data sources. Each of those three sources is described in greater detail below.

Classroom Observations. All of the “action” took place in the classrooms. In order to see (a) how often in a lesson teachers formatively assessed students, (b) how
teachers were formatively assessing students, and (c) how formative assessment affected instruction, the five teachers were observed for two lessons during the course of one unit and one lesson in a second unit. For this study, the “types” of formative assessment were categorized as written, oral, written and oral, kinesthetic, and technological. A table providing a definition and a few examples of each category is in the appendix section (see Appendix C). Within each type, there are subtypes of formative assessment that are described in more detail in the results of the study.

As a group, the five teachers determined which three lessons were observed. They had to come from one of the two CMP3 units, *Growing, Growing, Growing* or *Looking for Pythagoras*, since both units were piloted during the 2015-2016 school year. During this school year teachers were experiencing the CMP3 curriculum for the first time and did not include technology. However, the three teachers with technology planned to incorporate it into both units during the 2016-2017 school year.

All of the observations were scheduled ahead of time with each individual teacher. During the observations detailed notes were taken. Figure 2 is an example of the form used for taking notes during the observation and a larger example can be found in the appendix section (See Appendix D) as well as the correlation between the observation and key questions (See Appendix E).
All classroom observations were videotaped as well as audio recorded. The video and audio recordings from the observations were reviewed within one week of the observation to determine if any important details were omitted from the notes. Parts of the videos were used during the interviews with the teachers to remind them of student responses. Video clips were also used to show them a moment in the lesson and give them an opportunity to explain their decision making process in the moment. Being able to show teachers specific clips that show that classroom instruction deviates or does not deviate from the written lesson plan based on student responses allowed them the opportunity to explain their rationale about whether or not they decided to make a change to their lesson during the interview process. It was also possible that teachers

\begin{figure}
\centering
\includegraphics[width=\textwidth]{observation_notes.png}
\caption{Observation Notes}
\end{figure}
incorporated formative assessment that had not been previously planned when writing the Acquisition Lesson Plan. Being able to show the teachers video evidence of this allowed them the opportunity to explain why they included the additional formative assessment during the interview process.

During the first two observations, the teachers were not aware of the observer’s objectives, as notifying them may cause them to change their normal behaviors even more than the observation would on its own. Participants were told that I would be coming in to observe lessons from the units that were piloted the previous school year. The teachers with technology planned to incorporate technology into one or more of the lessons, however they were not told how to use the technology. Since I was interested in whether or not teachers were using technology as a tool for formative assessment, I wanted to make sure that I saw some lessons that incorporated technology.

At the end of the interview after the second observation, I let the teacher know that I was specifically looking for the use of formative assessment during the observation of the third lesson. Knowing my specific objective for that observation may have impacted how teachers planned for and implemented formative assessment as well as increased the amount of formative assessments I would observe. Additionally, I knew it was also possible that I might have seen a greater variety in the types of formative assessments used if they were made aware of my objective ahead of time.

**Interviews.** In order to determine how teachers interpreted the data collected from the formative assessment and how they used that data to impact instruction, I conducted several interviews. Each teacher was interviewed after their second observation and again
after the third, using a semi-structured format. A semi-structured format allowed me to come prepared with a set of predetermined questions to ask. However, it also allowed the interviewee freedom to express their own views and follow-up questions could be asked based on the teachers’ responses (Cohen & Crabtree, 2006).

I was interested in how and when the teachers choose to formatively assess their students. Did they use technology for formative assessment? What were the advantages or disadvantages of using technology for formative assessment? I was also interested in hearing how the formative assessment shaped instruction. Did it happen immediately? How did they determine what to do next in their instruction after assessing student understanding? Also, it was possible that a teacher may have incorporated formative assessments that they had not previously planned. I was interested in why they decided to incorporate the new formative assessment and what information about student understanding they gained from the impromptu formative assessment.

I developed an interview protocol for interviewing all of the participants after the second and third observations (See Appendix F and G). A table detailing the correlation between interview questions and key Question can be found in the appendix section (See Appendix H). The interviews took place during the teacher’s planning period or after school, in their classrooms. During each interview, I took notes as well as digitally recorded the responses. When analyzing the data, I coded the notes while also reviewing the recordings.
Artifacts. Since I was interested in how using the data gained from formative assessment impacts instruction, I not only observed the class but also analyzed the Acquisition Lesson Plan as well. This was not done to critique or evaluate a teacher’s math lesson plan but to see if, where, and how instruction changed due to what the teacher learns from the formative assessment. A table showing the justification between the key question and each data source can be found in Appendix I.

Data Analysis

The goal of this study was to see how formative assessment is being used in a few math classrooms and make some recommendations for future professional development in the district. Therefore, most of the analysis was inductive in nature. Srivastava and Thomson, in their research notes recommend the following framework for analysis of a qualitative study (Srivastava & Thomson, 2009).

1. Familiarization – become immersed in the data collected.
2. Identifying a thematic framework – recognizing emerging themes or issues in the data.
3. Indexing – identifying portions or sections of the data that corresponds to a particular theme. (Coding)
4. Charting – taking the data that was indexed and charting it and drawing a thematic framework.
5. Mapping and interpretation – analysis of key characteristics as they are laid out in the charts.
This was a fluid process. As I processed the data, I refined my thinking and themes began
to emerge. All the themes and findings were analyzed to help create recommendations for
future professional development.

I used the framework above, beginning by just reading through the observation
notes, Acquisition Lesson Plans and interviews for all five teachers. This came to a total
of fifteen Acquisition Lesson Plans, fifteen observations and ten interviews. From that
data I decided to use a subset of thirteen plans and observations and ten interviews. One
teacher, Teacher 5, was only able to teach the very first part of lesson one. A substitute
teacher taught the rest of lesson one and all of lesson two. The substitute was not
provided with the Acquisition Lesson Plan, but instead operated from Teacher 5’s
substitute plans and packet. The plans left for the substitute teacher did not match
Teacher 5’s Acquisition Lesson plan so no comparisons could be made. For that reason, I
did not include any data from the lesson plan or observations from Teacher 5’s first two
lessons.

*Analysis of classroom observations.* I began by recording all the data from the
notes sheets used for the observations into a spreadsheet. The spreadsheet included each
teacher by lesson and each of the seven categories that I looked for during the
observation; time in class period, time in lesson, type of formative assessment, type of
evidence from formative assessment, type of feedback, feedback given by, and when
feedback was received. An example of this spreadsheet can be found in Appendix J. This
first pass at reviewing the data revealed trends in the time during a class period and
lesson students were being formatively assessed and the type of data teachers were able
to collect from the formative assessment. Also, when looking at the initial data and the key Questions it became evident that not all of the categories were equally useful in helping to answer the questions. I chose to use a subset of the data; time in class period, time in lesson, type of formative assessment, and type of evidence from formative assessment.

Next, I compared the data in the spreadsheet of what I observed in the lessons with the Acquisition Lesson Plans the teachers had written. I noticed that what was observed and what was planned for did not always match up in terms of formative assessment. I observed more occurrences of formative assessment than what the teachers planned for in their lessons. I also notice that there were times that I thought an activity was for formative assessment, but the teacher did not use it as such. I developed another layer of coding to describe each of these occurrences, Purposefully Planned, Not Purposefully Planned, and Missed Opportunities. Each of the types is defined in the table below and again in the next chapter.

Table 3  Classification of Formative Assessment Observed

<table>
<thead>
<tr>
<th>Purposefully Planned</th>
<th>Not Purposefully Planned</th>
<th>Missed Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Included in ALP</td>
<td>* Not included in ALP</td>
<td>* May or may not have been included in ALP</td>
</tr>
<tr>
<td>* Teacher collected data</td>
<td>* Teacher collected data</td>
<td>* Teacher did not collect data</td>
</tr>
</tbody>
</table>
Based on this new coding, I went back to my original spreadsheet of all the observation data and my observation notes sheets and sorted the same data into the three subcategories described in the table. Analyzing the data from the spreadsheet helped me answer parts of the first key question, *How do middle school teachers plan for and collect data for formative assessment during a mathematics lesson?* It also helped in addressing the sub question, *When during the class period and lesson (if a lesson is longer than a class period) were the students formatively assessed?* For example, I was able to analyze the data in the spreadsheet and find patterns for when each of the three types of formative assessment, Purposefully Planned, Not Purposefully Planned and Missed Opportunities occurred within a class period. All findings and evidence are presented in the results chapters.

*Analysis of interviews.* After going through the notes from my observations and the teachers’ Acquisition Lesson Plans, I was able to come up with initial findings to many of the key questions. In order to find supporting evidence for these findings, as well as determine the findings for the remaining key questions, I went back and read through all of the interview transcripts. The first time I read through them, I coded for evidence to support findings that had previously been uncovered when analyzing the artifacts and notes. I kept a spreadsheet for each key question that contained the findings as well supporting evidence. I added any new evidence that I found from the interviews in this document. Before reading through the transcripts a second time, I first read through each of the key questions to determine which ones had not been addressed through the observations and analysis of lesson plans. I then re-read the transcript through two
different lens; how did teachers make decisions about types of formative assessments and how did they decide if instructional changes were going to be made. The themes and evidence are provided in the following results chapters in narrative form.

Over the next three results chapters, more detail about how the observations, Acquisition Lesson Plans, and interviews were analyzed comparatively will be laid out in detail. These three chapters are organized by key questions and they cover, planning and collecting data, the use of data to make decisions, and technology. As evidence, I provide tables of data, excerpts from Acquisition Lesson Plans, and quotations from the participants.
Chapter 4

PLANNING AND COLLECTING

Key Question One: How do middle school teachers plan for formative assessment and collect data during a mathematics lesson?

a. To what degree do teachers plan for and collect data?

b. When during the class period and lesson (if a lesson is longer than a class period) were the students formatively assessed?

c. How do middle school math teachers decide on the form of the formative assessment?

d. What type of evidence are the teachers able to collect from the formative assessment?

In this study, I chose to use Wiliam’s (2009) definition of formative assessment when observing the mathematics lessons. He stated that;

“An assessment functions formatively to the extent that evidence about student achievement elicited by the assessment is interpreted and used to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions that would have been taken in the absence of that evidence.”

In other words, to be a formative assessment, teachers needed to provide an opportunity for students to demonstrate understanding (or lack of understanding) about the
mathematics, to collect the data, and to make decisions about future instruction. This chapter addresses the first two activities – planning for formative assessment and collecting data. Chapter 5 will address how teachers used the data to make decisions about instruction.

I will begin this chapter by giving an overview of the results to the key questions. First, what types of formative assessments occurred during the lesson? Based on my observations and review of Acquisition Lesson Plans (ALPs), it appeared that there were three different classifications of formative assessments. Teachers, during the interviews, tended to place formative assessment into two different categories. Second, when during the lesson do the teachers collect evidence that could impact instruction? When looking for evidence for that question, I also assessed when within a class period teachers provided students with the opportunity to demonstrate their understanding as all lessons occurred over multiple class periods. Third, how did the middle school math teachers decide on the form of the formative assessment? What types of activity were they having the students engage in as a formative assessment? Again, based on the Acquisition Lesson Plan (ALP) provided by the teachers and my observations of the lesson, I noted that formative assessment activities occurred in five different forms. Fourth, what type of data were the teachers able to collect from the formative assessment activities they incorporated in the lesson? Based on my observations and lesson plan review, the types of data the five teachers were able to collect fell into five different categories.

Based on my observations of lessons, review of Acquisition Lesson Plans, and interviews with each teacher, I had six findings. I will outline them briefly here, in this
introduction, in regards to the overarching key question: How do middle school teachers use formative assessment during a mathematics lesson? Later in this chapter I will unpack each one, based on the specific sub question, with supporting evidence. First, there appeared to be three different types of formative assessments that occurred during the mathematics lessons: Purposefully Planned and Used, Not Purposefully Planned and Used, and Missed Opportunities. Secondly, teachers saw formative assessment as falling into two different categories, formal versus informal formative assessment. Third, I observed that unplanned formative assessment occurred throughout the class period and lesson, yet planned formative assessment happened primarily at the end of the period. Fourth, according to the teachers, the curriculum, often determined where in the class period and/or lesson the formative assessment occurred. Fifth, while observing classes and analyzing Acquisition Lesson Plans, it appeared that when determining the form of formative assessment teachers decided between a written one instead of one that was either oral or visual. While interviewing the teachers, I noticed them name or describe two different ways of determining the form of the formative assessment, purposefully versus intuitive. Finally, the five types of data teachers collected with the formative assessments were: 1) Recalling prior knowledge, 2) Identifying whether students were paying attention, 3) Understanding whether students “get it” or “don’t get it”, 4) Assessing attitude (how are students’ feeling about the math), and 5) Learning students’ specific understanding of content.
Findings

Key Question One A: What classifications of formative assessment were observed during a mathematics lesson?

First, there were three different classifications of formative assessments that I observed during mathematics lessons: Purposefully Planned and Used, Not Purposefully Planned and Used, and Missed Opportunities. An overall definition for each of the three types will be given here (See Table 4) and later in this section I will provide evidence for each one.

Table 4  Classification of Formative Assessment Observed

<table>
<thead>
<tr>
<th>Purposefully Planned</th>
<th>Not Purposefully Planned</th>
<th>Missed Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Included in ALP</td>
<td>* Not included in ALP</td>
<td>* May or may not have been included in ALP</td>
</tr>
<tr>
<td>* Teacher collected data</td>
<td>* Teacher collected data</td>
<td>* Teacher did not collect data</td>
</tr>
</tbody>
</table>

Formative assessment was considered to be Purposefully Planned if the activity was written into the Acquisition Lesson Plan, the teacher had the students complete the activity, and data was collected from student responses. Activities that occurred during a lesson where teachers collected data from student responses, but were not part of the Acquisition Lesson Plan were considered Not Purposefully Planned but Used formative assessment. Missed Opportunities were chances to collect data about student thinking, but did not result in data collection. Teachers included “activities” such as collaborative
pairs or turn and talks, but did not collect any evidence of student understanding from the activity that might impact current or future instruction. Since no data was collected the activity does not match the definition of formative assessment by Wiliam (2009). These Missed Opportunities, while not formative assessments, became important when reflecting on past professional development provided as well as thinking ahead to future professional development opportunities.

I define Purposefully Planned for and Used formative assessment as an activity that the teachers included in their acquisition lesson plan, enacted during the lesson, and from which data were collected. One example of this occurred during my observation of Teacher 1’s teaching and was documented in the lesson plan. The Acquisition Lesson Plan included the following activity that would help inform instruction at the start of the next class period:

<table>
<thead>
<tr>
<th>AP1: Identify y intercept and growth factor from an equation.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Answer AP1:</strong> Exit Ticket</td>
</tr>
<tr>
<td>This exit ticket has 2 parts. Part 1 students are asked to find the growth rate and y intercept of the equation (answer AP). Part 2 is asking students to write an equation given the y-intercept and growth rate. This is in anticipation for the following day’s task.</td>
</tr>
</tbody>
</table>

*Figure 3. AP1 in Teacher 1’s Acquisition Lesson Plan*
planned an exit ticket in which student responses would determine the order in which students would complete the self-paced activities on Schoology, the Learning Management System used by the district.

**Assignment/Differentiation:**

Students are given 3 tasks on Schoology to complete.

Task 1: “Questions from 2.2” is an assignment from section A of problem 2.2

Task 2: Error analysis where students read a problem and post to a discussion board whether they agree or disagree if the problem is correct.

Task 3: Students will be asked to create their own math problem and solve others.

All tasks provide practice to further understanding of the y intercept, starting point and how they are used to write an equation.

Students who received a STAR on their exit tickets should begin with task 2 then move back to Task 1. All students must complete task 1 and 2. Not all students will get to task 3.

*Figure 4. Assignment/Differentiation in Teacher 1’s Acquisition Lesson Plan*

Another teacher, Teacher 3, when asked during an interview why she put the activity in the lesson she responded, “I gave it to see who was having trouble identifying sides.” Based on student responses to the problem posed, Teacher 3 adapted her lesson by adding in a problem of the day the next day to address misconceptions. Both teachers used the category of formative assessment that was planned to formatively assess, was enacted, and collected data about students’ thinking.
The second type of formative assessment observed was Not Purposefully Planned but Used in the mathematics lesson. These formative assessments occurred during the lesson but the teacher had not planned for them when writing their Acquisition Lesson Plan. For example, the following is part of an interview with Teacher 2:

_Bonham_: So, on the second day, you were finishing 3.1 or the first third of the LEQ. That was where you had them write in their own words the relationship between the 3 areas of the squares…

_Teacher 2_: YES, that is what I did. I had forgotten that I had done that.

_Bonham_: Ok, so tell me about that.

_Teacher 2_: Um…in terms of articulation um… maybe 25 percent of the class actually wrote out that the sum of the two smaller squares equaled the larger square. Some kids were writing $A + B = C$ because that is what we were calling those squares. But in general more than half of them were in general somehow able to write out what the relationship was.

_Bonham_: Ok, so from that you were able to see that half your class understood or could articulate…

_Teacher 2_: Yes

_Bonham_: Ok, so, I don’t believe that… (While looking at lesson plan)

_Teacher 2_: That my lesson matched?

_Bonham_: And that is OK. So my question is, why you added that in there.

Into your lesson at that point?

_Teacher 2_: Just to summarize. Because I knew that I had forgotten to
write summaries into my lesson plan, so I put it in there as a summary.

_Bonham:_ Ok

_Teacher 2:_ But I did not specifically write that in my lesson plan.

_Bonham:_ Any reason you chose to do it that way?

_Teacher 2:_ Um… it flowed with the class. And it came at the end of the class period, which I always think is a good time for summary. Yes, you can summarize in the middle of a class period too, but … that’s it.

In her interview, Teacher 2, explained the purpose of the formative assessment and why she put it into her instruction where she did. Even though it was not purposefully planned for in her Acquisition Lesson Plan, she implemented this formative assessment. Not all formative assessments have to be pre-planned to be useful for instruction. Teacher 2 had not purposefully planned for the formative assessment that she enacted at the end of the class period on that particular day, but intuitively she knew that it was a good place for one. She was able to use that data to determine students’ understanding of the relationship between the area of the square formed off the two legs of a right triangle and the area of the square built off the hypotenuse.

The final category was actually not formative assessment based on the definition being used for this research. This category is what I called Missed Opportunities. These were activities that I thought during the observation were going to be a formative assessments, but did not result in data collection by the teacher. For example, one teacher used a collaborative pairs activity in which students were asked to talk to their partner about how to find the missing side of a right triangle given the hypotenuse and a leg, but
instead of circulating and listening to student responses or having groups share out their responses, the teacher used the time to complete housekeeping tasks at her/his desk. In this case the students were given an activity to keep them on task and occupied while the teacher tended to another matter. A different way that Missed Opportunities were observed was a teacher asking for a show of hands as to the students who felt comfortable with the example that had just been discussed and written on the SMARTboard. Very few hands went up. One boy, sitting directly in front of me, said, “I have no idea what you just did.” The teacher did not make any instructional changes, but instead just moved on to the next problem in the investigation. In this instance, the teacher either did not collect any data from the activity or the teacher choose to ignore the data and continue on in the lesson. Missed Opportunities only account for twelve out of ninety-two, or thirteen percent, of the observed formative assessments. Table 5 shows the number for each of the three types of formative assessments observed during the two lessons where the teachers were unaware of the key question focus.
Table 5  *Classifications of Formative Assessments Observed During Lessons Where the Teachers Were Unaware of the Intent of the Observations (Lessons 1 & 2).*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Lesson</th>
<th>Purposefully Planned</th>
<th>Not Purposefully Planned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher 1</td>
<td>1</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Teacher 1</td>
<td>2</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Teacher 2</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Teacher 2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Teacher 3</td>
<td>1</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Teacher 3</td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Teacher 4</td>
<td>1</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Teacher 4</td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Teacher 5</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Teacher 5</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>34</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

*Because I was not able to complete an observation for the first two investigations for Teacher 5, she could not be included in this data set.

The next table, Table 6, show the same information for each teacher after they were informed of the purpose for my observations.

Table 6 *Types of Formative Assessments Observed During Lessons Where the Teachers Were Aware of the Intent of the Observations (Lesson 3).*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Lesson</th>
<th>Purposefully Planned</th>
<th>Not Purposefully Planned</th>
<th>Missed Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher 1</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Teacher 2</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Teacher 3</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Teacher 4</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Teacher 5</td>
<td>3</td>
<td>7</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>23</strong></td>
<td><strong>6</strong></td>
<td><strong>4</strong></td>
</tr>
<tr>
<td><strong>Total for All 3 Lessons</strong></td>
<td><strong>57</strong></td>
<td><strong>23</strong></td>
<td><strong>12</strong></td>
<td></td>
</tr>
</tbody>
</table>
For the first two lessons, both of which came from the second Connected Math Project (CMP3) unit taught during the 2016 – 2017 school year, *Growing, Growing, Growing*. The teacher only knew that I was coming in to observe math instruction with the new curriculum. After I completed observing the two lessons for each teacher, I let them know formative assessment was the component of their instruction on which I was focusing my observation. There was a slight change in the types of formative assessments I observed in the third visit to their classrooms. After knowing the focus of the study, the average number of Not Purposefully Planned lesson decreased from 2.125 per lesson to only one per lesson. It is possible that since the teachers knew that I was taking notes specifically on formative assessment they made sure to include them when writing the Acquisition Lesson Plans. However, there were still unplanned formative assessments in some of the lessons. I personally believe that unplanned formative assessments will continue to occur in classrooms no matter how detailed and well thought out a lesson plan is. It is natural and appropriate, as teachers, to gather data on student understanding based on how you perceive your students are doing intuitively.

Not only was there a change in the average number of Not Purposefully Planned formative assessment, but there was also a change in the number of Missed Opportunities. When the teachers were aware of the lens I was using for the observations, the average number of Missed Opportunities stayed the same for one teacher and decreased for three of the teachers (See Table 7). There may be an association between the number of Not Purposefully Planned formative assessments decreasing and the number of Missed Opportunities increasing. While I do not have specific evidence for this
association, it is possible that when teachers became aware that this study was about formative assessment they made sure to purposefully plan for it, included it in their Acquisition Lesson Plan, and collected data.

Table 7  Change in Missed Opportunities (After Awareness - Before Awareness).

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Change in Missed Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher 1</td>
<td>-1</td>
</tr>
<tr>
<td>Teacher 2</td>
<td>0</td>
</tr>
<tr>
<td>Teacher 3</td>
<td>-1</td>
</tr>
<tr>
<td>Teacher 4</td>
<td>-3</td>
</tr>
<tr>
<td>Teacher 5</td>
<td>N/A</td>
</tr>
<tr>
<td>Total</td>
<td>-5</td>
</tr>
</tbody>
</table>

*Because I was not able to complete the first two investigations for Teacher 5 she could not be included in this data set.

The second finding for this key question was that teachers, when interviewed, tended to categorize formative assessment as either formal or informal formative assessment. Informal formative assessment is not the same as what I previously described as Missed Opportunities, nor is it the same as Not Purposefully Planned but Used formative assessment. Based on the teachers’ descriptions, informal formative assessments are not written. Informal formative assessments were activities where the teachers did collect data on student understanding, whether planned or not, but the teachers named the approach to formative assessment as informal based on the fact that it was not a written formative assessment. Classroom discussions were the most common form of formative assessments that teachers referred to as informal. For example when
one teacher, Teacher 3, was describing a formative assessment activity that she had planned for in the Acquisition Lesson Plan and enacted in class she said, “But it wasn't a formal assessment prompt. Like it wasn't, it was like, like I just wanted to see what they are doing assessment prompt. Not like anything formal, that they had to write on paper and turn in.”

Another statement was "I know in the beginning, just because it was new, so in 2.1 it was going to be more informal. Like let's, or I am going to ask you a question and hear the conversations you are having with your partner. Like very, very informal. But by here (pointing to section 2.3 in the investigation) I wanted to see more.” Teacher 4 commented during the second interview that “I think a lot of my formative assessments just happen within the conversations that are happening in class.” Based on teacher responses, informal formative assessments were the classroom conversations and one-on-one discussions in class where the formal formative assessments could not be collected.

Key Question One B: When during the class period and lesson (if a lesson is longer than a class period) were the students formatively assessed?

One of my findings for this sub-question is that formative assessment activities occurred throughout the class period and the lesson. However, planned formative assessment happened primarily at the end of a period (See Tables 8, 9 and 10).
Table 8  When during a class period did planned formative assessment occur? (All 3 Lessons)

<table>
<thead>
<tr>
<th></th>
<th>0 - 15</th>
<th>16 - 30</th>
<th>31 - 45</th>
<th>46 - 60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher 1</td>
<td>5</td>
<td>0</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Teacher 2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Teacher 3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Teacher 4</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Teacher 5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>8</td>
<td>10</td>
<td>24</td>
</tr>
</tbody>
</table>

Table 9  When during a class period did not purposefully planned for formative assessment occur? (All 3 Lessons)

<table>
<thead>
<tr>
<th></th>
<th>0 - 15</th>
<th>16 - 30</th>
<th>31 - 45</th>
<th>46 - 60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher 1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Teacher 2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Teacher 3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Teacher 4</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Teacher 5</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>5</td>
<td>8</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 10  When during a class period did Missed Opportunities Occur? (All 3 Lessons)

<table>
<thead>
<tr>
<th></th>
<th>0 - 15</th>
<th>16 - 30</th>
<th>31 - 45</th>
<th>46 - 60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher 1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Teacher 2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Teacher 3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Teacher 4</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Teacher 5</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

When formative assessments took place at the end of a class period, an exit ticket of some form was a popular way to gather data of student understanding. Students would
complete a math problem or answer a prompt and turn it in at the end of the period.

Teachers could read over student work after class and make instructional decisions for the next day. Teacher 4, when asked during the first interview where formative assessment occurred in the lesson, responded by stating that some exit tickets were used at the end of the class period in order to help inform the next day’s instruction.

_Bonham_: Alright, do you, well, take a second in your lessons and tell me where in your lessons you formatively assessed student understanding.

_Teacher 4_: I know we had some exit tickets that we did that kind of helped me look at that night so that going into the lesson the next day and let me figure out is it something that would need to guide my instruction the next day? Would it be something I had to address with the whole class or would it be something and oddly enough it seemed like the problems seemed to be limited to just a few students that I addressed during warm-ups or the next day when I was passing things out. I would put little notes on them and just have quick conversations with them and ask them if they then understood. So it was mostly exit ticket and the check-ins at the ends of the classes.

This teacher frequently used an exit ticket at the end of the class period in order to assess how misconceptions needed to be addressed the next day, if there were any that needed to be addressed at all. Between both the Purposefully Planned and the Not Purposefully
Planned for but Used formative assessments, thirty out of the eight occurred at the end of the class period. While the end of a class period was a popular time to assess student understanding, the percent of formative assessment within the lesson had a slightly higher frequency within the second third and final third of a lesson (see Table 11).

Table 11  When during a lesson did Formative Assessment and Missed Opportunities occur? (All 3 Lessons)

<table>
<thead>
<tr>
<th></th>
<th>Purposefully Planned formative assessment</th>
<th>Not Purposefully Planned but Used formative assessment</th>
<th>Missed Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st Third 2nd Third 3rd Third</td>
<td>1st Third 2nd Third 3rd Third</td>
<td>1st Third 2nd Third 3rd Third</td>
</tr>
<tr>
<td>Teacher 1</td>
<td>4 4 8</td>
<td>1 2 1</td>
<td>1 2 0</td>
</tr>
<tr>
<td>Teacher 2</td>
<td>2 1 4</td>
<td>0 3 2</td>
<td>0 2 0</td>
</tr>
<tr>
<td>Teacher 3</td>
<td>5 5 3</td>
<td>1 3 2</td>
<td>0 1 0</td>
</tr>
<tr>
<td>Teacher 4</td>
<td>4 6 4</td>
<td>2 3 2</td>
<td>2 2 1</td>
</tr>
<tr>
<td>Teacher 5</td>
<td>2 1 4</td>
<td>0 1 0</td>
<td>0 0 1</td>
</tr>
<tr>
<td>Total</td>
<td>17 17 23</td>
<td>4 12 7</td>
<td>3 7 2</td>
</tr>
</tbody>
</table>

As the end of class assessments tended to be formal, it is no surprise that formative assessment that happened at the end of the class period was Purposefully Planned. Teachers used it as a way to end a period and check for student understanding before the next class period. All of the observed lessons lasted more than one class period, and each of the lessons I observed were completed at the end of a period. For that reason, it is not surprising that thirty out of the eighty formative assessments observed occurred during the final third of the lesson.
One factor in determining where in a lesson formative assessment occurred was the curriculum. During the interviews, four out of the five teachers mentioned that the structure of the curriculum impacted how teachers decided where to place formative assessments. As Teacher 4 put it during the second interview; “Sometimes the curriculum helps me determine how many assessment prompts I am going to have.” Teacher 2 also determined where to put the formative assessment based on the curriculum.

_Bonham_: So in your lesson plan, um, can you tell me how many assessment prompts you had planned in the full lesson.

_Teacher 2_: I had 3.

_Bonham_: Ok, and why 3?

_Teacher 2_: 3 because there were 3 sections in the book and each section touched on a different part of the LEQ.

The CMP3 curriculum is broken into investigations that cover key concepts. Each investigation is made up of usually three to five sections, called problems, which lead students to discover the key concepts. For example, in one for the first of the three lessons I observed, the lesson essential question (LEQ) was: How can you apply the Pythagorean Theorem to find the distance between two points? In problem one (3.1 in the curriculum), the students explore the relationship between the area of the squares that can be drawn using each leg as a side compared to the area of the square drawn off the hypotenuse. Next in problem two (3.2), students manipulate puzzle pieces of squares and triangles to prove the Pythagorean Theorem geometrically. Finally, in the third problem (3.3), students use what they know about right triangles and the Pythagorean Theorem to
find the distance between two points on a quadrant grid. Teachers often plan to put the formative assessment at the end of each section in the investigation. When asked how she determined where in the first lesson on Pythagorean Theorem she chose to put a formative assessment, Teacher 5 stated: “So I used a formative for each of the 3.1 and 3.2 and 3.3. So the formatives are what I wanted them to get out of it. So for this one, the connection with the areas and everything, that was the first lesson. So after each part I had a little mini formative.”

*Key Question One C: How do middle school math teachers decide on the form of the formative assessment?*

It is important to know the variety of forms of formative assessment that occurred during the thirteen lessons observed and how they were categorized. The five different categories are: written, oral, written and oral, kinesthetic, technology. The count in Table 12 included both Purposefully Planned and Not Purposefully Planned formative assessment, but not Missed Opportunities and included examples of each type of forms.
Table 12  *Forms of Formative Assessments Observed Planned & Unplanned*

<table>
<thead>
<tr>
<th>Form</th>
<th>Formative assessment observed</th>
<th>Total number of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral</td>
<td>Class Discussion</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Penny for Your Thoughts</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Turn and Talk</td>
<td>5</td>
</tr>
<tr>
<td>Kinesthetic</td>
<td>Card Sort</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Show of Hands if you…</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Thumbs Up/Thumbs Down</td>
<td>6</td>
</tr>
<tr>
<td>Written</td>
<td>Answering the Lesson Essential</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Question or Focus Question</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Completing a Graphic Organizer</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Exit Ticket</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Letter to Absent Student</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Quick Write</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Working on Practice Problem</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Writing a Text Message or a Tweet</td>
<td>2</td>
</tr>
<tr>
<td>Written &amp; Oral</td>
<td>Problem of the Day</td>
<td>14</td>
</tr>
<tr>
<td>Technology</td>
<td>Multiple Choice</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Written</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>80</td>
</tr>
</tbody>
</table>

The most popular form of formative assessment was written, and it occurred 46.25 percent of the time. Of those thirty-seven written formative assessments, the most popular choice was an exit tickets. The teacher frequently used exit tickets as a written form of formative assessment at the very end of the class period, even if the lesson occurred over multiple periods.

A lot of purposeful thought was given by some teachers as to how the formative assessment was enacted. Here is an interview excerpt with one of the teachers about how the form of the formative assessment was determined:
Bonham: For each of the assessment prompts you had, how did you determine how you wanted to formatively assess the students? How did you decide what activity you wanted to do?

Teacher 1: I feel like for me a lot goes into that and a lot goes into the flow of the lesson. So the first one I knew by day…for my second activity I needed to know what they got from the first day. So I had to give them an exit ticket where could I give them an equation and could they identify which piece was the starting point and which piece was the growth factor. So that was the first part of the question. And the second part of the question that was on there was can they write the equation. And I wanted them to be kind of working to see where they were with that, to see where we would be starting the next day with the online portion. Um, so I definitely needed a clear picture of can they identify the pieces of the equation. And then at day two, for 2.2, um, I really, there wasn’t any one thing that I was looking at. I was looking at, kind of, like making sure they could understand where the, kind of how they would influence each other on the different online activities that I had. I also used the one online activity where the students had to create their own questions. I knew that wouldn’t give me any steadfast, they get it they don’t get it. But it was giving me a clear understanding of which parts they were getting and which parts they weren’t. As far as um, students being able to type in how to put exponents as they are typing in.
So some kind of technical things. Also if students were saying; I had one student put on the discussion board that they had bees and there were 5 and they are doubling but then the growth factor was 3. So I knew they were still having trouble on the writing side of things, on the creating side of things, of really understanding doubling and times-ing by 3. They essentially gave me 2 growth factors. So that was helpful and gave me a clearer understanding of where we needed to go from there. So that activity stemmed; the students’ writing their own problems started off our next day. So we could go over some different things from that. And I like that in the students’ writing their own formulas I could see where they were at, because students are going to write questions that they are comfortable in doing. So the students that just said write an equating for starting point of 5 and something that is doubling, I knew where they were at. They were at a more basic level of understanding. When I had students trying to write a formula, some of them successfully, about having a certain amount of money and it multiplied by 3 every week and when would a person have a certain amount of money, they were at a little higher level of understanding. And for the last one, was a district formative assessment. I did a summarizing activity in the middle because I wanted to see, have them put in their own words how you can find the growth factor and starting point just to see where they were, to see how much more practice we needed. From standing over them, right
intuitive, it looked like everyone had a pretty good understanding and then I could check in with the few who didn’t. And then at the end of the lesson the kids did the district formative assessment which they were given the growth factor and a couple of pieces of information and then they had to work backwards to find the starting point and then write the equation.

This teacher purposefully planned for a variety of different forms of formative assessment based on the data she was trying to collect. This teacher had a written formative assessment in the form of an exit ticket in order to be able to review student work sometime after the class period to determine what knowledge or skills they had gained as well as what questions they still needed answered. This lesson also included a formative assessment on Schoology. The students were able to create their own problem involving growth rate. The teacher could review each problem to check not only for correctness but also level of sophistication. Finally, this teacher also planned for and included a written and oral formative assessment. As the students were working through the problem that was to check for understanding the teacher walked around and looked over their shoulders to see the work they were doing as well as listened in on the conversations the students were having.

While observing the lessons and analyzing the Acquisition Lesson Plans, it appeared teachers determined the form of the formative assessment based on if they wanted something to be formal or informal (See Table 13). In formal formative assessments the students produced some type of written product and often the teachers
collected the formative assessment to review at a later time. Informal formative assessment did not require the student to necessarily do any writing and there was nothing tangible for the teachers to collect and review.

<table>
<thead>
<tr>
<th>Formal</th>
<th>Informal</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Usually Written</td>
<td>* Usually Oral</td>
</tr>
<tr>
<td>* Able to be Viewed Later by Teacher</td>
<td>* Not Able to be Viewed Later by Teacher</td>
</tr>
</tbody>
</table>

Table 13  *Formal vs. Informal Formative Assessment*

Teacher 2, used an exit ticket that was collected and reviewed as a formal formative assessment and used listening to students as they worked in groups as an informal formative assessment.

*Bonham:* Ok. So for each of those 3 formative assessments, how do you determine how you are going to formatively assess the students? For instance you sometimes use an exit ticket. So how do you decide in which format or which way you are going to formatively assess for those particular 3.

*Teacher 2:* So for the first one I did do an exit ticket, um…I decided to do it that way so that I had something tangible that I could actually see if each kid got it or not. Um, also during that same part of the lesson, part of my assessment was just walking around and making sure they were on the
right track with the questions. But that is not really a formal formative assessment.

Formal formative assessment does not have to be pre-planned and informal formative assessment does not have fall in the category of Not Planned for but Used. Both the formal formative assessment (exit ticket) and the informal formative assessment (listening and observing) that occurred in Teacher 2’s lesson were Purposefully Planned For and Used formative assessments. In fact, at times the decision between a formal formative assessments versus an informal formative assessment came down to purposefully planning based on the instructional goal of the teacher:

_**Bonham:**_ Why that activity right there?

_**Teacher 4:**_ Um, that is a great question? Why the turn and talk there. Just to vary how we are doing it, to get them talking about math more. I just don’t feel like they talk about math enough.

Being able to communicate mathematically is one of the goals we worked on in this district. This particular teacher chose an oral form for the formative assessment to increase the students’ opportunity to talk about mathematics. It was the purpose of the formative assessment that helped the teacher determine how he or she was going to collect the data. Informal verses formal is just a way that teachers chose to describe the difference between something that was tangible as opposed to an oral or visual response from the students.
When interviewed, teachers described the decision about the form of the formative assessment as either intuitive or as purposeful. Teachers often felt like they just “knew” what type of formative assessment was needed as they knew both the content and their students.

_Bonham:_ Um, some were on a post-it note, and then you had page 34, #7. And then you had the Schoology ones. So some were written, some were oral and some were technology. What goes into determining how you are formally assessing your students? You mentioned that in 2.1 in was all new so conversation was a good form of formative assessment there, but how do you make some of those determinations as to how you are going to gain that data from kids?

_Teacher 3:_ I feel like it is an intuitive thing. You just know. Like you have to know the expectations of each section and know the progression to know, like...they don't have to have mastery here in 2.1....I am not going to give them a goal sheet in 2.1.

This teacher mentioned that you “just know.” If you “just know” what you want your students to know and if you “just know” the scope and sequence of the curriculum, then you “just know” how you are going to check for student understanding.

Another example:

_Bonham:_ So how you want to get that data from your kids or what you want to do with that data might impact what the activity?
Teacher 5: That makes sense, but again, I think it goes back to knowing the curriculum and your students and…I think it is really just intuitive for me. Sometimes teachers were not able to give a specific reason for why they chose the form of the formative assessment that they did, they described it as being “intuitive.” Is intuition really due to having purposefully planned the formative assessment or ones naturally in the flow of planning the lesson?

Key Question One D: What type of evidence did teachers collect from formative assessments?

The type of evidence that teachers collected from formative assessment fell into one of five different categories: 1) Recalling prior knowledge, 2) identifying whether students paid attention, 3) understanding whether students "get it" or don't get it", 4) assessing attitude (how students are feeling about the math), 5) learning students’ specific understanding of content. During this study, I saw thirteen lessons and observed eighty formative assessments, Purposefully Planned for and Not Purposefully Planned for, and twelve Missed Opportunities. All the data that was collected or could have been collected by the teachers from those ninety-two classroom activities fell into one of those five categories (See Table 14).
An example of a way that teachers collected evidence to see if students recalled prior knowledge was a Problem of the Day (PoD). At the beginning of a class period, each teacher used a PoD, often on the first day of the lesson to check for student understanding about prior knowledge that would be built upon during the current lesson. It gave the teachers an opportunity to not only assess whether or not students could recall the prior knowledge, but, as one teacher mentioned, it also reminded the students of the concept that was going to be built upon.

*Bonham:* So, take a look at the lesson that you have there, and tell me where in your lesson did you formatively assess for student understanding?

*Teacher 3:* I know I did a quick one of could they find, oh I remember this….

*Bonham:* So, the first day I saw you was Nov 16.

### Table 14 Types of Data Teachers Collected from Formative Assessments

<table>
<thead>
<tr>
<th>Type of Data Gained</th>
<th>Teacher 1</th>
<th>Teacher 2</th>
<th>Teacher 3</th>
<th>Teacher 4</th>
<th>Teacher 5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recalling prior knowledge</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Paying attention</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>&quot;Get it&quot; or &quot;Don't get it.&quot;</td>
<td>10</td>
<td>5</td>
<td>6</td>
<td>12</td>
<td>5</td>
<td>38</td>
</tr>
<tr>
<td>Attitude: How the students feel about the math.</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Specific understanding</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>10</td>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>13</td>
<td>15</td>
<td>23</td>
<td>8</td>
<td>80</td>
</tr>
</tbody>
</table>
Teacher 3: Oh dear, like a month ago.

Bonham: (Pull up video of Nov 16th class … Do you want to be a Millionaire clip)

Teacher 3: Ok, that was… yeah

Bonham: And they had to try to decide which two square numbers….

Teacher 3: So that was when they were figuring out the types of triangles. So I really did that because I really wanted to see what knowledge they had about triangles.

Bonham: Then you went to the family tree.

Teacher 3: That was the flashback because I wanted to see what they remembered.

Bonham: Ok, so you did a formative assessment to check into prior knowledge.

Teacher 3: Yes, because that is where I wanted them to see the connection between like the two, like this is what we are doing now but we are doing it in another way.

In this example, the teacher included a PoD at the very beginning of the lesson on Pythagorean Theorem in order to see what prior knowledge about triangles they could recall. If a student had forgotten a previous concept it afforded an opportunity for a quick tutorial from either the teacher or fellow classmates as the class discussed strategies for coming up with their solutions.
A second teacher, Teacher 5, also used a PoD to determine students’ prior knowledge about triangles.

*Bonham:* There was a moment on that same day, the 12th, where you did a, you had all the students write down everything they could think of about a triangle. Everything they knew about a triangle. Then they did a give one get one. What were you able to learn about your students from this activity?

*Teacher 5:* Ummm… that they varied in their knowledge of triangles. Cause some of them were basic knowledge. They tripped me out when they said, you know a regular triangle. And I said, well, what is a regular triangle? You know a regular triangle, dot, dot, dot. (While drawing an acute triangle in the air with finger.) Even some of them had that basic understanding and some of them were able to explain a little bit more about you know, somebody said, it had vertices. That impressed me that they said three vertices making that connection that those were the points where the segments meet. So using that vocabulary that impressed me. And some said it had three sides. So just the variation with the kids in terms of, their knowledge and use of vocabulary. Some were very basic. You had others that could be more specific. You have triangles that could be different size. Um, someone threw out some of the measure of the angles and someone said, oh they add up to 180. So just seeing that
variation from some of the basics of a triangle to some that were very specific.

This teacher included a Problem of the Day in the lesson to see what the students remembered about triangles. This information let the teacher know that he/she did not have to go back and fill in any missing knowledge before beginning the lesson. Based on student responses from that activity, the teacher was pleased and able to move on with the lesson. Knowing if the students are able to recall prior knowledge that will be linked to the new lesson is important. If the teacher was able to determine through formative assessment that the students could recall previous knowledge, then he or she can begin with the new material and students will have an entry point to the new information. However, if the data from the formative assessment showed that the students could not recall the previous information, a change in instruction might be appropriate.

Occasionally the teachers included an activity that checked to see if students paid attention to the material being discussed in class. This check was often done by having students participate in a collaborative pairs’ opportunity or by cold calling on several students to answer a question. Collaborative pairs is a strategy used in Learning-Focused classrooms that actively engages students by having them discuss information learned, actively listen to each other, and share out responses with the class. During this time the teacher is able to walk around and listen to partners talk as well as select which groups should share out responses. This particular partner activity was different than the Turn and Talk activity that was described as a Missed Opportunity in the previous chapter. In that turn and talk, the teacher had the students discuss the concept with their partner about
the math concept, but never circulated through the room or cold called students to gather any data. Sometimes a formative assessment strategy that was meant to see if students “get it” or “don’t get it” or even check for student attitude can lead to data about whether or not the students were paying attention. One teacher asked the students a question that required the response of thumbs up for “I get it” or thumbs down for “I don’t really get it.” Instead what the teacher learned based on the lack of thumbs that even went in the air was that there were some students who were not really paying attention at all.

_Bonham_: So, on the second day that I saw you, so it was still part of LEQ3, but you were still in 3.1 and you had done a Penny for your Thoughts, and you had visited the different groups, but later on in the lesson you asked the kids for a show of hand how many of you could tell me the type of triangle if I gave you these areas. So I am going to show you that video clip. (Showed clip) So you polled your class, from that, what data did you have about your students?

_Teacher 4_: That most of them, well that some of them weren’t even paying attention to the question. And some, and most of them either weren’t able to identify the types at that point or they weren’t willing to admit that they could identify them.

The above is an example of a formative assessment that could have been categorized as both checking to see if students “get it” or “don’t get it,” and if the students had paid attention. At the time of the initial observation, I categorized it as the former rather than the latter. Even if it had been included in the checking to see if students paid attention
during the lesson, that category would still have been the least common type of data collected that was observed during these lessons.

Teacher 2 also checked on the attitude of the students by collecting an exit ticket that was Not Purposefully Planned for but Used at the end of the period. During the second interview, the teacher mentioned that this formative assessment was included in instruction because she wanted to see who had paid attention to the lesson.

*Bonham:* And then you collected the assignment from the book as your third check for understanding. What did you learn about your students there?

*Teacher 2:* I learned that they ones who paid attention were able to explain how to do those three parts. And explain how to get the growth factor and how to write the equation. That was really the point of collecting their papers.

*Bonham:* So, any of them that were paying attention and turned something into you…did all of them completely ace it? Or were there students who still had misconceptions?

*Teacher 2:* For the most part they did really, really well. And I think it helped that we basically answered all of those questions through the “I noticed I wonder.” So basically they just had to verbalize it. And for the most part they did well with doing that.

While this formative assessment was put into place in order to help the teacher determine which students had paid attention to the lesson, it did much more than that. The papers
that the teacher collected allowed him/her to not only determine if the students had paid attention to the lesson, but for those that had, it gave the teacher some insight to what they had learned and if those students had any misconceptions.

The most common type of data collected was whether or not students “got it” or “didn’t.” Of the eighty formative assessment observed, whether they were planned or not planned, determining if a student “got it” occurred 48.75 percent of the time. This type of formative assessment occurred in a variety of ways, walking around and listening to students working on problems, exit tickets, and Problems of the Day, are only a few of them. One example of a teacher circulating through the classroom and listening and watching groups work to determine if they “got it” is:

*Teacher 2:* We were finding the distance between two points, so they had to make the triangle using those two points, find the lengths of the legs, and use the Pythagorean Theorem to find the hypotenuse. So then after we did that once together they worked in their groups and I was assessing whether or not they were able to do that.

*Bonham:* And how were you assessing that?

*Teacher 2:* Just looking at their work, how they were working, if they were working? If they were able to follow those same steps.

*Bonham:* By walking around and watching the groups?

*Teacher 2:* By walking around, yes.

During her time of walking through her classroom, looking at how the groups of students worked on the problem, and listening to their discussions, this teacher was able to see
which students “got it” or “didn’t” at the time. She was also able to sit down in a vacant desk at a group and work with students who “didn’t get it.” In another interview a teacher stated:

**Teacher 1:** I could tell through their discussions and then looking at their predictions and looking at student work as I was circulating, that they were still struggling with finding areas of the squares that helps us determine Pythagorean Theorem. Um, they could do the squares that are perfectly aligned on the dot paper, and the ones that are tilted or skewed, they were having a hard time finding the area.

In both instances, the teachers circulated around the room watching students work out the problem as well as listening to their discussions with either their partner or their group. Based on watching and listening the teachers were able to get a good feel for whether or not the students were catching on to the concepts.

Attitude, or how students feel about their understanding of mathematics at a given point in the lesson, was another type of data that teachers were able to gather from their formative assessment. To check for students’ attitude about the mathematics at the time, teachers often asked a question and had the students respond by giving a thumbs up or a thumbs down. The teacher was then able to scan the classroom and get a feel for which students felt positive and which ones did not feel positive about the content. One teacher would check the students’ attitude and then make a decision about instruction.

**Bonham:** So, on day 2, which would be January 11, you said to your class, “How are you feeling about this? Give me a thumbs up or a thumbs
down.” And you got a general pulse on you pulse on your class. What do you do with that information? How does that impact your instruction?

Teacher 4: I guess if there are a lot of kids with thumbs down then you dive in a little deeper to figure out what is wrong. See where the sticking points are. If there are only a few I make a mental note to check in with those kids later on. Again, I wasn’t worried about it too much for this late because as I said it gets formalized later on in the book. So at that point I wouldn’t worry too much about it. But you know it is nice sometimes, because you know at times you have those kids who just won’t talk. So, I find that they share out more if we do a quick thumbs up check in. So I will do that from time to time just to see where we stand right now.

Teacher 2 also checked on the students’ attitudes by using thumbs up and thumbs down. During the first lesson, Teacher 2, asked her students to give a thumbs up if they were feeling pretty confident about finding the hypotenuse of a right triangle given the two legs and a thumbs down if they were not feeling very confident. Fifteen out of the eighteen students gave Teacher 2 a thumbs up. At that point, based on what was written on the Acquisition Lesson Plan, Teacher 2, continued with the lesson and did not make any instructional changes.

Teachers often chose the thumbs up/thumbs down method as quick formative assessment on students’ attitudes about the mathematics. Those attitude checks by the teachers seemed to come early in the lesson, when the content was just being presented.
At that point, how students felt about what they were hearing or seeing mattered to the teachers.

The final category of data that was collected during these lessons was for specific understanding. Teachers used their formative assessment to check in with students to determine exactly what the students understood or what misconceptions they had.

*Teacher 2:* From the exit tickets, I figured out that some of them were…they all understood the concept of what the number is and how it changes but some of them picked some wanted to use it to add by instead of the multiplication factor. So that was one common misconception…it wasn’t that common but it was the one mistake I saw. They used the correct format, it was \( y = \) starting point and then a number and then the exponent. Since they were putting the starting point and what they believed the growth factor was it told me they knew how to make the equation.

Another teacher purposefully used the Problem of the Day to help determine students’ specific understanding of the Pythagorean Theorem.

*Bonham:* Why was that your problem of the day there?

*Teacher 3:* Because that was an application. Like I wanted to be able to have that, like see a real world example instead of just a basic triangle. Not necessarily just a triangle, triangle, triangle.

*Bonham:* So what information were you able to get from your students from that?
**Teacher 3:** If they could set up an equation, if they could solve for the hypotenuse and take what they know and make sense of the problem. Not just do the computation. But to understand what the question was and how to answer it.

In these examples, the teachers had purposefully planned for a formative assessment opportunity where they could collect student work and look for specific understanding. In fact, in the first instance the teacher was able to determine that the students could or could not write the correct equation from the given information. In the second instance, the teacher was actually able to determine three different things the students either understood or had some misconceptions: 1) Can they understand what the word problem was asking them to do, 2) Can they set up the correct equation, and 3) Can they use the correct steps to solve the equation.

In this chapter, I looked at how the formative assessment was planned and collected. There were three different types of formative assessments observed that occurred throughout the lesson: Purposefully Planned and Used, Not Purposefully Planned and Used, and Missed Opportunities. By using a variety of forms of formative assessments, oral, kinesthetic, written, written and oral, and technology, teachers were able to collect five different types of evidence: recalling prior knowledge, paying attention, “get it” or “don’t get it”, attitude, and specific understanding. In the next chapter, I will provide examples and evidence for how middle mathematics teachers used the data gained from formative assessment during a lesson.
Chapter 5

USING THE EVIDENCE GAINED

Key Question Two: In what ways did teachers use evidence gained from formative assessment to change their instruction, if at all?

Wiliam (2011) claims that formative assessment is the point in the lesson where instruction can change based on the evidence of the students’ current understanding. In this study, I looked at whether and how middle school mathematics teachers changed their instruction based on data from formative assessment. For this key question and this subsection, there were two findings. First, based on this sample, teachers more often than not made no instructional change after a formative assessment. Secondly, if teachers did make an instructional change, it was in the form of the following: they added something new to the lesson to help students’ understanding of the concept, changed the mode or pace of instruction, or adjusted instruction for future lessons. These findings will be described in this chapter.

Findings

Key Question Two: In what ways did teachers use evidence gained from formative assessment to change their instruction, if at all?

While observing four of the five teachers teach three lessons and the fifth teacher teach one full lesson, I observed eighty formative assessments. Of those eighty formative
assessments, 27.5 percent of the time teachers made an instructional change based on evidence.

Whether the formative assessment was purposefully planned for or not did not appear to impact whether or not an instructional change occurred. I observed teachers incorporate fifty-seven Purposefully Planned formative assessments. Of those formative assessments, they made changes to instruction sixteen times or 28.1 percent of the time. There were twenty-three Not Purposefully Planned but Used formative assessments observed and instructional change occurred six times, or 26.1 percent of the time. Missed Opportunities were not included in this comparison since no data was collected during those activities and they did not meet the criteria for formative assessment.

I determined that the teachers changed their instruction after collecting formative assessment, whether Purposefully Planned for or Not Purposefully Planned for but Used formative assessment, by comparing the Acquisition Lesson Plan that the teacher provided prior to the lesson being taught and my observations of what actually occurred during the lesson. Those instructional changes fell into one of three categories: something new added to the lesson to help students’ understanding of the concept, the mode or pace of instruction changed, or instruction for future lessons was adjusted. Teachers added something new to that lesson or changed the mode or pacing of their instruction more than they used the evidence to change instruction for future lessons. Change in instructional mode occurred fifty percent of the time and included switching from individual or pairs working to whole class instruction, slowing down the pace of
instruction, peer teaching, and the teacher working one on one with individual students (See Table 15 below).

Table 15  *Instructional Change Made Based on Evidence from Formative Assessment.*

<table>
<thead>
<tr>
<th>Instructional Change</th>
<th>Examples</th>
<th>Number of times specific change occurred</th>
<th>Percent of specific change occurred</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in Instructional Mode</td>
<td>Switch from Individual or</td>
<td>3</td>
<td>13.64</td>
</tr>
<tr>
<td></td>
<td>Pairs to Whole Class</td>
<td>2</td>
<td>9.09</td>
</tr>
<tr>
<td></td>
<td>Slow Pace of Instruction</td>
<td>2</td>
<td>9.09</td>
</tr>
<tr>
<td></td>
<td>Pair Up Students – Peer Teaching</td>
<td>3</td>
<td>13.64</td>
</tr>
<tr>
<td></td>
<td>Work with Individual Students</td>
<td>3</td>
<td>13.64</td>
</tr>
<tr>
<td></td>
<td><em>Total</em></td>
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<td>50.00</td>
</tr>
<tr>
<td>Add Something New</td>
<td>New Problem</td>
<td>7</td>
<td>31.82</td>
</tr>
<tr>
<td></td>
<td>Graphic Organizer</td>
<td>1</td>
<td>4.55</td>
</tr>
<tr>
<td></td>
<td>New Prompt for Class Discussion</td>
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<td>4.55</td>
</tr>
<tr>
<td></td>
<td>New Groups/Partners</td>
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<td>4.55</td>
</tr>
<tr>
<td></td>
<td><em>Total</em></td>
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<tr>
<td>Adjust Future Instruction</td>
<td>Concept</td>
<td>1</td>
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<tr>
<td></td>
<td><em>Total</em></td>
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<td>4.45</td>
</tr>
<tr>
<td>Grand Total</td>
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<td>22</td>
<td>100.00</td>
</tr>
</tbody>
</table>

During her first interview, one teacher explained why she decided to switch from students working in partners to whole class during the lesson that I observed in her room.

*Bonham:* You mentioned that the students were struggling with the coordinate grid.

*Teacher 1:* Yes, that was in 3.3.
**Bonham:** What was your evidence of that struggle?

**Teacher 1:** Um… when 3.3 opens they are finding lengths on dot paper which was very similar to finding areas so they did OK with that. But then one of the questions in section C in 3.3 goes back to a map that we did in the beginning of the book where there are two coordinates and they have to find the distance between how far it is. So they are looking for the helicopter distance. And that was intended for the students to do in partner work, but for that class, I had to stop and say “Remember when we looked at this map before. And remember when we couldn’t figure out how far the one place was from the other place because we didn’t know how long that line was? Well now if we draw the line what else could we do?” And the answer would be to draw the line, create the right triangle, and use the Pythagorean Theorem.

**Bonham:** So why, with that class, um, did you feel you needed to pull the class back to a whole group discussion? What was, what prompted that from you?

**Teacher 1:** They were working on 3.3, I really saw them moving through section A which was finding the distances on the dot paper, I saw them moving through B and then when they got to C they read the problem and they looked like they could not do it. And they would talk to their partner and they would tell me they still couldn’t do it. So that is where it became…let’s make sure we all understand what is going on.
She was formatively assessing her students as she was circulating through her classroom listening to her students and responding to their questions as they worked in pairs. The evidence showed that many of the students were still struggling with the activity. Based on the high number of students struggling, she modified the mode of instruction and brought the whole class together to work through the activity.

During another observation, a teacher choose to slow down the pace of the lesson. That decision was based not only upon evidence from the formative assessment activity the student were working on, but also based upon the general attitude and readiness of the class.

*Bonham:* About 42 minutes into the class you gave them um, I know a Triangle Makes a Right Triangle When… and there is a place for examples and non-examples. What did you notice of your students’ understanding from this? What did you learn about your students?

*Teacher 1:* I noticed that that day the students were struggling with, I don’t even want to say with math, I think they were just struggling to be in school that day. That was a hard day for them to even be picking up pencils for whatever reason. I noticed that immediately. We were trying to have a basic discussion of an anticipation guide I had them complete when they came in. Um, but when I specifically had them write that down in their notebooks I noticed them um, let me think, I am pretty sure that that was the class that it was hard to get them to see that I can make a right
triangle if the Pythagorean Theorem works. They were still equating it back to the areas of the squares and maybe doing a less efficient strategy then I would anticipate for them. So I saw they were struggling a little bit with confusing that activity with the Pythagorean Theorem.

*Bonham:* And how did that impact instruction for you?

*Teacher 1:* So we had to slow things up a little but on that lesson. There was more practice coming so I wrote more on that notebook page on the board then I originally intended to. So that changed and there was a lot more of repeating instructions. And then being about to get through a formative assessment so that they could then get more specific practice the following day.

This teacher gave her students a formative assessment activity to complete; *I know a Triangle Makes a Right Triangle When.* As they worked on it she circulated around the room and observed what the students were writing down. She saw evidence that many of the students were struggling to fill out examples and non-examples of right triangles, which should have been a tie in to what was covered the previous day, and evidence that others were very slow to get started that day and had not written anything down at all. Based on that evidence, this teacher modified her instruction, slowed the pace of the lesson, and repeated content, directions, and instructions more than once during that particular class period.
A third way that I observed teachers modifying instruction due to the evidence gathered from formative assessment was switching from the teacher doing the explaining to the students doing the explaining.

_Bonham:_ Alright, on the last day of this lesson, you said to them, thumbs up, thumbs down and you were checking with them, um, the table had been…the snakes, 2 years and 25 snakes, 3 years and 125 snakes, and 4 at 625 snakes and filling out the table. And you asked for a thumbs up or thumbs down and said, “I am hearing from 2 and I need to hear from more than that.” That was a was a very quick formative assessment of your class

_Teacher 1:_ (shaking head yes)

_Bonham:_ What did you gain about your classes understanding of your class at that moment?

_Teacher 1:_ Well, I was doing that right there because those numbers were coming right off of the graph. And I knew where we were about to go which was to use that graph to work backwards and find the starting point, so I wanted to make sure that I was aware of that the students knew where those numbers so that they knew where we were going to be going to find these numbers. So if we are looking at numbers and we are trying to use them to find the starting point and we don’t understand where those numbers came from it is going to be very confusing. So I wanted to make sure that even though when I said give me a thumbs up and I first heard
from 2, I needed more students to let me know if they knew or didn’t know where those numbers came from. I needed us to be on the same page as a whole group before moving on.

_Bonham:_ Shortly after that you asked the kids what the growth factor was and you were kind of polling the class. Not a lot really responded to you. So you immediately said, “If you know the growth factor stand up.” About 5 kids stood up. Do you remember what you did next?

_Teacher 1:_ Yes, I had them go find someone who was sitting and help them out and talk to them about what the growth factor was and why.

_Bonham:_ Do you think that activity impacted student understanding.

_Teacher 1:_ I do, because it put the students talking to the students instead of me saying why the growth factor was 5. Because I know the students, if they are listening to another student explain it they are going to be more likely to listen and receive the information.

This teacher had already taught the concept and when she performed a quick data collection for formative assessment, thumbs up or thumbs down, the data she got back showed that many of the students were still confused. To adjust her teaching as a result of these data, instead of re-teaching the concept herself, she had the student who felt confident with the concept pair up with a student who was still confused. The student became the teacher. After a few minutes, all students were on the same page and the teacher was able to continue the lesson. This was an example of a Change in the Mode of Instruction. This part of the lesson had been
planned, and enacted, as the teacher providing the instruction to the students.

Based on the data the teacher gathered from the formative assessment, a switch was made to student teaching students.

The final type of instructional change that fell into the category of Change in Instructional Mode was teachers working with individual students instead of whole class instruction or students working with a partner or small group. This change in instructional mode occurred when the evidence showed that just a few students were struggling with the concept or skill.

_Bonham:_ Ok, now with the Schoology. You said that they had completed.

_Teacher 1:_ Yes

_Bonham:_ Is completion enough?

_Teacher 1:_ The way the lesson was structured, there were three sets with 5 questions each. They would work through the problems, submit their answers and through Schoology, Schoology would grade it for them and let them know if they were right or wrong. They had to get a certain number correct in order to move on to the next set of questions. So if they were struggling…and they could submit it up to 3 times…so if they were submitting it the 3rd time and they still weren’t getting at least 3 correct, I would sit down with them and make sure that they knew how to do it.

This teacher was able to see the student responses on Schoology as they finished them. When a student didn’t get the problem right the first or second time, they
were directed to different videos and tutorials that the teacher had posted in Schoology. If on the third attempt the students were still struggling with the concept, the student worked one on one with the teacher instead of continuing to work with their partner.

While changing the mode of the instruction was the most common category for instructional change, adding some new problems to the lesson was a specific change in instruction that occurred more often than any other change. Adding new problems to the lesson accounted for 31.8 percent of the instructional changes observed. Adding new problems came either in the form of a new Problem of the Day to start of a class period, when a lesson spanned multiple days, or new practice problems embedded in the lesson. One teacher explained that based on the evidence from the formative assessment on Schoology, which she had reviewed after the first day of the lesson and before the second, showed that some students were still a little confused, but she knew that the curriculum would spiral back and address the concept again. So instead of slowing down the pace and re-teaching, she gave them a quick opportunity to see it again by changing her Problem of the Day.

Bonham: So the fact that you still had some that were a little confused, did that impact this particular lesson?

Teacher 3 Yes. So especially, like where it…was like this part with the snake, the going back part…

Bonham: And that was the Schoology part of this lesson on day 3.
Teacher 3: Yes, so it was definitely going to come up again so I changed my PoD to make sure it incorporated the concept to continue to give kids an opportunity to see it.

This teacher knew from the formative assessment the students had completed on Schoology that some students need a little more practice. To make sure they started the next class period with a little review she changed her Problem of the Day to one that covered the area of weakness the students were having.

While the evidence from the formative assessment often showed that the students were ready to move on, there were instances when the teacher was aware that the evidence showed that students still did not understand, but the teacher choose to move on at that point. However, she planned to make a change to a future lesson, not only this year, but also next year.

Teacher 1: So, the next section in the book is dealing with rational and irrational numbers and repeating decimals, knowing that I have a pretty good understanding of where the students are when there is the “not pretty math numbers.” They are not confident in them. So I know I am going to have to make sure that we do that next section at a decent pace and get from understanding of those numbers. And then for next year, I actually wonder if I can bring any of those lessons earlier in the book. So that we do Pythagorean Theorem and we got some of those numbers it won’t be so difficult for them and they aren’t so discouraged by them.
Knowing the curriculum and knowing that mastery of rational and irrational numbers was not required at this point, the teacher chose to move on but made intentional plans to address the misconceptions in future lessons. She also planned to modify lessons for next years’ students so that those misconceptions might not occur. Thus, this teacher’s knowledge of the trajectory of ideas in the curriculum helped the teacher decide whether or not a change in instruction was needed.

In this chapter, I outlined the types of instructional changes that teachers made based on the evidence from formative assessments. The changes fell into three categories; Adding Something New to the lesson, Adjusting Future Lessons, and Change in Instructional Mode. When teachers added something new to their lessons it came in the form of new problems, a graphic organizer, a new prompt for class discussions or new partners. There were four different ways that they choose to change the mode of instruction; switching from individual or pairs to whole class, slowing up the pace of instruction, having students teach students, or switching from whole class or pairs to working with individual students. The final change was adjusting future instruction. In the next chapter, I will look at how middle school math teachers use technology for the purpose of formative assessment.
Chapter 6

FORMATIVE ASSESSMENT AND TECHNOLOGY

Key Question Three: How do middle school mathematics teachers use technology when engaging in formative assessment during a mathematics lesson?

My original interest going into this study was to see how teachers incorporated formative assessment into their mathematics lessons. I conjectured that technology would be one way in which the teachers gathered information about students’ understanding for formative assessment. I held this conjecture because three out of the five teachers involved in this study had access to classroom sets of either iPads or Chromebooks. Additionally, I expected the teachers to use technology for formative assessment because three of those teachers had also received professional development on technology through either the district or the state. In this study I was not only investigating if and how teachers were using formative assessment but also what, if anything, teachers took away from professional development that had been delivered using technology for formative assessment.

As one example of using technology for formative assessment, clickers were used as a means of formative assessment. This technology also gave teachers the ability to give immediate feedback to the students. The use of the clicker could also increase engagement in the formative assessment and class instruction due to the fact that students
were able to stay anonymous. I conjectured that I would see teachers using programs like Socrative (https://www.socrative.com/), an online student response system that teachers can use to poll students’ responses as a means of formative assessment. I made this assumption because Socrative was one of the different web based sites that teachers had used during previous professional developments. Formative assessment through the use of technology occurred about thirteen percent of the time (See Table 16). However, I did not observe a clicker system being used in any of the lessons that I saw.

Table 16 *Forms of Formative Assessments, both Planned and Unplanned, Observed in Classrooms with Access to Technology*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Lesson</th>
<th>Written</th>
<th>Oral</th>
<th>Written &amp; oral</th>
<th>Kinesthetic</th>
<th>Technology (written or multiple choice questions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher 1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Teacher 1</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Teacher 1</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Teacher 3</td>
<td>1</td>
<td>8</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Teacher 3</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Teacher 3</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Teacher 4</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Teacher 4</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Teacher 4</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Totals</td>
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<td>12</td>
<td>6</td>
<td>3</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Percent</td>
<td>51.67%</td>
<td>20.00%</td>
<td>10.00%</td>
<td>5.00%</td>
<td>13.33%</td>
<td></td>
</tr>
</tbody>
</table>

Even though all three of these teachers had received professional development on different web-based technologies that could be used for formative assessment, only 13.33 percent of the time did the teacher use technology when formatively assessing students.
Instead the most common method for checking for student understanding was written (51.67 percent). Using technology can give teachers instant feedback while written formative assessment requires teachers to take the time to read over those assessments. In this chapter, I unpack the finding for this key question and provide the evidence.

**Findings**

*Key Question Three: How do middle school mathematics teachers use technology when engaging in formative assessment during a mathematics lesson?*

While I never observed technology being used solely for the purpose of formative assessment, I did observe eight occurrences where a full lesson or class period (if the lesson lasted longer than one class period) was delivered through technology (Schoology) and it included formative assessments. The teachers who used technology for formative assessment also used technology throughout the lesson in other ways rather than bringing in technology only for formative assessment. Teacher 3 and Teacher 4 put their entire second lesson onto the Learning Management System (LMS), Schoology, for the students to engage in the content. For the lesson designed to answer the following lesson essential question: “How can you determine whether a triangle is a right triangle if you know only the lengths of its sides,” students watched videos, read about the Pythagorean Theorem, and used that information to complete the activities from the curriculum that was put onto Schoology. Throughout the two day lesson they included three different “check-ins” as a formative assessment, two during Day 1 and one during Day 2. The next figure, Figure 3, shows the Schoology lesson that students worked on in both Teacher 3 and Teacher 4’s classes that spanned two class periods. Students had their own devices to use but were
seated in pairs and allowed to work through the activity together. They begin by clicking on the first icon under day 1. Once they completed that activity the first activity, #MCM, they moved on to the next icon. The lesson is self-paced. Throughout both days there were three formative assessments embedded in the Schoology lesson; Check-In after B, Check-In after C3 and Goal Sheet.

Figure 5. Schoology lesson for Teacher 3 and Teacher 4: Looking for Pythagoras
From their own computers, as teachers, they were able to monitor student responses and target which students had misconceptions. Both teachers also put one part of the third lesson “What do the y-intercept and growth factor represent in an exponential function and how can you use them to write the equation?” (Day 3 out of 3) on Schoology in a similar format. (See Figure 4)

![Schoology lesson for Teacher 3 and Teacher 4: Growing, Growing, Growing](image)

Figure 6. Schoology lesson for Teacher 3 and Teacher 4: Growing, Growing, Growing

Teacher 1 did not have an entire lesson on Schoology but she did have the students engage in the content on one day of two different multi-day lessons on
During the second day of a two day lesson students worked through three different activities on Schoology. Formative assessment was built into the lesson; as the students submitted each assignment which contained five different problems, they were able to receive immediate feedback. Based on that feedback students either moved on to the next assignment or watched a few short videos that Teacher 1 had created and posted on Schoology to help correct misconceptions. (See Figures 5 - 7)

A common mistake students made when trying to use the Pythagorean Theorem to find the hypotenuse is that they forgot the final step of taking the square root for the sum of the two sides. In this example, Teacher 1 set the feedback choosing 400 km as the correct answer, by asking students if they had remembered to take the square root. If that
comment helped the student remember all the steps and they were able to move on, they could do so. But if a student was not sure what the comment meant or was still confused by the Pythagorean Theorem all together, they could watch a video with some examples to help them.

*Figure 8. Schoology lesson for Teacher 1: Looking for Pythagoras question 2*
In this question, students were not provided a written clue as to why they might have gotten the problem wrong, but they were provided a video link that they could view to help them remember how to find the hypotenuse of a right triangle given the two legs.

![Question 4](image)

**Figure 9.** Schoology lesson for Teacher 1: Looking for Pythagoras question 4

The response to a wrong answer for this question was to provide the process for solving for the hypotenuse.

Feedback was not only given to students if they got the question wrong. If students got the question correct, they received positive feedback as seen in the next figure.
Figure 10. Schoology lesson for Teacher 1: Looking for Pythagoras questions 3 to 5
The positive feedback was not the same comment each time. The students received a variety of positive comments from Teacher 1. By using technology, the students were able to receive immediate feedback and they were able to work at their own pace.

Each of the teachers who had technology available to them embedded either part or all of a lesson into Schoology, which allowed the students to work at their own pace. In each of those lessons, the teachers included check-ins or formative assessments. From their own computer the teacher was able to monitor student responses in real time and make decisions about student understanding. While formative assessment was not the purpose for using technology for those lessons, formative assessment was embedded into lessons that were delivered through technology. These formative assessments were examples of purposefully planned for and used formative assessments. One teacher, Teacher 1, used the data that she gained from one of her formative assessments that was embedded into technology to determine how she was going to start the next class. She planned a Problem of the Day based on some of the misconceptions she saw in their answers.

I had planned to ask teachers how they decided when to use technology for formative assessment, but based on how I observed technology being used in the classroom I revised my question. Instead I asked them, “How do you decide when to use technology in your lessons?” I had hoped that formative assessment would be part of their responses, such as;

- I like to use it to help me see what students currently understand and to be able to differentiate based on students’ responses.
- I used it to get a quick snapshot of student understanding.
- I use it when I want the students to be able to work at their own pace but still receive feedback. With technology they can then go onto new problems and review the concept and go back and try again.

While the teachers did not mention that formative assessment had any part in their decision making for when to use technology, their responses did include three different criteria for deciding when to use technology. Those three criteria were: a point in the lesson based on time, a point in the lesson based on delivery, and a point in the lesson for student writing.

For Teacher 3, placement in the lesson played a part in when she decided to use technology. She stated: “I would rather use it towards the end because sometimes I feel like kids get lost with the computer. And I would rather have more time for discussion earlier.” I observed Teacher 3 teach two consecutive lessons that spanned seven days, five for the first lesson and two for the second lesson. Technology was used on day six and seven as seen in Figure 9 below. In the third lesson that I observed Teacher 3 teach, technology was used on day three, the final day of the lesson.
For Teacher 1, it wasn’t about the point in the lesson based on time, but instead the point in the lesson based on fit with delivery. When planning she looked at the entire investigation to determine the mode of delivery for instruction for each of the problems.
I felt when I looked over the lesson for all three days, 2.1 was some whole group and some partner work so it was kind of teacher centered. The first part of 2.3 was whole group and teacher centered. So I wanted to get something more student centered and students driving what they needed to do. And when I was looking over the questions for 2.2; and like I said earlier, I felt like there wasn’t really a whole bunch added on so we could go ahead and they could do at their own pace with technology.

She found the point in the lesson where placing the problem on Schoology was appropriate for her students and purposefully planned the use of technology in her classroom.

While Teacher 1 chose to use technology based on how it fit with delivery and Teacher 3 choose to input technology into a lesson based on placement in the lesson, Teacher 4 had a different criterion. It was a place in the lesson where Teacher 4 wanted a written response from the students. Teacher 4 chose places where he/she felt the students would enjoy using technology more than class discussion or paper and pencil.
Figure 12. Schoology lesson for Teacher 4: Written assignment.

Teacher 4 even asked the class why they liked doing the lesson on Schoology. Teacher 4 told me about students’ responses during our second interview.

_Bonham_: How do you decide when to use technology in your lessons?

_Teacher 4_: I thought I would get a better response from the students if they could type their questions instead of writing them. I decided that I would have a conversation with students themselves about technology being used in that format. So basically what it was, we put on part of 3.1.
We put up the table and asked the students based on the table what type of questions do you think you could ask? And I was able to see are they using math vocabulary and incorporating what they had learned in the last lesson in their questions. It was a way to quickly see what they remembered about starting point and growth factor but also launch into the next lesson. Some kids asked, what was the growth factor? Some asked, what was the starting point? Some asked, what was the starting point? Some asked, was it linear or exponential? And it was interesting to see that come up. And then I asked the kids who liked doing it this way. Part one was they had to write a question and part two was that they had to… and I set it so that they had to write their own question before they could see other students questions.

_Bonham:_ Right

_Teacher 4:_ Part two was that they had to answer a classmate’s question. Or if they couldn’t answer a question they had to ask a second question that was better or more specific or mathy that what you wrote the first time. And they seemed to really kind of enjoy it. I asked them what were the benefits of doing it this way.

_Bonham:_ And what were they?

_Teacher 4:_ Kids were like, well, you know… one kid said that gave them plenty of think time. They said that sometime when I call on them in front of the class “sometimes I get nervous and feel like I have to have an
answer right away” Um, even if I provide think time for them they feel
like they are under pressure because the class is waiting on them to
respond. Whereas here they could take time to think about what they
wanted to say or what they wanted to write before typing it. Some said
that they don’t like speaking so it was nice that I could just type
something. I think I got more responses with them typing.

Teacher 4 had chosen to use technology instead of paper and pencil to complete part of
the third lesson that I observed. Technology was used because Teacher 4 thought the
students would enjoy doing the work in Schoology more than writing in their notebooks.
It appeared that the students agreed with him.

I went into these observations expecting to see technology as a means to
formatively assess students during a lesson. Instead I saw teachers using technology as a
means to deliver the lesson. However, all three of the teachers who used the technology
to deliver all or part of a lesson, embedded formative assessment into it. They included
checkpoints along the way in order to check for student understanding during the
Schoology lesson. Some include immediate feedback to students so that students could
feel confident moving forward in the lesson or accessing videos to help correct
misunderstandings. Other times students did not receive feedback via the technology but
instead after viewing the check-in, the teacher provided verbal feedback to individual
students as needed. While I was not able to collect data or answer one of my original key
questions, how do teachers decide when to use technology for formative assessment,
because teachers did not pull in technology only for formative assessment. They did
embed entire lessons or the entire day in technology that included opportunities for formative assessment; what I did learn will help inform future professional development in the district and will be discussed in chapter seven.
Chapter 7

DISCUSSION & IMPLICATIONS FOR PRACTICE

The purpose of this study was to investigate how middle school math teachers have implemented formative assessment in their mathematics classrooms, including whether and how they used technology to do so. Teachers in the study have received some level of professional development in both Learning-Focused Strategies and in integrating technology into their classroom. Through three Key Questions, my study suggests that teachers do implement instructional activities that can be (and often are) used for formative assessment, but the teachers also regularly missed opportunities to use their instructional activities for formative assessment. The study also suggests that although formative assessment was embedded into lessons that used technology, technology was not solely used for the purpose of formative assessment.

This study has served as a formative assessment for myself as a building instructional math coach as well as one of the district’s Learning-Focused trainers. I must use the data gathered from this study to make decisions about future professional development as well as coaching opportunities that I can provide to these teachers. Given these findings, these teachers would benefit from the opportunity to learn not only which activities can be used as formative assessments, but also how to collect and use the data collected from formative assessment activities. They also would benefit from the
opportunity to experience different ways technology can be used to formatively assess students. In this chapter, I will reflect upon how future professional development and the in-the-moment coaching can be designed based on data from this study as a formative assessment of my work.

**Contributions**

Based on this study, formative assessment activities in these middle school mathematics lessons fell into one of three categories; Purposefully Planned and Used, Not Planned for but Used, and Missed Opportunities. The first two categories are formative assessments because the teachers used data from the activities to determine student understanding and make decisions about instruction. However, the Missed Opportunities were not formative assessments. There were instances when I was observing the lessons that teachers had students engage in an activity that I had assumed was for the purpose of formative assessment, and based on the Acquisition Lesson Plan it was listed as formative assessment, but data were never collected. In order to be formative assessment, as defined in this study, data on student understanding needed to be collected and used. Teachers missed opportunities to gain insight to student understanding that would allow them to make in the moment decisions about instruction if they did not collect and analyze data. Missing those opportunities to correct misunderstandings in the moment, if there are any, could cause deeper misunderstanding of the concept among students as the lesson moves forward.

When teachers did include formative assessments in their Acquisition Lesson Plans, it was rare that the plans also included the exact interventions they would use if the
data showed that some or all of the students held some misunderstanding. Their lesson plans often omitted detailed plans, as their plans usually did not include anticipated student responses to the formative assessment, nor ideas for how to adjust instruction depending upon how students responded. The Acquisition Lesson Plans also rarely included how a teacher would differentiate the lesson if the data showed that students had different levels of understanding. Because of the teachers’ lack of planning of both anticipated student thinking and possible teacher responses, the impact on instruction was not as immediate as it could have been. While teachers did frequently add new problems to the instruction or modify the mode of instruction, those changes often came the next day in a multi-day lesson as opposed to in the exact moment that the formative assessment activity occurred. Again, waiting before addressing the misconceptions can cause those misconceptions to be more ingrained in the students understanding of the concept. However, if the interventions were included in the plans as possible instructional responses to anticipated students’ thinking, teachers may have been able to put changes to instruction into place in the moment and avoided students leaving the math class that day with the misunderstanding.

Lastly, this study showed that teachers with technology available to them did use their technology as a means to deliver content. Those lessons did include formative assessments, but technology was not used solely for the purpose of formative assessment. There are many ways that technology can be used to quickly collect data on student thinking and that data can either be used by the teacher or the whole class immediately. It can be used to show the data and allow students the opportunity to discuss
misconceptions as well as clarify content and skills with their peers, allowing them to take more ownership in the learning process. Teachers have been exposed to many of the ways that technology can be used for formative assessment; however it has not been the latest professional development on technology. Over the past two years the district has focused on professional development of the learning based management system: Schoology. It was the use of Schoology that I observed the teachers incorporating into their lessons. These teachers appear to need support integrating alternative uses of technology for formative assessment into their implementation of lessons with Schoology.

This study also became a formative assessment for me. As an instructional coach, I have worked with all of these teachers. I have provided professional development on the implementation of the new curriculum, CMP3, with other instructional coaches in the district. I also attended and then provided training in Learning-Focused Strategies which included how to write Acquisition Lesson Plans. During this study I realized that the teachers were all working hard to deliver the content in ways that will keep the students engaged and promote high levels of understanding. They were also trying to write their plans in the framework they have been provided by Learning-Focused Strategies, as well as to include technology based on the professional development they have received. One thing that I learned during this study is that although we may believe that we have provided professional development that included formative assessment, maybe we were not explicit enough about how to use the data from the activities. Although we talked with teachers about differentiation and planning to differentiate, maybe as coaches we
were not modeling these instructional practices enough through our professional development.

**Implications for Future Inquiry**

This study was purposefully designed to focus on one grade level of middle school teachers. It was important to observe the same lessons being taught by all the participants; this study included only eighth grade teachers. Often when the math teachers in this district receive professional development around content, it is done in grade level groups. All of these eight grade teachers received the same professional development. Future inquiry could expand the investigation of teachers’ use of formative assessment to other grades. If this study had also included teachers from both sixth and seventh grade, would the findings be the same in those classrooms?

This study was also purposefully set in this particular district. What conditions within this district led to these particular results? This district is very committed to providing ongoing professional development as well as having building level coaches to support the classroom teachers. If this study had been done in a different district that did not provide the same level of support would I have observed even more Missed Opportunities? Why or why not? This particular district has plans to transition to a district where each student has access to a device in every class beginning in 2018. If this study were to occur after that, would technology be used more often or even differently for formative assessment than what was observed once students have their own personal devices to use daily?
While this study did not focus on how the various categories of formative assessments related to each other and interacted, it would make for a definite extension of the study. An interesting finding revealed by this study was that teachers saw formative assessment falling into two categories, formal (written) verses informal (oral) formative assessment. Teachers described how they determined the form of formative assessment as purposeful or intuitive. An extension of this study could be to see if there is a connection between when a teacher just intuitively knows which form of formative assessment to use and informal or oral formative assessment is the assessment of choice. Are they calling it ‘intuitive’ because in the moment the teacher chose to interject a question in order to determine student understanding? A possible extension of this study would be to determine if teachers’ intuition is truly aiding in accurate selection of proper assessment format. Another interesting relationship to look at would be the form of the formative assessment and the type of evidence collected. Formative assessment occurred in the form of written or oral and written fifty-one out of eighty times. Determining specific understanding was the type of data collected thirty of the eighty times. Do teachers believe that in order to determine specific understanding that they should have some type of written or formal assessment (as they would characterize it)?

Although this study was informative and has implications for both teachers’ instruction and future professional development, and coaching, it did not touch on teachers’ beliefs. To further understand why teachers made these decisions about formative assessment, future inquiry could address teachers’ beliefs. What do teachers believe that formative assessment is supposed to do for them? Do they believe they are
implementing formative assessment effectively as part of their instruction? What support do they want or need from an instructional coach? If teachers believe they are implementing formative assessment effectively, how does an instructional coach provide additional support to help teachers continue to grow even if they don’t see the need for it?

**Implications for Mathematics Teaching**

This study has implications for teaching in the Polk School District. First, teachers are using formative assessment activities in their instruction but they need professional development on how to collect and use data from those formative assessment activities. Second, teachers need help on how to pre-plan for possible interventions based on possible student responses during formative assessments. And third, teachers need to be able to experience different ways technology can be used to formatively assess students. This section will focus on the support and guidance for middle school math teachers in the district.

**Support and guidance for teachers with collecting and using data.** Polk School District provides multiple opportunities for teachers to participate in and receive professional development throughout the year. All of the middle school math teachers have received training on Learning-Focused Strategies and how to write Acquisition Lesson Plans. Part of that training includes purposefully planning formative assessments and chunking instruction. The teachers also have had professional development over the past two years on the CMP3 curriculum that was piloted the first year and then fully implemented the second year. During those professional development sessions, formative assessment was discussed and at times specific activities were designated as activities
that all the teachers would use. As seen during this study, teachers were doing a good job of implementing those activities in their instruction, as evidenced by the fact that I observed 92 activities that could have been used for formative assessments over the course of fifteen lessons. However, there are often missed opportunities where implement occurs, but teachers fail to collect or use the data. Furthermore, teachers need to be purposeful in the types of evidence they are attempting to collect. Is “get it” or “don’t get it” really useful information or should they be gathering data showing specific understanding? Support and guidance for teachers can be delivered through district and building level professional development, as well as in the moment coaching by the building or district math coach. It can also occur through a video study during grade level professional learning communities (PLCs); which meet one day a week during planning period, or on professional development days.

**Support and guidance for teachers through in the moment coaching.** As a building instructional coach, I have the opportunity to be in the math classrooms. Based on this study, building coaches need to include formative assessment as a focus when working with our teachers when we are in their classrooms. When the coach sees the formative activity take place, but the teacher misses the opportunity to collect or use the data, the coach has a chance for some “in the moment” coaching. In the moment, the coach can discreetly interject a question or a comment that will allow for the teacher and the class to address the misconception. For example, in one of the lessons I observed, the teacher asked the students to put their thumbs up if they understood the concept and a thumbs down if they did not understand. Very few students participated and a few of the ones
who did had their thumbs down. The teacher moved onto the next problem. At no point during that class period or during the lesson, which spanned multiple days, did the teacher adjust instruction to address any misconceptions or confusion the student currently had. The data from the activity suggest that many of the students were not comfortable at that point with the concept. An instructional coach could interject a question or comment such as:

- I wonder if (insert a student name) could explain how we arrived at the answer to that problem.

- Excuse me (insert teacher’s name), I think I missed something. Could you please tell me again how you

- (Collaborative Pairs) Have one from each pair explain to the other how the problem was worked. Then call on a few students to share what their partner just explained to them.

After interjecting one of the statements above, the teacher or the coach could re-poll the class to check for understanding.

An important part of “in the moment” coaching is the follow up conversation the coach has with the teacher after the lesson. The teacher may not have been aware of how to deal with the data they received from their formative assessment so they kept to their original lesson plan. Or the teacher may have included the thumbs up or thumbs down activity just because they have seen it used in a professional development and they are not comfortable making in the moment instructional decisions based on the activity.
There are many reasons why teachers may include a formative assessment activity but not collect and/or use the data. Through coaching the teacher can begin to become more aware of those missed opportunities and ways to avoid having them. A follow-up conversation needs to occur in order to help the teacher understand why the formative assessment could have become a missed opportunity. As a team, the teachers and coach, could also brainstorm other ways the teacher might have handled the moment differently the next time they receive the same type of data from a formative assessment activity. Through the “in the moment” coaching and conversations with teachers, the number of missed opportunities could decrease.

**Support and guidance for teachers through video study.** Teachers along with the building coach can participate in a lesson video study. Grade level teachers meet frequently as either building level PLC’s or during building or district level professional development. Part of this time could be used for a video study. Since this would be done in grade level teams, all teachers would be teaching the same investigations around the same time and would be familiar with the content and lesson in the video clip. A protocol for this video study can be found in Appendix K. After videotaping a lesson, or part of a lesson (if the lesson spans multiple days), the teacher or teacher and coach would select a portion of the video to focus on during the PLC. During the PLC meeting the teacher whose lesson is being viewed would facilitate the conversation but not participate until the end. During the conversation, the group would discuss;

- What formative assessments occurred?
- What type of evidence was gathered or was the teacher attempting to gather?
• What instructional changes were made?
• What were the outcomes from those changes?
• And what missed opportunities occurred?
• How could those missed opportunities become formative assessments?

When addressing the last bullet, how could those missed opportunities become formative assessments, the teacher would not only facilitate but also participate in the brainstorming of ideas.

This video study can benefit all members of the PLC. By watching the video through the lens of formative assessment and missed opportunities it can help them to become more aware of what missed opportunities are. Brainstorming how to turn missed opportunities into formative assessments will give them a bank of ideas that can be used in the future when they are planning future lessons. This discussion should help turn missed opportunities into formative assessments, whether they were purposefully planned or added into a lesson in the moment.

**Support and guidance for teachers with planning for possible interventions.**

As stated earlier, teachers did a good job of including activities that could be used for formative assessment throughout their lessons. Often they collected data and made instructional decisions based on that data; very rarely did they include possible interventions based on students’ responses in their Acquisition Lesson Plans. This situation is one of those formative assessments for myself as a coach and as a Learning-Focused Trainer. Many of our professional developments have highlighted understanding student thinking through formative assessments and possible activities that can be done as
those assessments. Our professional development has included differentiation. We were never intentional or explicit on how to plan for interventions based on hypothesized student responses. However, if teachers include possible interventions in their plans before teaching the lesson, it allows for the interventions to be interjected into the lesson more immediately as opposed to if they have to plan the intervention based on the data after the class period has concluded and implement it the next day. It also helps to avoid an “on the fly” intervention that might not be as purposeful or powerful as one that is pre-planned.

As coaches, we need to do the same action in our planning for professional development or facilitation of professional learning communities that include formative assessment. We need to pose questions and allow for discussion that causes teachers to think about the possible students’ responses and how they may address those responses before they teach the lesson. As coaches, we can also model that in our professional development. As we plan for professional development we can anticipate teachers’ needs and plan for differentiation or interventions, while making them aware that we did so. Modeling and being explicit about the pre-planning, the type of evidence we hope to collect (recalling prior knowledge or specific understanding), and intervention based on student data is one way that the building and district coaches can address the district math teachers’ need for understanding how to plan for possible interventions when planning for the formative assessment.

Pre-planning possible interventions for every formative assessment could become a daunting task for a teacher. The advantage of building and district grade level PLCs is
that we can divide and conquer. We also have the advantage of a common Learning Management System for the district. Based on the need seen from this study we will be starting a depository in Schoology. This depository will include formative assessments for the various grade level units. Each formative assessment will have the activity “look fors” and possible interventions due to those “look fors.” As teachers use those activities they can leave comments for the other grade level teachers as to what students’ responses they received, as well as how students responded to the interventions.

**Support and guidance for teachers with using technology for formative assessment.** The middle school math teachers in the district, as a collective group, need opportunities to experience different ways technology can be used to formatively assess students. They also need to see ways that those different formative assessments, via technology, can be used in conjunction with Schoology. Teachers can receive guidance and support through professional development and by the creation of a depository of resources in Schoology. First teachers will need time to learn about and play around with different websites and ways that technology can be used for formative assessment. While this may be a review for some, it was obvious during this study that even if teachers had at one time learned about it, they are not implementing it in their classrooms. Building and district level math coaches should elicit the aid of the technology coaches in the district to create professional development opportunities for the teachers. Teachers also need to learn through the professional development how the formative assessment opportunities via the internet can be integrated into lessons that they are placing on Schoology.
Over the course of professional development teachers and coaches should begin to populate and maintain a resource folder in Schoology. The depository on Schoology should include items such as:

- Links to useful website URLs that can be used for formative assessments.
- Examples of how technology can be used for formative assessments.
- Discussion boards for teachers to talk about their experiences in using technology for formative assessment.
- Copies of the professional development lesson plan or a video of the PD so that teachers can go back and review it if needed. It will also be available for teachers who were unable to participate in the professional development.

This resource would be available for teachers who are able to attend the professional development as well as those who are not. It would also be preserved and available as a resource for new hires in future years.

**The Depository**

A depository, on Schoology can be built to house formative assessment activities and links to instructional technology that can be used to formatively assess students understanding. It would be organized first by grade levels and then by units. Teachers and instructional coaches can upload not only any formative assessment activity they use into the folder, but also a cover sheet (see Appendix K). That cover sheet (see Appendix L) will include information about where in the lesson the formative assessment could be
used. It would also include “look fors” as well as possible interventions if students have misconceptions.

**Conclusion**

It is important for teachers to know what students understand or what misconceptions they may have if they are going to plan and implement lessons that will allow all students to learn and grow academically. Waiting to see if students fully understand the concepts at the end of the lesson or at times even the end of the unit is too late for some. For that reason it is important for teachers to chunk their instruction and use formative assessments throughout the lesson to check in with student and collect data on the level of understanding for each of them. At times those formative assessments are planned for before the lesson and at other times they happen in the moment without being included in the Acquisition Lesson Plan. Either way, through formative assessment, teachers have the opportunity to collect data and make decisions about current and future instruction. Using technology as a means to deliver formative assessments can allow teachers to gain and analyze the data quicker. It also allows the student data to be shared with the class while keeping each student anonymous. Professional development, video studies, and the creation of resources that can be stored in Schoology can help teachers learn how to more effectively implement formative assessment in their mathematics classrooms.
REFERENCES


Quinn, R. E. (2017). Clickers in the Classroom: Study into the use of interactive quizzes In a practical environment. *Journal of Academic Development and Education, (7).*


# Appendix A

## ALP Template

<table>
<thead>
<tr>
<th>Learning Goals for this lesson:</th>
<th>Standards:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students Will Know:</td>
<td>Students Will Be Able To:</td>
</tr>
<tr>
<td>Lesson Essential Question:</td>
<td></td>
</tr>
</tbody>
</table>

### Activating Strategy

**Key Vocabulary to preview and vocabulary strategy**

### Lesson Instruction

**Learning Activity 1**

**Assessment Prompt for LA 1**

**Learning Activity 2**

**Assessment Prompt for LA 2**

**Learning Activity 3**

**Assessment Prompt for LA 3**

**Summarizing Strategy**

---

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Appendix B

Observation Walkthrough Tool

<table>
<thead>
<tr>
<th>Key Principle 2 - Teaching Practices: Check for Understanding</th>
</tr>
</thead>
</table>
| D. Teacher deliberately checks for understanding throughout the lesson and adapts the lesson according to student understanding (written and verbal). | \_
| \_
| \_
| \_
| \_
| \_

<table>
<thead>
<tr>
<th>Key Principle 3 - Student Practices: Check for Understanding</th>
</tr>
</thead>
</table>
| D. Students explain and justify their thinking at multiple times throughout the lesson in a variety of ways (written and verbal). | \_
| \_
| \_
| \_
| \_

<table>
<thead>
<tr>
<th>D. Evidence:</th>
</tr>
</thead>
</table>
| \_

(2,000 Character Limit)

<table>
<thead>
<tr>
<th>5. Additional Observations/Comments/Feedback:</th>
</tr>
</thead>
</table>
| \_

(2,000 Character Limit)

Submit Form  Save as Draft  Cancel
### Appendix C

#### Categories for Formative Assessment

<table>
<thead>
<tr>
<th>Type</th>
<th>Definition</th>
<th>Examples</th>
</tr>
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<tbody>
<tr>
<td>Written</td>
<td>Students are asked to show what they know by writing it down.</td>
<td>Ticket out the Door</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 – 2 – 1</td>
</tr>
<tr>
<td>Oral</td>
<td>Students are asked to demonstrate what they know through oral response</td>
<td>Think – Pair – Share</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Collaborative Pairs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Responding to a question posed by the teacher.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Responding to a question posed by another student.</td>
</tr>
<tr>
<td>Kinesthetic</td>
<td>Students are asked to demonstrate what they know through physical movement.</td>
<td>Stand up if your answer is…</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 Corners</td>
</tr>
<tr>
<td>Technology</td>
<td>Students are asked to demonstrate what they know by using technology.</td>
<td>Twitter</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Schoology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Poll Anywhere</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kahoot</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Socrative</td>
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## Observation Notes Sheet

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
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<th>Week 6</th>
<th>Week 7</th>
<th>Week 8</th>
<th>Week 9</th>
<th>Week 10</th>
<th>Week 11</th>
<th>Week 12</th>
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</thead>
<tbody>
<tr>
<td><strong>Date:</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Teacher:</strong></td>
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<td></td>
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<td></td>
<td></td>
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</table>

### Observation Details

<table>
<thead>
<tr>
<th>Date</th>
<th>Lesson</th>
<th>Teacher</th>
<th>Formative Assessment Time in Class</th>
<th>0-15 minutes</th>
<th>16-30 minutes</th>
<th>31-45 minutes</th>
<th>46-60 minutes</th>
<th>61-75 minutes</th>
<th>76-90 minutes</th>
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</thead>
<tbody>
<tr>
<td>Note/Received</td>
<td>Feedback</td>
<td>Feed back</td>
<td>Assessed Formative Assessment</td>
<td>Type of Feedback</td>
<td>Type of Feedback</td>
<td>Type of Feedback</td>
<td>Type of Feedback</td>
<td>Type of Feedback</td>
<td>Type of Feedback</td>
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<tr>
<td>Note/Received</td>
<td>Feedback</td>
<td>Feed back</td>
<td>Assessed Formative Assessment</td>
<td>Type of Feedback</td>
<td>Type of Feedback</td>
<td>Type of Feedback</td>
<td>Type of Feedback</td>
<td>Type of Feedback</td>
<td>Type of Feedback</td>
</tr>
</tbody>
</table>

### Observation Notes

- **Teacher:**
- **Formative Assessment Time in Class:**
- **0-15 minutes**
- **16-30 minutes**
- **31-45 minutes**
- **46-60 minutes**
- **61-75 minutes**
- **76-90 minutes**
- **Feedback:**
- **Assessed Formative Assessment:**
- **Type of Feedback:**
Appendix E

Correlation Between Observation Note Sheet and Key Questions

<table>
<thead>
<tr>
<th>Formative Assessment Description</th>
<th>Type of Formative Assessment</th>
<th>Type of Feedback</th>
<th>Feedback Given by</th>
<th>Feedback Received</th>
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<tbody>
<tr>
<td>Written (Type &amp; Pencil)</td>
<td>Grade</td>
<td>Teacher</td>
<td>During Class Period</td>
<td></td>
</tr>
<tr>
<td>Oral</td>
<td>Written Comment</td>
<td>Student(s)</td>
<td>Next Day</td>
<td></td>
</tr>
<tr>
<td>Kinaesthetic</td>
<td>Grade &amp; Written Comment</td>
<td>Teacher &amp; Student(s)</td>
<td>Within a Week</td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>Oral Communication</td>
<td>After a Week</td>
<td>Time</td>
<td></td>
</tr>
</tbody>
</table>

Research Question:

1. How is formative assessment being incorporated in classrooms that are utilizing technology and moving towards a blended learning environment?

1a. How many times during a lesson were the students formally assessed?

1b. In what ways are students formally assessed?
Appendix F

Interview Protocol after the Second Observation

Rationale: The purpose of the interview is to gain an understanding of how teachers’ plan and implement their lessons. The interview protocol is also aimed at understanding how the teachers who have technology available to them are incorporating technology. What are the benefits the teachers see to using the technology and how do they determine when to use it?

Interview Protocol – Teacher (Within a week of classroom observation.)

I want to thank you for taking the time to talk to me today. My name is Jennifer Bonham and I would like to talk to you about how formative assessment was incorporated in your lesson. I am interested in how you planned your lesson as well as your thoughts and reflections on the lesson. I am also interested in how and why you might have chosen to use or not to use technology in this particular lesson.

I know you have a busy schedule so I will try not to take up too much of your time. This interview should take less than an hour. During the interview I will not only be taking notes but I will also be taping the session to ensure that I do not miss any of your comments. No one else will have access to this interview but the responses will be part of my data analysis for the study. You do not have to answer any question that you do not want to answer and you may end the interview at any time.

Do you have any questions before we get started? Are you willing to participate in this interview?

1. Thank you for letting me come into your room and be just an observer and not a coach for the lessons. How do you think the lessons went?
2. Let’s talk for a minute about how you planned for these particular lessons. What were the key learning, or main concepts you wanted your students to get out of the lessons? (Name the investigation instead of calling them the lessons.)
3. Do you feel your students obtained that key learning through that lesson?
4. What evidence do you have that your students learned what you wanted them to learn? OR What evidence do you have that students did not learn what you wanted them to learn? OR What evidence do you have of student learning or lack of student learning?

5. What impact on instruction did the evidence of student understanding or lack of understanding have on this lesson? In other words, did you revise this lesson based on students’ responses?

6. What impact on instruction did the evidence of student understanding or lack of understanding have on future investigations in this unit or upcoming units?

7. If you had to do it all over again, this year, would you do anything differently? If so, what?

8. REPEAT QUESTIONS 1 – 5 for 2nd lesson.

AFTER SECOND INTERVIEW: Thank you for your time today. I will be coming into your classroom as an observer one more time. During that time, I am particularly interested in how you formatively assess your students during your lesson and how you deal with the data you receive from formative assessment.
Appendix G

Interview Protocol for Interview after 3rd Observations

Rationale: The purpose of the interview is to gain an understanding of teachers’ views on the formative assessment in the mathematics classroom. What types of formative assessment do they incorporate in their class? How and when does the evidence of student understanding impact instruction? The interview protocol is also aimed at understanding how the teachers who have technology available to them are incorporating technology as a formative assessment tool. What are the benefits the teachers see to using the technology to formatively assess student learning?

Interview Protocol – Teacher (Within a week of classroom observation.)

I want to thank you for taking the time to talk to me today. My name is Jennifer Bonham and I would like to talk to you about your lesson and how formative assessment was incorporated. I am interested in how you chose your formative assessment, how you analyze the student data and how the evidence of student understanding impacts your instruction. I am also interested in how and why you might have chosen technology as a way to formatively assess your students.

I know you have a busy schedule so I will try not to take up too much of your time. This interview should take less than an hour. During the interview I will not only be taking notes but I will also be taping the session to ensure that I do not miss any of your comments. No one else will have access to this interview but the responses will be part of my data analysis for the study. You do not have to answer any question that you do not want to answer and you may end the interview at any time.

Do you have any questions before we get started? Are you willing to participate in this interview?

1. Thank you for letting me come into your room and be just an observer and not a coach for the lesson. How do you think the lessons went?
2. What was the key learning goal?
3. Do you feel the students achieved the key learning goal of this lesson? Why or why not?
4. (Using the lesson plan as evidence) According to your lesson plan, you had designed (#) assessment prompts. Why (#) formative assessments?
5. For each formative assessment, how did you determine how you were going to assess the students?
6. For each formative assessment, how and when were the students going to receive feedback?
7. During your lesson (describe how the teacher formatively assessed students’ knowledge or show video clip from lesson), what were you able to learn about student understanding at the time?
8. How did you learn this?
9. Based on students’ responses during this formative assessment, did you adapt your lesson? If so, how? Why?
10. Did these adaptations help your students?
11. What evidence do you have of this?
12. During your lesson, I observed that you formatively assessed the students at this point (describe or show video evidence), but it was not part of your original lesson plan. Can you tell me why you decided to add that formative assessment?
13. How did data from that new formative assessment impact your instruction in this particular lesson?
14. Thinking back over your lesson. Is there any point in the lesson that looking back you think would have been a good place to have formatively assessed your students, but you didn’t?
15. During your lesson, you formatively assessed the students (describe the formative assessment), and students’ responses showed that many of them had some misconceptions. (Show video clip) At that point in the lesson, you kept with your original lesson plan (ALP) and did not address the misconception. Why did you decide to keep going at that particular point?
16. Why did you choose to use (or not use) technology to formatively assess the students?
17. How does this technology help you formatively assess your students?
18. What is challenging about using this technological tool to formatively assess your students?
## Appendix H

**Correlation between Key Questions and Interview Question**

<table>
<thead>
<tr>
<th>Interview Question</th>
<th>Research Question</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you feel the students achieved the key learning goal of this lesson? Why or why not?</td>
<td></td>
<td>Setting the stage of the lesson and helping the interviewee feel comfortable</td>
</tr>
<tr>
<td>(Using the Lesson Plan as evidence) In this lesson you had (#) assessment prompts. Why (#) formative assessments?</td>
<td>1</td>
<td>How is formative assessment being incorporated in classrooms that are utilizing technology and moving towards a blended learning environment? (Planning)</td>
</tr>
<tr>
<td>For each formative assessment, how did you determine how you were going to assess the students?</td>
<td>1b</td>
<td>In what ways are students formatively assessed?</td>
</tr>
<tr>
<td>For each formative assessment, how and when were the students going to receive feedback?</td>
<td></td>
<td>How is formative assessment (including feedback) being incorporated into the classroom?</td>
</tr>
<tr>
<td>During your lesson (describe how the teacher formatively assess students’ knowledge or use video evidence), what were you able to learn about student understanding at that time?</td>
<td>1b</td>
<td>What evidence of student learning are the teachers able to gain?</td>
</tr>
<tr>
<td>How did you learn this?</td>
<td>1b</td>
<td>Clarification or deeper understanding of what evidence of student understanding (or lack of understanding) the teacher gains.</td>
</tr>
<tr>
<td>Based on students’ responses, how did you adapt your lesson? If so, how? Why?</td>
<td>2b</td>
<td>What instructional changes did teachers make, if any to their lessons, as a part of their formative assessment efforts?</td>
</tr>
<tr>
<td>Did these adaptations help your students?</td>
<td>2c</td>
<td>Did the instructional change improve student understanding?</td>
</tr>
<tr>
<td>What evidence do you have of this?</td>
<td>2c</td>
<td>Did the instructional change improve student understanding? What evidence do you have to support this?</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>----</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>During your lesson you formatively assessed the students (describe or show video evidence) but it was not part of your original lesson plan. Can you tell me why you decided to add that formative assessment?</td>
<td>2</td>
<td>What instructional changes did teachers make, if any to their lessons, as a part of their formative assessment efforts?</td>
</tr>
<tr>
<td>Did the instructional change improve student understanding? What evidence do you have to support this?</td>
<td>2c</td>
<td>Did the instructional change improve student understanding? What evidence do you have to support this?</td>
</tr>
<tr>
<td>How did data from that new formative assessment impact your instruction in this particular lesson?</td>
<td>2b</td>
<td>Did the teachers make an instructional change? If they did, why did they make that instructional change?</td>
</tr>
<tr>
<td>Thinking back over your lesson. Is there any point in the lesson that looking back you think would have been a good place to have formatively assessed your students, but you didn’t?</td>
<td>1</td>
<td>Was there a missed opportunity for formative assessment? Do teachers realize the missed opportunity?</td>
</tr>
<tr>
<td>During your lesson, you formatively assessed the students (describe the formative assessment), and students’ responses showed that many of them had some misconceptions. (Show video clip) At that point in the lesson, you kept with your original lesson plan (ALP) and did not address the misconception. Why did you decide to keep going at that particular point?</td>
<td>2b</td>
<td>What reason might teachers have for not making an instructional change? Did they misinterpret the data? Did they decide to do the instructional change at a later date?</td>
</tr>
<tr>
<td>Why did you choose to use (or not to use) technology to formatively assess the students?</td>
<td>3a</td>
<td>How do teachers decide when to use technology for formative assessment?</td>
</tr>
<tr>
<td>How does this technological tool help you formatively assess your students?</td>
<td>3b</td>
<td>What are the advantages to using technology to formatively assess students?</td>
</tr>
<tr>
<td>What is challenging about using this technological tool to formatively assess your students?</td>
<td>3b</td>
<td>What are the advantages to using technology to formatively assess students?</td>
</tr>
</tbody>
</table>
Appendix I

Spreadsheet for Data Collection
Appendix J

Protocol for Video Study

LESSON VIDEO STUDY
Formative Assessment and Missed Opportunities

**Step 1:** Either the teacher and/or the coach watches the video clip of a lesson. Pick a section of the video clip that includes either formative assessments or some missed opportunities.

**Step 2:** During PLC, as a group watch the video clip and use the space below to record any formative assessments or missed opportunities.

**Step 3:** The teacher in the video facilitates a PLC conversation. (See guiding questions).

Formative Assessment and Missed Opportunities Record Sheet:

<table>
<thead>
<tr>
<th>Formative Assessment Activity Seen in Video (Describe Activity)</th>
<th>Data Collected from Formative Assessment Activity (Describe the data collected or leave blank if no data was collected)</th>
<th>What Happened Next? (Describe what happened next in the lesson after the formative assessment activity occurred.)</th>
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Guiding Question for PLC Conversation:

1. How many formative assessment activities did you see during the clip? (Look to see if everyone saw the same activities.)

2. Were there any missed opportunities during this part of the video?

3. Let’s brainstorm some ways that I could have turned the missed opportunity into a formative assessment.

4. What type of data do you think I would have received from those missed opportunities?

5. How might that data impact instruction?

6. During this clip you saw this formative assessment. (Describe FA)
   a. (If they were able to see or hear the data that was collected) What did the data tell you about student understanding?
   b. What instructional decisions might you have made based on this data?
   c. (If they were not able to see or hear the data that was collected) What data do you think I was able to collect from the students? (After they respond, tell them what data was actually collected).
   d. What instructional decisions might you have made based on this data?
Appendix K

Depository
Formative Assessment for 6 - 8 Math

Resources > Formative Assessment Activities

- **Formative Assessment Cover Sheet**
  - Added by You: Nov 19, 2017

- **6th Grade**
  - Added by You: Nov 19, 2017

- **7th Grade**
  - Added by You: Nov 19, 2017

- **8th Grade**
  - Added by You: Nov 19, 2017

Formative Assessment for 6 - 8 Math

Resources > Formative Assessment Activities > 6th Grade

- **Prime Time**
  - Added by You: Nov 19, 2017

- **Comparing Bits and Pieces**
  - Added by You: Nov 19, 2017

- **Let's Be Rational**
  - Added by You: Nov 19, 2017

- **Covering & Surrounding**
  - Added by You: Nov 19, 2017

- **Variables & Patterns**
  - Added by You: Nov 19, 2017

- **Decimal Ops**
  - Added by You: Nov 19, 2017

- **Data About Us**
Appendix L

Formative Assessment Cover Sheet

**About the Formative Assessment**
(Please include this sheet with your formative assessment activity when you upload it into Schoology.)

<table>
<thead>
<tr>
<th>Look fors</th>
<th>What do you hope to see?</th>
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<table>
<thead>
<tr>
<th>Misconceptions/Interventions</th>
<th>What possible misconceptions might you see?</th>
<th>What possible interventions match the misconception?</th>
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