

EXPLORING MIDDLE SCHOOL MATHEMATICS TEACHERS' FEEDBACK
PRACTICES

by

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Exploring Middle School Mathematics Teachers' Feedback Practices

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ABSTRACT

EXPLORING MIDDLE SCHOOL MATHEMATICS TEACHERS' FEEDBACK PRACTICES

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Feedback has long been viewed as an important component in classrooms where teachers and students engage in learning activities. Early research into the influence of feedback on mathematics achievement demonstrated that students performed better when given feedback that included specific information that identified errors and detailed why an answer is correct, as opposed to simply indicating an answer is correct or incorrect. Since these early studies, researchers have continued to investigate the characteristics that make feedback most effective in mathematics classrooms. Despite the availability of literature and evidence that teachers can be taught how to implement effective feedback practices, there is evidence that “traditional” feedback practices continue to be used in mathematics classrooms. One reason for the continued use of traditional feedback strategies in mathematics classrooms could be the lack of guidance and effective training of these particular practices. The present study explores the processes middle school mathematics

teachers' experience while determining feedback for students. The study revealed feedback is a multifaceted process that middle school mathematics teachers are concerned with on a regular basis. Several themes and a theoretical construct were developed that speak to specifics regarding what teachers consider and how they determine feedback for students. Common methods of communication and delivery of feedback were identified as well. Educational implications were discussed regarding teacher preparation programs and professional development to support teachers' learning effective feedback strategies.

Keywords: *Feedback, formative assessment, mathematics education, instructional practices*

SECTION 1: THE PROBLEM

Feedback has long been viewed as an important component in classrooms where teachers and students engage in learning activities (e.g., Carless, 2006; Kluger & DeNisi, 1996; Kulhavy, 1977; Van Der Kleij & Adie, 2020; Wexley & Thornton, 1972; Zahorik, 1968). Classroom feedback is generally delivered verbally or via written remarks (Hargreaves et al., 2000; Harris et al., 2014; Zahorik, 1968) and is most often transferred from teacher to student regarding the students' performance on academic activities (Askew & Lodge, 2000; Boud & Molloy, 2013; Sadler, 1989). Hattie and Timperley (2007) defined feedback as “information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding” (p. 81). Early research into the influence of feedback on mathematics achievement demonstrated that students performed better when given feedback that included specific information that identified errors and detailed why an answer is correct, as opposed to simply indicating an answer is correct or incorrect (e.g., Elawar & Corno, 1985; Wexley & Thornton, 1972). Since these early studies, researchers have continued to investigate the characteristics that make feedback most effective in mathematics classrooms (e.g., Chu & Fowler, 2020; Kyaruzi et al., 2019; Labuhn et al., 2010) and many have synthesized the qualities of effective feedback so that educators can work to implement these practices in classrooms (e.g., Black & Wiliam, 1998; Brookhart, 2008; Hattie &

Timperley, 2007). In addition to explaining why an answer or process is correct or incorrect, as opposed to simple identification of correct or incorrect, feedback is more likely to be effective if it is clearly stated in a way that is appropriate for the students' level of comprehension and if it relates to the learning goal, specifically identifying where the student is in relation to the goal (Boud & Molloy, 2013; Brookhart, 2008; Hattie & Timperley, 2007; Sadler, 1989). Feedback can also occur at different levels, which can have varying degrees of effectiveness on deeper learning of concepts and skills. In short, feedback that clarifies how a student can improve in processes related to skills (e.g., specific steps involved in solving equations) or self-regulation (e.g., how a student can better monitor their engagement during an activity) is likely to be more effective than feedback related only to an activity (e.g., evaluation of students' performance) (Hattie & Timperley, 2007). Alongside investigating effective feedback practices, researchers have explored the prospect of teaching teachers to implement effective feedback practices in mathematics classrooms and positive result suggest teachers can learn how to implement effective strategies that benefit their mathematics students' achievement (e.g., Elawar & Corno, 1985; Fonseca et al., 2015). With effective professional development, teachers can learn to provide effective feedback that clearly guides students to know how to interpret and utilize that feedback, thereby increasing students' likelihood to experience success in mathematics.

Statement of the Problem

Despite the availability of literature and evidence that teachers can be taught how to implement effective feedback practices, there is evidence that “traditional” feedback

practices, such as simple identification of correct or incorrect answers, lack of alignment to a student-understood learning goal, and limited use of process or self-regulation level feedback, continue to dominate mathematics classrooms (Haara et al., 2020; Hartland, 2020; Monteiro et al., 2019; Rathje, 2018). One reason for the continued use of traditional feedback strategies in mathematics classrooms could be the lack of guidance and effective training of these particular practices (Rathje, 2018; Shrum, 2016). Teachers often develop their feedback practices as a result of mentor or peer observations and/or through experience since there is little to no guidance regarding these practices in teacher preparation programs. While some professional development programs have experienced success in teaching teachers to implement effective feedback strategies that improve students' mathematics achievement (e.g., Elawar & Corno, 1985; Fonseca et al., 2015), other programs that have seen mixed results in terms of teacher improvement in effective feedback practices and/or student improvement in mathematics achievement (e.g., Beesley et al., 2018; Dixon & Haigh, 2009; Gamlem et al., 2019; Van den Burgh et al., 2014). For example, Beesley et al. (2018) witnessed significant improvement in teacher feedback practices, but no significant improvement in students' mathematics achievement. Since there is evidence that improvement in both areas is possible (e.g., Elawar & Corno, 1985; Fonseca et al., 2015), it seemed there could be issues or challenges in the teacher implementation of these practices. Research focused on understanding *how* teachers develop feedback may provide insight that could be useful in developing programs designed to improve teacher feedback practices.

Literature Review:

Effective Feedback Practices and the Use in Mathematics Classrooms

Classroom feedback has become a prominent research topic in educational research due to its influential quality on student learning (e.g., Carless, 2006; Kluger & DeNisi, 1996; Kulhavy, 1977; Van Der Kleij & Adie, 2020; Wexley & Thornton, 1972; Zahorik, 1968). The following review will provide a synthesis of several qualities of effective feedback practices according to current relevant literature. This synthesis will be followed by an overview of the empirical evidence of the influence of those effective feedback practices on student learning in mathematics classrooms, as well as evidence of a lack of implementation of these practices in many of today's mathematics classrooms despite evidence that teachers can be taught to implement effective practices. The literature review concludes with justification for the current study, which proposes to examine the ways in which middle school mathematics teachers develop feedback for students in response to their performance in learning activities.

Qualities of Effective Feedback

Different Levels of Feedback

Studies over time have focused on understanding the dynamics within classroom feedback processes between teachers and students, and the influence of these interactions on students (e.g., Elawar & Corno, 1985; Kulhavy, 1977; Labuhn et al., 2010; Wexley & Thornton, 1972; Zahorik, 1968). Attempts have been made to analyze, synthesize, and present findings in a way teachers could understand and use to guide their teaching practices (e.g., Black & Wiliam, 1998; Brookhart, 2008; Hattie & Timperley, 2007;

Kluger & DeNisi, 1996; Sadler, 1989). Feedback practices can be categorized based on the level at which they are directed (Hattie & Timperley, 2007). Task-level feedback is feedback regarding the correctness of content knowledge and/or how well a task is completed. Additional levels of feedback include process-level, self-regulation level, and self-level. Process-level feedback involves feedback related to the underlying processes within content knowledge skills. Self-regulation feedback is feedback regarding an individual's performance in self-regulation processes, including self-monitoring and self-reflecting. Table 1 provides examples for each level of feedback related to a geometry learning goal.

Table 1

Examples of the Different Levels of Feedback Related to a Geometry Learning Target

Geometry learning target: Students will use the midpoint formula to find the midpoint of two points in the coordinate plane.	
Feedback level	Example
Task-level	“This point is not the <i>midpoint</i> – it’s not <i>right in between the two points</i> . If we graphed the points and the midpoint you found, we could see it’s not quite in the middle of the two given points.”
Process-level	“It looks like you substituted the wrong <i>numbers</i> in for the x- and y-variables. Next time you start the problem, it may be helpful to write “ x_1, y_1 ” and “ x_2, y_2 ” over the points, so you have reminders for

	which number to substitute into each variable in the formula.”
Self-regulation level	“After you’ve found your answer, it would probably be helpful to check your answer by typing all three points into the graphing calculator – the two given points and the point you found – to see if the point you found is actually in the middle of the two points you were given.”
Self-level	“That’s not quite the correct answer, but you made a good effort.”

Note. This table provides examples of each type of feedback level in relation to the geometry learning target provided at the top of the table.

While task-level feedback is vital in supporting students’ content development, process-level and self-regulation level feedback are more effective in developing deeper learning. This is because feedback at the process-level and self-regulation level assist students in constructing meaning related to content and/or skills, and this in turn leads to deeper understanding. Self-level feedback is feedback that includes an evaluation of a person’s worth or abilities. Examples include, “Good work” or “You’re so smart”. This level of feedback is viewed as the least effective form of feedback since it usually contains no information related to the task. Additionally, self-level feedback may be detrimental to student learning if students begin to rely on praise from others for motivation. Teachers can prevent damaging behaviors, such as learned helplessness or self-handicapping, by emphasizing that students can improve through effort, practice, and resilience to setbacks.

The quality of the presentation (i.e., clarity, specificity) and content (i.e., tone, vocabulary, context) of feedback can highly influence the student reception and use of the feedback (Black & Wiliam, 1998; Brookhart, 2008; Hattie & Timperley, 2007; Sadler, 1989). Three characteristics that lead to high-quality feedback (i.e., effective feedback) include language that is appropriate and supportive, context-specific and related to an identified learning goal, and an appropriate mix of task-, process-, and self-regulation level feedback.

Feedback Should Include Appropriate and Supportive Language

A starting point for effective feedback is that students must be able to understand it and hear/listen to it (Black & Wiliam, 1998; Brookhart, 2008; Hattie & Timperley, 2007; Sadler, 1989). Teachers must recognize that the language with which they discuss content and learning processes may contain vocabulary that students are unfamiliar with (Brookhart, 2008; Sadler, 1989). Sadler (1989) explained that teachers develop *tacit knowledge* – knowledge of content or skills that is difficult to explain or identify the origins of learning – related to content and learning through teaching practice and experience. When discussing the learning activity and skills with students, it's important that teachers explicitly teach academic vocabulary related to the content but also reinforce students' understanding by using vocabulary students are familiar with. In addition to presenting feedback in a manner that students can comprehend, teachers should present feedback in a positive way that is supportive of a student's ability to improve (Brookhart, 2008). Students interpret teachers' beliefs about their (the student's) abilities through the feedback they receive (Black & Wiliam, 1998) and these perceived

beliefs can influence students' self-perceptions of their abilities and ultimately their achievement (Black & Wiliam, 1998; Hailikari et al., 2008; Pitsia et al., 2017; Rubie-Davies, 2006). Rubies-Davies (2006) investigated the relationship between teacher expectations and students' self-perceptions of ability in reading and mathematics. Teachers in the study were identified as having high or low expectations regarding students' potential to succeed. There were no differences at the start of the year between the high-expectation class and the low-expectation class in terms of students' self-perceptions in reading or mathematics. There were statistically significant differences in the students' self-perceptions by the end of the year: students in the high-expectation class had experienced an increase in self-perception of ability, while students in the low-expectation class experienced a decline in self-perception of ability. This suggests that students' self-perceptions of ability may be related to teachers' beliefs in students' potential to succeed. To further the importance of this finding, Hailikari et al. (2008) and Pitsia et al. (2017) each found various forms of self-beliefs (e.g., self-efficacy, self-perception) significantly influenced students' mathematics achievement. Taken together, if teachers' beliefs in their students' abilities can influence students' self-perceptions of ability and students' self-beliefs influence their achievement, it is reasonable to say that teachers' beliefs in their students can influence students' achievement. Feedback may be one way in which students interpret teachers' beliefs about their (the students') abilities and this underscores the importance of teachers presenting feedback in a way that supports and encourages students. When students understand and feel empowered by

teacher feedback, they are more likely to be open to implementing the feedback they receive (Black & Wiliam, 1998; Brookhart, 2008; Hattie & Timperley, 2007).

Feedback Should Include Task-, Process-, and Self-Regulation Level Feedback

A second quality of effective classroom feedback is that it emphasizes the processes in which students are involved (Brookhart, 2008; Black & Wiliam, 1998; Hattie & Timperley, 2007). Teachers should include specific instructions related to skill sets students are utilizing in the learning tasks (i.e., specific steps used in solving equations, specific styles of writing). Harks et al. (2014) conducted a study in which ninth-graders received either grade-oriented or process-oriented feedback regarding their performance on learning activities in a mathematics unit. Grade-oriented feedback was given as a score from one (best) to five (poorest). Students who received the grade-oriented feedback also received an overview of the class grades, as well as the class average. Process-oriented feedback was given as statements regarding students' apparent confidence (e.g., "Working on arithmetic problems, you are still uncertain when dealing with several topics"), encouragement on strengths (e.g., "You can handle the following topic well: simplifying the described situation adequately and making adequate assumptions for solving the problem"), and suggestions for improvement (e.g., "You could improve in the following area: describing the result of your calculations in a sentence") (Harks et al., 2014, p. 277). Students' perceived usefulness of feedback and mathematics achievement were measured in pre- and post-assessments. Results revealed the process-oriented feedback was perceived as more useful. Additionally, the process-oriented feedback had a stronger influence on mathematics achievement through

perceived usefulness. While process skills can be related to specific content processes, they can also be related to self-regulation process skills. Feedback that incorporates strategies for self-regulation (e.g., self-monitoring, self-reflection) can develop students' self-regulation skills (Hattie & Timperley, 2007; Moylan, 2013). Moylan (2013) implemented a cyclical feedback intervention with the hopes of improving students' mathematics achievement and self-regulation skills. Several forms of feedback were implemented in the intervention, including a self-reflection tool that students completed after receiving a graded quiz. The tool prompted the students to reflect on how long they studied for the quiz and the accuracy of their confidence rating (made prior to starting the quiz), and then gave them an opportunity to correct their work using the content feedback they received in addition to their grade. Moylan (2013) found greater mathematics achievement and calibration (accuracy in self-evaluation) in students who were highly engaged in this self-reflection process. Feedback that presents students with clear guidance on how to improve their skills and learning, by emphasizing process and self-regulation skills, creates opportunities for students to confidently move towards success.

Feedback Should Be Context-Specific and Related to the Learning Goal

A third quality of effective feedback is that feedback should be related to the learning goal (Brookhart, 2008; Hattie & Timperley, 2007; Sadler, 1989). More specifically, it should identify where the student is in relation to that goal, and then suggest the steps and processes needed to move towards the goal. Hattie and Timperley (2007) summarized how feedback must address the learning goal:

Effective feedback must answer three major questions asked by a teacher and/or by a student: Where am I going? (What are the goals?), How am I going? (What progress is being made toward the goal?), and Where to next? (What activities need to be undertaken to make better progress?) (p. 86).

Students experience greater success and satisfaction when they receive feedback that evaluates their work or performance against a previously identified learning goal and provides specific information about how the student should edit their work in order to move closer to reaching the learning goal (Clarke, 2000; Krijgsman et al., 2019; Moeller et al., 2012). Clarke (2000) implemented an intervention in which teachers clearly identified the lesson learning goals at the start of a class, both orally and in writing, and then provided “closing the gap” prompt comments (i.e., feedback) that guided students towards the learning goal. In one example, an elementary student wrote a letter to a magician in an attempt to meet the learning goal, which was to write a persuasive letter. The teacher identified ways the student made progress towards the learning goal and then added the “closing the gap” prompt, which stated, “Tell the magician why you are writing this letter” (Clarke, 2000, p. 41). As a result, the student added the line, “I am writing to say can you please give the smells back (Clarke, 2000, p. 41). Clarke (2000) collected students’ perspectives on this practice and found positive experiences: “[s]he writes the learning intention on the board for every lesson and it’s very useful... Before I was trying to do everything and now I concentrate on just what I need to do” (pp. 39-40). When students receive feedback that clearly identifies where they are in relation to the learning goal and what steps they should take to close that gap, they experience far less frustration

and pressure (Krijgsman et al., 2019). Krijgsman et al. (2019) conducted a study in which physical education students completed questionnaires, following lessons, related to perceived goal clarification, need satisfaction, and frustration. These questionnaires were completed six different times for all students over the course of a spring term. Results revealed perceived goal clarification was significantly positively related to competence and autonomy (each part of need satisfaction). Similarly, perceived goal clarification was negatively related to experienced competence and autonomy frustration at a significant level. When students know what learning goal they're moving towards and when they receive feedback that makes achievement attainable, they feel more competent and can focus on implementing teacher suggestions in order to improve their learning

Feedback in Mathematics Classrooms

Mathematics is notorious for being a subject in which students struggle and experience frustration (Heyd-Metzuyanim, 2015; Morgan et al., 2015; Newcombe et al., 2015). Students often shut down when they experience failure in understanding concepts and are not provided with information on how to improve or better understand a concept (Brown et al., 2008; Lewis, 2013). The use of high-quality feedback in mathematics classrooms has been explored and evidence suggests the use of effective feedback strategies can have a significant positive influence on student achievement in mathematics (e.g., Anderson & Palm, 2017; Elawar & Corno, 1985; Kyaruzi et al., 2019; Labuhn et al., 2010). Labuhn et al. (2010) conducted a study in which students received feedback in the form of a graph so they could see their performance over time. The researchers found the students who received feedback regarding their performance on

completed worksheets in the middle of a learning unit performed significantly higher on post-tests than those students who didn't receive feedback. Kyaruzi et al. (2019) investigated students' perceptions of feedback and the effect this had on students' mathematics performance. Results indicated students who perceived teacher feedback as for the purpose of monitoring (i.e., to track learning) were less likely to use the feedback, whereas feedback that was perceived as scaffolding (i.e., to support learning) was much more likely to be used. In an early study, Elawar and Corno (1985) explored the effects of training teachers to write constructive feedback on sixth-grade students' mathematics homework on mathematics achievement. Nine teachers were trained to provide specific feedback to students through a seven-hour training session. Teachers were instructed to consider four questions while reviewing students work:

What is the key error? What is the probable reason the student made this error?

How can I guide the student to avoid the error in the future? and What did the student do well that could be noted? (Elawar & Corno, 1985, p. 166).

Teachers were also instructed on how to provide feedback in light of these questions on student work for the students to read and use. In contrast to this feedback received by the experimental group, students in the control group received their homework back with only correct answers identified. Pre-tests and post-tests were conducted to assess students' mathematics achievement and analyses revealed students in the treatment group scored significantly higher on the mathematics post-test. This study, along with others, also demonstrates that teachers can be trained to deliver effective feedback, often as part of a formative assessment-based approach (e.g., Anderson & Palm, 2017; Beesley et al.,

2018; Elawar & Corno, 1985). Black and Wiliam (1998) define formative assessment as “activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning in which they are engaged” (pp. 7-8). As evidenced in the definition, feedback is an inherently vital component of formative assessment and when feedback practices are taught, they are often taught as part of an overarching formative assessment model (e.g., Andersson & Palm, 2017; Beesley et al., 2018).

Andersson and Palm (2017) investigated the effects of teacher formative assessment practices, including feedback and learned in a professional development program, on student learning. Teachers participated in the professional development program in the spring term prior to the school year in which the formative assessment practices were implemented and the impact of those practices tracked. The professional development program consisted of weekly meetings that included lectures of formative assessment theories, activities to practice implementation, and group discussions in which the teachers shared about their experiences in implementing strategies in their classrooms (these implementations were viewed as practice in the spring term and were not included in the data). In addition to these weekly meetings, teachers were given opportunities to research formative assessment, and plan and reflect on experiences. The researchers conducted interviews with the teachers and found all teachers implemented new formative assessment strategies. In terms of feedback specific strategies, teachers reported using comments instead of grades, specifically identifying what the students were doing correctly and steps they should take to improve. The researchers measured

students' mathematics achievement using pre- and post-tests and found that students whose teachers had received the professional development training significantly increased their mathematics learning over the school year. Measured significant growth has also been observed in teachers' practices as a result of professional development (e.g., Beesley et al., 2018).

Beesley et al. (2018) conducted a study in which they piloted a professional development program, called Learning to Use Formative Assessment in Mathematics, which utilized an Assessment Work Sample Method (AWSM). The 47 teachers in the study were guided through the three dimensions of the program over the course of nine in-person meetings. The first dimension addressed the process of aligning learning goals with an appropriate learning task, the second addressed defining success criteria, and the third addressed the process of developing descriptive feedback. In order to measure changes in feedback practices, teacher feedback work samples were collected in the form of student work that had been graded and/or contained feedback prior to and after the professional development. The teacher work samples were graded using the AWSM rubric, which provided criteria for six categories:

(a) focus of the goals on student learning; (b) alignment of learning goals and task; (c) alignment of learning goals and assessment criteria; (d) clarity of the student assessment criteria; (e) feedback type; and (f) feedback integrates student involvement (Beesley et al., 2018, p. 9).

Analysis revealed statistically significant growth in feedback before the professional development and at the end of the study. Specifically, teachers demonstrated the greatest

development in the feedback type and in the level of student involvement in the feedback process. For example, regarding the change in feedback type, teachers began using ungraded activities (e.g., quizzes and feedback centers) so students had more low-risk opportunities to work with the content and receive feedback on their progress. Teachers also incorporated success criteria that allowed students to self-evaluate in order to have more student involvement in the feedback process. While there was significant growth in teacher practices, students did not score significantly higher on post-tests, suggesting that while practices changed, it wasn't enough to affect student performance. Since there is evidence of studies significantly influencing student performance (e.g., Andersson & Palm, 2017), it seems the framework and delivery of the professional development programs can greatly affect the influence the learned feedback practices have on student learning. Additionally, the varying results imply we have not yet identified a reliable structure to routinely implement in training teachers to use effective feedback practices.

While challenges exist in implementing effective feedback practices into mathematics classrooms, the discussion regarding teacher use of feedback has become increasingly widespread. As student involvement in the learning process has been linked with deeper understanding of concepts (e.g., Butler & Winne, 1995; Labuhn et al., 2010; van Loon & Roebbers, 2017), mathematics teachers are being encouraged to abandon traditional feedback practices and instead incorporate effective feedback practices that demonstrate the potential to better support students' mathematics achievement.

The Need for Effective Feedback Practices in Today's Mathematics Classrooms

Despite the available research and resources encouraging the use of feedback with the discussed qualities, it seems mathematics classrooms are among those that still experience more traditional feedback practices (e.g., Bature & Atweh, 2020; Haara et al., 2020; Hartland, 2020; Monteiro et al., 2019; Rathje, 2018). Rathje (2018) conducted a study of three secondary mathematics teachers' feedback practices using observations and semi-structured interviews. As a result of the observations, the researcher found task-level was the primary feedback type while observing secondary mathematics teachers' feedback practices. Additionally, Rathje (2018) reported that the mathematics teachers resorted to a particular feedback cycle throughout the class periods referred to as IRF – initiation, response, feedback – in which a teacher would ask a question, a student would provide an answer, and the teacher would only indicate whether the answer was correct or incorrect. As was earlier discussed, this task-level feedback is an important type of feedback in mathematics classrooms. However, process-level and self-regulation level feedback have been linked with deeper learning (Hattie & Timperley, 2007) and thus should be incorporated into lessons alongside task-level feedback. In other words, task-level feedback should not significantly outnumber process-level and self-regulation level feedback (Hattie & Timperley, 2007). The prevalence of the primarily task-level feedback use (e.g., the IRF cycle) not only provides little attention to feedback related to processes underlying content and skills, but also overlooks the much deeper learning that can take place when students own their learning through the development of self-regulatory skills. In a similar study, Hartland (2020) investigated how two elementary

mathematics teachers naturally provide feedback to their students. Through observations, and audio and video recordings, Hartland (2020) also found the teachers primarily provided task-level feedback. Additionally, self-level feedback was regularly provided to students, which, as earlier discussed, can have little to no effect on student learning and can even be detrimental to student learning if students begin to rely on this feedback for motivation. The continuation of traditional practices could be the lack of guidance on implementing feedback practices (Rathje, 2018; Shrum, 2016) and/or implementation of programs that are missing components that limit students' mathematics performance improvement (e.g., Beesley et al., 2018; Dixon & Haigh, 2009; Gamlem et al., 2019; Van den Burgh et al., 2014).

Teaching Mathematics Teachers Effective Feedback Practices

Mathematics teachers are among those who feel they need support in implementing effective feedback practices (Rathje, 2018; Shrum, 2016). Rathje's (2018) and Shrum's (2016) studies each involved interviews with teachers who were observed for the studies. Rathje (2018) found "[n]one of the teachers reported having any formal training or any courses in how to assess students formatively or how to deliver feedback effectively" (p. 74). Additionally, the teachers reported their current knowledge of feedback practices were formed through observing peers and mentors, and through experience. Shrum (2016) found teachers acknowledged a need of administrative support – both in the form of encouragement and in knowledge of effective practices – as they pursued a stronger understanding of effective feedback practices. While there remains a need for guidance and support, recent studies do show efforts to teach educators how to

implement effective feedback, though many are still in need of adjustments in order to see improvement in students' mathematics achievement (e.g., Beesley et al., 2018; Dixon & Haigh, 2009; Gamlem et al., 2019; Van den Burgh et al., 2014). For example, Beesley et al.'s (2018) study, discussed earlier, revealed no or little insignificant growth in students' mathematics achievement despite the significant growth teachers demonstrated in their feedback practices. Van den Burgh et al. (2014) conducted a similar study in which 16 middle school mathematics teachers participated in a professional development program on effective feedback practices lasting four months. While teachers' beliefs in the importance of providing feedback increased, analyses revealed no significant growth in teacher feedback behavior. Dixon and Haigh (2009) speculated on a similar outcome as a result of their qualitative case study involving mathematics teachers who participated in professional learning on feedback. One of their cases, Fran, experienced changes in her perception of and beliefs in feedback practices, but demonstrated minimal implementation. Dixon and Haigh (2009) suspected that Fran's lack of understanding regarding how to use the data prevented her from continuing to implement the learned feedback practices. There is promising evidence that the encouragement, guidance, and training related to effective feedback practices in mathematics classrooms is spreading, though there remains a clear need to develop these programs further so that teachers can appropriately support students' mathematics learning.

The Present Study

Research suggests students can improve academically when high quality feedback is used in mathematics classrooms (Chu & Fowler, 2020; Elawar & Corno, 1985;

Gamlem et al., 2019; Kyaruzi et al., 2019; Labuhn et al., 2010). Evidence shows teachers can be trained to implement effective feedback practices through professional development (e.g., Elaware & Corno, 1985; Gamlem et al., 2019). However, while teachers' beliefs and feedback behaviors have been improved as a result of these professional development programs (e.g., Beesley et al., 2018; Dixon & Haigh, 2009; Elaware & Corno, 1985), not all implementations have resulted in increased use of feedback practices or improvement in students' mathematics achievement (e.g., Dixon & Haigh, 2009; Gamlem et al., 2019; Van den Burgh et al., 2014). Andersson and Palm (2018) identified that research on how to support teachers in developing formative assessment practices is lacking. Since feedback is an essential component of formative assessment, this suggests there is a lack of research on how to support teachers in developing feedback practices as well.

Purpose of the Study

There is a lack of research into the processes mathematics teachers experience as they develop feedback for their students. Understanding how teachers develop feedback could provide insight that could be used to design professional development that will support teachers in growing their feedback practices as they incorporate quality feedback strategies. Therefore, the purpose of this study is to understand how mathematics teachers develop feedback they give to students in response to academic learning activities.

Research Questions

The purpose of this study is to understand how middle school mathematics teachers develop the feedback they provide to their students in response to learning activities. The primary and secondary research questions driving this study are:

1. How do middle school mathematics teachers determine the feedback they will give their students in response to learning activities?
 - a. What do middle school mathematics teachers consider when determining feedback for students?
2. How do middle school mathematics teachers communicate feedback to students?

SECTION 2: METHODS & DATA ANALYSIS

Methods

Participants

Six middle school mathematics teachers participated in the current study. The teachers were all from a large suburban school district about 40 miles outside of a major metropolitan area that serves a diverse population. Teacher race and ethnicity within middle schools in this school division is about 72% White, 13.8% Black/African-American, 9.6% Hispanic of any race, 2% Asian, 0.2% American Indian/Alaskan, 0.2% Hawaiian/Pacific Islander, and 2.1% two or more (data as of 2020). Additionally, middle school teachers in this division are 74.2% female and 25.7% male.

Each participant had between seven and 20 years of teaching experience and each taught a variety of courses throughout their experience. Table 2 lists individual teachers' experience, as well as additional demographic and experience information.

Table 2

Participant demographics

	P1	P2	P3	P4	P5	P6
Sex	Female	Female	Male	Female	Female	Female
Years of experience	12	20	15	19-20	11	7
Work outside education?	Yes	No	Yes	Yes	No	Yes
Grades/Levels of math	6 th grade extended	8 th grade science,	University math, 7 th	Elementary school, 5 th	Elementary school,	6 th grade math –

taught/Other content areas taught	math, 7 th grade & 7 th grade extended	reading, language arts, 6 th grade math, 7 th grade math, 8 th grade math, algebra in middle school	grade math, 8 th grade math, algebra in middle & high school, geometry in middle & high school	grade math, 6 th – 8 th grade, 6 th – 8 th grade science, remedial math classes	ESOL classes/co- teaching and traditional classroom, 7 th grade math, remedial math classes	8 th grade math, algebra in middle school
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Note. This table provides individual participant demographics.

Middle schools in this school division offer several levels of mathematics courses ranging from Grade 6 to Geometry. Extended level courses, including 6th Grade Extended and 7th Grade Extended combine 6th and 7th grade mathematics and 7th and 8th grade mathematics into year-long courses to allow students to advance at a quicker pace through the content. Students enrolled in Algebra 1 and Geometry receive high school credits for these courses.

Teachers were recruited through colleague connections the researcher had within the school district. The researcher sent out emails to personal colleague connections and math department chairs at different middle schools and asked colleagues to reach out to math teachers at their schools to see if any would be interested in hearing more about the study and potentially participating. Colleagues forwarded contact information to the researcher who then reached out to potential participants. The six participants in the study were the only six individuals to agree to be part of the study.

Procedures and Data Collection

The six teachers were interviewed using a semi-structured interview format. The interview questions can be found in Appendix A. The interviews ranged in length from 38 to 58 minutes. Interviews were conducted via Zoom and were recorded using Zoom's recording feature.

Data Analysis

The semi-structured interviews were transcribed verbatim using Descript software. Each participant was given an identifier, P#, representing the order in which their interview was conducted (e.g., P1; P6). The resulting transcriptions and recordings were examined simultaneously to correct errors in the software's transcription. Once the transcripts were deemed accurate, the following coding approaches were used to code the data:

- Process codes were used to identify teachers' processes used to develop feedback for their students. The following process subcodes were developed while analyzing the data:
 - Assessing
 - Formally assessing
 - Informally assessing
 - Interpreting
 - Deciding
 - Prompting

- Values codes, specifically beliefs and attitudes, were used to identify teachers' views of feedback.
- Emotions coding were used to identify teachers' emotional experiences with developing and providing feedback to their students. The emotions subcode "Awareness of student emotions" was developed while analyzing the data.

Additionally, the following a priori codes (parent code and subcodes) were used to code the different feedback levels the teachers utilize:

- Feedback
 - Task-level feedback
 - Process-level feedback
 - Self-regulation level feedback
 - Self-level feedback

Finally, three in vivo codes – "I know my kids," "Growth mindset," and "Multiple choice (questions)" – were identified due to common references/topics discussed among interviewees.

MaxQDA software was used to code the data and the Complex Coding Query tool was utilized to retrieve intersections of codes that were believed to be potentially helpful in analyzing the data and answering individual research questions. Prior to addressing the study's research questions, analysis was conducted to better understand individual participants, as well as similarities across participants. Segments were retrieved, from all participants, from the intersection of codes "values" and corresponding subcodes with "assessment" and corresponding subcodes. Retrieved segments were organized by

participant and summaries were written for each participant to represent participants' values around assessment. Segments were documented as quotes to illustrate participants' particular values. The same process was conducted to identify participants' values around feedback. Segments were retrieved, from all participants, from the intersection of codes "values" and corresponding subcodes with "feedback" and corresponding subcodes. Retrieved segments were documented as quotes and were organized by participant, along with summaries for each participant to represent participants' values around feedback. Summaries and representative quotes were organized in a table, along with participants' sex, years of experience, indication as to whether they have experience working outside of education, and grades/levels of mathematics taught. This table was referenced throughout analysis when a better understanding of a participant and/or their values would be helpful in interpreting the data.

Following analysis of individual participants, research question #1, *How do middle school mathematics teachers communicate feedback to students?*, was approached. Segments were retrieved from the intersection of codes "prompting" and "feedback," including "feedback" subcodes. The list of retrieved segments was then condensed to eliminate duplicates. This final list of segments was then analyzed and methods of communicating feedback were identified (e.g., "verbal," "written"). Once the list had been fully analyzed, methods of communicating feedback were listed and organized.

Research question #2, *What do middle school mathematics teachers consider when determining feedback for students?*, was approached next. Segments from the

intersection of codes “feedback” and corresponding subcodes with “deciding,” “growth mindset,” “emotions” and corresponding subcode, “values” and corresponding subcodes, and “I know my kids” were retrieved. The retrieved segments were condensed to eliminate duplicates and the resulting list was analyzed for themes that followed the form “Determining feedback means considering...”. These resulting themes were condensed to eliminate duplicates and equivalents, and this final set of themes were organized by hierarchy. The same process was used to answer research question #2a, *How do middle school mathematics teachers determine the feedback they will give their students in response to learning activities?* Segments from the intersection of codes “feedback” and corresponding subcodes with “processes” and corresponding subcodes and “values” and corresponding subcodes were retrieved. The retrieved segments were condensed to eliminate duplicates and the resulting list was analyzed for themes that followed the form “Determining feedback means...”. These resulting themes were condensed to eliminate duplicates and equivalents, and this final set of themes were organized by hierarchy. Unlike research question #2, it was discovered that several themes remained after initial organization and a theoretical construct was developed to represent the remaining themes.

Validity

Several validity strategies were used to ensure trustworthiness in the data. Open-ended neutral questions were developed to allow participants to richly share their perspectives. Open-ended follow-up questions, such as “Can you give me an example of...?” were used as needed to gather specific details regarding experiences in an effort to ensure authentic data was collected and not implied during data analysis. The researcher

memoed before and after each interview to deepen insights, reflect on questions, and identify biases the researcher may have held. The acknowledgement of biases was particularly important in this study as the researcher is a middle school mathematics teacher who values effective feedback practices and interviewed other middle school mathematics teachers on their feedback practices. Brief memoing before the interviews encouraged the researcher to set aside known biases and approach each interview openly to hear the participants' experiences. Thorough memoing after the interviews allowed the researcher to reflect on the data and identify biases in order to accurately interpret the data. Verbatim transcription, completed through the use of Descript software and review of produced transcription alongside recording, improved accuracy in the data. The variety of coding strategies (e.g., coding approaches, a priori codes, in vivo coding), theme development, and reporting data from all interviews lead to a thorough and accurate representation of participants' experiences. Member checking was also used as a validity strategy. The researcher shared themes identified within the data with three of the six participants to ensure accurate interpretation of data and gathered additional insights participants offered.

Self as a Researcher

The researcher has been a middle school mathematics teacher for eight years and has a personal interest in encouraging the use of effective feedback practices in mathematics classrooms. The researcher's personal knowledge of teaching mathematics, developing feedback, and providing feedback to students offers invaluable insight to interpret and understand the data resulting from the interviews. At the same time, this

personal knowledge can bias perceptions and interpretations of the data. Additionally, the researcher's personal interest in encouraging the use of effective feedback practices in mathematics can present as both invaluable insight and a potential bias. For example, the personal interest has led to the researcher gaining an understanding of effective feedback practices, which provides an understanding of the varying levels of feedback and what effective feedback practices can look like (e.g., written comments, verbal statements, one-on-one conferences). However, this understanding also has the potential to limit the researcher's scope of what effective feedback can look like. Through the use of the discussed validity strategies, the researcher attempted to approach this study with a neutral and open mind towards receiving the data through participant interviews.

In addition to personal experience and interest in feedback practices, the researcher conducted a pilot study of the interviews for a previous course. The questions used in the pilot study interviews were expanded upon, but several questions remain the same for the present study. The experience of conducting the pilot study informed the researcher's thinking and planning for the present study. One instance of this is related to the study research questions. One of the primary questions for this study, *How do middle school mathematics teachers determine the feedback they will give their students in response to learning activities?* was the only question for the pilot study. The secondary question related to this primary question, *What do middle school mathematics teachers consider when developing feedback for students?* was developed as a result of the pilot study after the data presented a theme of factors teachers consider when preparing feedback for students (e.g., students' emotional states, students' levels of

comprehension). The second primary question, *How do middle school mathematics teachers communicate feedback to students?* was developed in a similar way after themes of feedback presentation (e.g., written notes, verbal comments) also surfaced in the data. Similar to the personal experience and interest in feedback, the researcher recognizes the potential for the pilot study structure and data to inform and also bias the researcher's planning and data in the current study. The use of a variety of validity strategies also lent to reducing bias resulting from the pilot study towards the current study.

SECTION 3: RESULTS AND DISCUSSION

Results and Discussion

The data resulting from the interviews provided invaluable insight that assisted in working towards answering the three research questions driving this study. Methods of communication and delivery of feedback were identified to answer research question #1. Additional insight related to location and content of feedback also became clear while working to answer research question #1. One theme was developed to answer research question #2, while two broad themes and a theoretical construct were developed to answer research question #2a. Each theme and theoretical construct are made up of minor themes that speak to specifics regarding what teachers consider when determining feedback for students or how they determine feedback for students.

Findings for Research Question #1

Research Question #1: *How do middle school mathematics teachers communicate feedback to students?*

While analyzing the data for the ways in which teachers communicate feedback to students, it was determined that there was an important distinction between *delivering* feedback and *communicating* feedback, and there was evidence that each is important to providing students with feedback. It became clear that feedback *delivery* occurs when teachers *transfer* feedback to the students. The most commonly referenced forms of feedback delivery included verbal feedback, written feedback, and markings on papers or

whiteboards (e.g., circling errors, check marks, X-marks). Table 3 includes a more complete list of methods of feedback delivery.

Table 3

Findings related to research question #1 - How do middle school mathematics teachers communicate feedback to students?

Means of delivering feedback	Methods of communicating feedback	Location where feedback is communicated
Verbal	Explanations	Whole class discussions
Writing (e.g., sentences, comments) Paper assignments/assessments White boards	Asking questions Instructing (i.e., giving directions) Prompting (i.e., an action to encourage or remind a student to look for an error)	Online assignments/assessments, which could be real-time synchronous or asynchronous One-on-one with a student Small groups of students
Marking (i.e., circling errors, grades) Paper assignments/assessments White boards	Challenging (e.g., “Are you sure?”, “Really? Two plus six equals seven?”)	Recorded videos in online course
Typing (e.g., sentences, comments) Online programs Online assessments Shared documents/assignments	Encouraging (i.e., students are doing a correct process, approaching a problem correctly)	On papers returned to student On white boards in class
Demonstrating (i.e., showing how to solve a problem) On large classroom whiteboard Small white boards with small groups or with individual students		

Stamps

Graphs of class performance

Lack of grade or comments

Providing an easier problem
to solve

Students' log of assessment
scores

Recordings

Gesturing (i.e., pointing to
error)

Activities in which students
receive peer feedback or
view and discuss other
students' work

Note. This table provides examples of how teachers deliver (i.e., transfer) feedback to students, communicate (i.e., formulate) feedback for students, and locations where they provide feedback to students.

As compared to feedback delivery, the methods of *communicating* feedback are the ways in which teachers *formulate* their feedback. For example, a teacher may *explain* why a student is correct or incorrect, *challenge* a student to rethink their answer, or *prompt* a student to look at a particular step the student performed while solving an equation by saying “look here” (see table 2 for additional examples). While delivering and communicating may be two different processes related to providing feedback, it does seem that they generally both occur within a given instance of providing feedback. For

example, P6 explains, “I’ll circle it and put a question mark or write, ‘Really? Two plus six equals seven?’, something like that. Or I’ll write, ‘Use your calculator’, circle the mistake and write, ‘Use your calculator’.” Within this one instance, P6 is delivering feedback via marking – circling and drawing a question mark – and written remarks, but they are also communicating the feedback through challenging – “Really? Two plus six equals seven?” – and instructions – “Use your calculator”. Additionally, it may seem that marking is simply a method of delivery, but it is also delivering a *prompt* to the student: circling generally indicates that the student should focus on that point in the problem they were solving. This point implies that students need to know how to interpret feedback, which will be touched upon later when discussing what teachers consider when determining feedback for students (research question #2). In addition, the potential for numerous combinations of delivery and communication methods implies questions about how teachers decide to present feedback to students. While the theme of consideration behind determining feedback will be discussed more fully later, there are a few points that provide insight to understanding how feedback is communicated and will be discussed next.

During interviews, participants routinely touched upon knowing what feedback and delivery style was best for individual students based on working with individual students and learning what information was most helpful for them. This knowledge of students’ needs was a clear factor that teachers considered when determining how to provide feedback to students. P6 described student differences in needing more or less

guidance in understanding a concept and this need influences the feedback delivery and communication style:

I think identifying the students that need the conversation, as opposed to just the writing... some kids, you really need to explain it to them. Other kids, they'll see it and they'll be like, "all right, I got it." You know, circle the mistake and they can figure it out. But some kids, I need to talk them through it, whether it's because they just don't understand it at all, if there's a language barrier there or you know, just to explain it to them helps clarify it.

Differentiation is a widely encouraged practice in classroom settings since the goal is to acknowledge each individual students' needs related to learning and use that information to support the student as they work towards the learning goals (O'Meara, 2011).

Participants provided examples that illustrate differentiated feedback based on students' needs:

... with a kid who's made careless errors like, "Okay, go back and check your calculation." My kid who I could tell they didn't understand the algorithm, "Hey, go back and redo that Desmos we did, go back and look at your notes." I might give them an easier problem, "Solve this problem and bring it back to me so that I can see how you did it" ... "Go back and show all of the steps that allowed you to get this answer" (P2).

In addition to content needs, feedback should be differentiated based on what students need to hear about their potential (Brookhart, 2008). Several participants discussed the awareness they have of the tone of their feedback and the desire to present feedback in a

way students will receive. P1 noted the intentionality of the delivery of feedback and the messages that can be relayed: “I will circle, I won't X things out because I want them to know that it's not, it's not done, it's not over”. P4 acknowledged the struggle students often experience in math and their focus to provide “feedback that tries to undo the negative images of their own abilities, [and] also just their negative impression of math in general and how it fits into their life.” While teachers formulate and deliver feedback based on students’ needs, they also construct feedback that supports the student in knowing how to proceed with their learning.

Effective feedback lets the students know, specifically, what they need to do to improve their learning (Brookhart, 2008; Clarke, 2000). Participants in the study demonstrated their efforts to provide students with specific direction and/or information they can use to progress:

I'll take the time to explain it. For instance, if I give a problem... that is on scientific notation... and they might've put a decimal point in the wrong place. I'll ask them questions like, “What's the rule for this?” Or “...go back and take a look at where you placed your decimal point,” you know, without giving them the answer (P2).

“Okay, here's where you got off track...” or “why did you divide by two? What made you do that?” You know, asking more thought-provoking questions, trying to get at their thinking while they were working, as opposed to the answer was just right or wrong (P4).

... then when it's not there, make a comparison to what you told them you wanted and what they actually did so they can see what's missing. Like ... "You need to edit this" or "Don't do this" type of thing, but be very specific about it (P6).

The content and delivery of feedback in these examples demonstrate how intentional teachers are in working to craft feedback that supports students' learning. In addition to awareness of content, teachers' accounts presented that communicating feedback also involves a variety of locations and number of recipients.

Communicating feedback means teachers need to formulate helpful feedback and determine the means of delivery, but it also involves making decisions about who and/or how many students need to receive the feedback. This decision influences the choices related to feedback formulation, delivery, and *location* where feedback is provided (see table 2 for list of examples). P3 explained feedback is "differentiated on the basis of individual versus small or large group" and P1 demonstrated the process of determining this. At one point in the interview P1 described,

... as I kind of you know, walk through the room and see how they're doing... if it's the recurring scenes or it's the 'Hey, we don't get this one, we don't get this,' so I'm like, 'Oh, okay, okay, up here, let's do number seven together'.

Shortly after, P1 went on to say, "... when a kid has whatever difficulties and, you know, scores at 25[%], I will try to, you know, personally talk to them" to encourage them and provide them with the help they need. P1 provided examples of whole-class and one-on-one delivery, but teachers also often organize activities involving small groups (e.g., 3-7

students) when “a small group of students... [make] a similar mistake, but the whole class doesn't need to hear it” (P3). While these are all examples of verbal feedback occurring in the classroom, location can also include written on paper, whiteboards, or even in online programs that are more recently accessible to schools. Additionally, these can present feedback to multiple students in the case of group work or on an individual basis. The many options teachers have for presenting feedback to students allows teachers to make decisions that will best relay helpful information to students based on students’ needs.

The teachers’ narratives identified numerous types of feedback formulation and delivery, as well as decisions related to location and number of recipients. In addition to providing insight into how middle school mathematics teachers communicate feedback to students, the teachers’ narratives also highlighted important themes related to how they determine the feedback they provide.

Findings for Research Question #2

Research Question #2: What do middle school mathematics teachers consider when determining feedback for students?

One broad theme and four subthemes were developed related to what teachers *consider* when determining feedback for their students. The overarching concept is that determining feedback means teachers consider how to make feedback effective. Within this broad idea, teachers consider (a) what information will help the student improve and/or continue being successful, (b) how to encourage students, (c) logistics around providing feedback, and (d) goals for student learning.

Information to Help the Student Improve

The first subtheme to present was that determining feedback means considering what information will help the student improve and/or continue being successful.

Teachers discussed working to identify “what type of information [they] want to relay to [their] student” and “where the room for improvement is” (P3). Several participants spoke about the practice of observing students to look for common errors and then creating opportunities to review or reteach a particular skill:

[I]f I see that there's a problem that a lot of kids got wrong... I'll go over the problem when I give the test back with the correct answer and I'll ask them to copy the corrections down. I do think that helps... doing the problem for them so they can follow through and see where they made their mistakes (P6).

In addition to providing information in large groups, teachers discussed working to provide tailored information to support individual students' needs. Specifically, there was a focus on understanding the cause of the students' errors, whether they were “careless errors” or the student “didn't understand the algorithm” (P2). Understanding the cause of these errors allowed teachers to formulate feedback that students can “understand and that they can act upon” (P3). Several teachers also noted that within this process of providing specific information, the goal was often to avoid directly giving the students the answer or correct way of solving a problem:

Like if they're with me and they made a silly mistake, I'll circle it and put a question mark or write, ‘Really? Two plus six equals seven?’, something like that.... I don't like to give them the answers because I'd rather they look at it and

figure it out themselves, or at least ask me. But if I just write everything there, sometimes they'll just file it and be done with it (P6).

My questions are usually so that they take another look... I'm putting questions, 'cause I want them to add the solution, I'm not giving them answers. I never give the right answer until there's no chance for you to turn the assignment in again. And once, you know, you attempted for the last time, then I'll give the right answer (P2).

This process of providing specific information without giving the solution supports the idea of considering what information will be helpful; effective feedback emphasizes the processes students are involved in and is supportive in making progress within those processes (Brookhart, 2008; Black & Wiliam, 1998; Hattie & Timperley, 2007). The *supportive* aspect of effective feedback is related to the second subtheme that presented within the teachers' narratives.

How to Encourage Students

The second subtheme that evolved from the teachers' insight was that determining feedback means considering how to encourage students. Much of the commentary that supports this theme centered around the ideas of knowing their individual students and their needs – so much so that the in vivo code “I know my students” was developed – as well as formulating feedback that was supportive and encouraging. While discussing knowing their students, teachers talked about knowing students' comfort levels with

receiving feedback, students' self-perception of ability, and the influence of peer pressure:

I think you have to know the student. There are some students who will respond even more favorably, you know, one-on-one, you'll find out stuff and they're open to it. Especially in middle school, peer pressure is very prevalent. So, I think a lot of it is knowing the student and getting a feel (P3).

... a lot of it's based on personality of the student.... the kids who are very outgoing and willing to engage, then it's, it's easy to kind of talk to them in a more open setting and, you know, with their small group that they're working in.

Others, it needs to be a one-on-one conversation. Yeah, so it does, it really just depends on the individual student (P4).

In addition, teachers were aware of the fact that feedback coming from them isn't the only thing the students are focused on at any given time. P3 stated, "I don't believe [feedback] operates in a vacuum, I think there's a lot around it...". P4 also acknowledged how this can influence how students respond to feedback, "There's just so many different, different responses depending on the kid in the day and the topic and the, you know, all the other things going on in their world." Recognizing students' needs and the external influences around them allowed these teachers to understand that the way they formulate and deliver feedback influences how their students will receive it.

Formulating feedback while considering how you want the receiver to receive it demonstrates an intentionality that these teachers bring to their classrooms. P1

emphasized utilizing a growth mindset approach in their classroom and discussed how that informed the feedback they give to their students:

I want them to know just kind of more from a growth mindset standpoint, like, “oh, okay, we've met this level of proficiency now we're ready to... level up with, you know, two step equations or two step equations with improper fractions” or, you know, like, “okay, now we're ready for that next layer or level.” Um, and just kinda that whole idea that we're not necessarily done-done, we're just building... I used to have a stamper... one of those, uh, self-inking things... it was something like, "You've only failed if you've given up", you know, try this again and resubmit it.

P3 also discussed how formulating feedback with the goal of meeting students where they at not only supports students but can create a better relationship between the student and teacher:

I think it's a really good way to, kind of join forces with the student and show that you're on the same page with the student, rather than just giving, you know, "Well, this is what you missed", it's more putting you on the same team and saying, "Well, this is what we can do going forward and this is the result that I expect". I think it's really important for human beings, to hear things like that.

Students develop perceptions of their teachers' beliefs about their (the students') abilities and these perceived beliefs can influence the students' academic success (Black & Wiliam, 1998; Hailikari et al., 2008; Pitsia et al., 2017; Rubie-Davies, 2006). Feedback is one way that students can interpret teacher beliefs. The teachers in the current study

demonstrated an understanding of this relationship and a desire to provide feedback from which students can feel supported. While developing supportive and helpful feedback for students is an important process teachers are involved in, the teachers in the current study were also aware of the logistics that are involved with developing and providing feedback and this resulted in the third subtheme that will be discussed.

Logistics around Providing Feedback

The third subtheme to surface from the data was determining feedback means considering logistics around providing feedback. The most commonly discussed logistical challenge related to feedback was the time involved, especially when written feedback is involved:

If it's written, it takes a long time. So, time, written feedback would be very time consuming (P4).

... sometimes I don't, I'm not able to give the level of feedback I want to in a written assignment because I'm also one of those people... if it kills me, I'm going to get them back the next day, because I don't want time, too much time to go by... homework, I try to get back the next day. There's sometimes I'll give a completion grade simply, because I want to make sure that I can just get through it and answer questions without holding on to it too long, um, because they need to know before we move on to the next thing. So, in a situation like that, I'm giving a completion, "okay, you did it now, let's give it back and really go through it" (P2).

Time is also a challenge for providing feedback during class. P5 explained that they often go over the various types of assessments after they've been grading to ensure students understand their errors and that this can take a significant amount of time away from instruction: "We dedicate usually half a class period to going over the formative question-by-question. And it's usually a full class period to go over summatives because it's longer." As was discussed earlier, teachers were aware of the support that can be given through individual feedback, but there's a sense that there's just not time for it in the current structure of education: "Time, time. It's, it's really hard to, I don't get to do as much individual feedback as I would. Like I could do a lot more with that if I had time" (P3).

In addition to time, logical challenges are present when teachers organize in-class activities and are working to support students during those activities:

Even in my classroom when they're working in small groups it's always a challenge to be giving feedback to one group and making sure that the other groups are continuing on track with focusing on what they need to be focusing on (P4).

There is also a timing issue surrounding feedback: different skills benefit from receiving feedback at different points within the skill and students' individual abilities will factor into this timing as well (Brookhart, 2008). P4 acknowledged this while discussing providing feedback and expressed that "knowing when they're ready for me to give them some feedback" can be a challenge as well.

While timing and classroom dynamics were the primary challenges discussed, teachers also mentioned logistics related to grading, transparency, and whether students know how to utilize the feedback they're given. The division the teachers are from has implemented standards-based grading, which emphasizes evaluating students only on abilities demonstrated (i.e., grades reflect students' knowledge; participation/effort are not included). Grading within this structure involves particular language related to different levels of success, such as "proficient," "mastered," and "approaching," and this needs to be communicated with the student (P1). Additional challenges occur within this system when expectations aren't clear and P1 expressed on those challenges related to providing feedback: "I still have a debate in my head as to whether there should be a partial credit for all this work shown in an incorrect answer, or, you know, are we going by the answer." Additionally, communication is encouraged, particularly since standards-based grading may be a new system for parents and this requires "transparen[cy] about what's expected of [the student]... to the kid and the parent." Finally, P3 spoke about the need to "educate" students on how to accept and utilize feedback to their benefit:

... it's hard for all of us to accept criticism and particularly hard at that age. So, I think part of what we have to do is teach them the process before we start teaching them where the mistakes are. I think we have to teach them to understand the intent. We have to teach them to how to use it to their advantage and not see it as such a negative thing.

It is obvious that teachers need to consider a number of variables when determining how to provide feedback and logistics related to class time, time needed to communicate

feedback, and dynamics involved when communicating the feedback can create challenges to work with, particularly when class and planning time is short. A final subtheme that developed, which can also have logistic considerations, is related to goals for student learning.

Goals for Student Learning

The fourth and final subtheme that was developed from the data was determining feedback means considering goals for student learning. Teachers spoke about feedback with a sense that there is a purpose of the feedback to move students forward in their learning, but also with a sense that there were additional, underlying purposes as well. For example, teachers generally felt that the goal of feedback is to help students understand how they are performing and progress in terms of a learning goal:

[I]t's kind of a way for kids to say, "Okay, I did this great work, and one little part here didn't come out quite right" (P1).

[F]eedback just lets kids know what they achieved or mastered... what it is they set out to do (P2).

I think the student needs to understand where they are... and what the goal is and whether they're falling short or whether they're achieving (P3).

However, teachers also demonstrated a belief that feedback can support non-content-specific skills or understandings. P1 stated they "don't write the letter grade [on graded assessments] 'cause [they] want [the students] to build the 'what does this relate to?'" In

other words, P1 wants their students to understand that a 90% doesn't just mean an "A," it means they've demonstrated they understand 90% of a particular skill. P4 explained that another goal of feedback is to support students' autonomy:

I try to have them own their grades... and they keep a running log of their formative and summative assessments... so that we can have conversations about you know, how formative predicts summative and if you didn't do well on this, formative then that prompts you to know, "Hey, I need to go back and, you know, figure out what I missed, but also figure out why I missed it and what I need to do to get past that, so you know, when I get to the summative, I'm on track for what I, you know, what I'm supposed to be doing or that I know that I understand it" (P4).

[A]nother piece of the feedback is for them to be able to make choices. So that [if they have a] C in the class and they get an F on a summative and still have a C in the class then, you know, then that gives them the opportunity to weigh their options and think about, you know, "Is this a skill I'm going to need later?" (P4).

When P4 discussed how they have students keep a running log of their assessment scores, they were also demonstrating a third underlying goal of feedback, which is to positively influence and support future skills and learning. P3 demonstrated a belief in this goal as well:

I hope they get feedback that they can actually use and that they can appreciate. And then it becomes a positive influence and something that they would welcome

again in the future. So that you're building that cycle of class and work and feedback, and then improvement, so we should build an improvement cycle there. The teachers' narratives suggest that they work to keep these underlying goals in mind as they develop feedback that supports their students not only academically in terms of the content, but also supports their skills as a learner and as an individual who is capable of making progress towards goals. This subtheme and the previous three each demonstrate the plethora of factors that teachers are aware of as they consider how to make feedback effective for their students. While teachers' considerations influence the feedback they develop, there are additional facets of feedback development and the more general research question #2a analyzed the data to better understand teachers' feedback determination at a broader level.

Findings for Research Question #2a

Research Question #2a: *How do middle school mathematics teachers determine the feedback they give to students in response to learning activities?*

Two broad themes and a theoretical construct were developed after analyzing the data for information about how teachers determine feedback for their students. Three subthemes were developed within each of the two broad themes. While the subthemes in the section for research question #2 were discussed in their own subsections, the subthemes will be discussed together due to the closer interaction they share within the themes. The theoretical construct will be discussed last on its own. Due to the broader nature of the current research question, several of the previously discussed themes or concepts will be referred to.

The first of the two central themes is teachers determine feedback by analyzing students' work, identifying students' level of performance, and knowing students' abilities. The subthemes for this theme are teachers determine feedback by (a) creating additional learning activities, during which feedback can be determined and provided, (b) observing student performance, and (c) interacting with students. The second theme revealed is determining feedback means providing students with the information and support they need to succeed. Within this theme are the subthemes determining feedback means (a) giving helpful information that will support student understanding and development, (b) encouraging students and providing positive support, and (c) focusing on improvement/growth. Finally, the theoretical construct developed is determining feedback is inherent to and engrained within teaching.

Analyzing Students' Work, Identifying Levels of Performance, and Knowing Students' Abilities

The first developed theme encompasses many of the concrete, physical actions teachers implement to determine feedback for their students. Teacher-planned learning activities can be viewed as the starting point for the feedback process, as teachers need to see work-in-progress or completed work to be able to provide feedback. The data supported this perspective as the first subtheme to present is that teachers determine feedback by creating learning activities, during which feedback can be determined and provided. Teachers discussed the opportunities they create in their classrooms for students to demonstrate what they know about a particular topic:

... a question that you know, it goes a little deeper, ask for more free-range responses to try to get into the student's head and try to think about trying to understand that thought process. Sometimes it's a more shallow... mechanical kind of point that you're trying to tease out and try to understand exactly where the little mechanical issue is that you're trying to correct (P3).

[D]uring class, I stop a lot, I give a lot of wait time. I'm big on letting kids answer each other's questions, even little things... You know, and I'll have kids restate that question. I have kids once they explain it, I'm like, "okay, now you tell me what he just said". And then if they... you don't explain it, right, I'm like, "Nope, that's not what he said. You explain it again... So, I'm real big on having kids explain things to each other. They just understand their language (P2).

[M]any times, I'll have them bring their workbook under the document camera just, and not even knowing if it's correct or not like, "Okay, well, let's talk about this." So, I guess that whole idea of, of not necessarily being right or wrong, but the process of math, and then I'll just the process also of talking through the math to, you know, to build the rationale (P1).

Teachers were also aware that these opportunities allow students to reach challenges, which can be then addressed: "they will compare their answers with their... table group partners, and then.. the math dialogue gets going, and then after some period of time, depending on the complexity I'll take questions from them" (P1). Additionally, these

learning activities were opportunities for teachers to provide feedback on previous learning activities. Teachers gave examples of creating discussions and activities, as opposed to simply telling students what they should have done differently:

I think error analysis works really well, showing an equation and I think maybe even focusing or showing specific errors that you have seen, or even showing students' work and saying, "We were having trouble dividing one-step, you know, negative two X equals eight. We're having trouble dividing by negative two, we want to divide by two" so it can be very pinpoint-type of issue that you show is an error and that you try to generate discussion and feedback on that (P3).

"Okay, here's where you got off track so I can see that you..." you know, or "what were you thinking when you did this?" Or "why did you divide by two? What made you do that?" You know, asking more thought-provoking questions, trying to get at their, their thinking while they were working, as opposed to the answer was just right or wrong (P4).

Each of the examples discussed demonstrates the purposeful activities that teachers plan that allow them to collect evidence of their students' understanding of current content. While these activities are taking place, teachers are actively observing student performance and interacting with students, which are the second two subthemes that were developed from the data.

The teachers in the study provide much evidence of observing student performance and interacting with their students, though the majority of these actions are

implied through their explanations of activities they implement in their classrooms or beliefs they have about feedback. For example, P2 was cited earlier regarding the practice of having students restate explanations they heard from other students. P2 uses this opportunity to listen to students' explanations to ensure they understand a concept. There were countless more examples in the data of teachers listening to students' explanations, watching students work with concepts, and paying attention to patterns in the students' work. Additional examples demonstrate that teachers determine feedback by interacting with students. P4 was cited earlier regarding the practice of asking students questions to better understand their thought processes related to solving a problem. Through this interaction, P4 is able to understand the students' misconceptions and/or gain a better picture of what the students understands about a skill or topic. Once again, there were additional examples in the data of teachers presenting students with prompts, engaging students in conversations, and challenging students' thinking and answers to support students' understanding.

The teachers' narratives provide evidence for the active ways teachers gather information on student understanding and use that analysis to determine feedback for students. Once teachers determine this feedback, they are able to support student learning by providing students with information and encouragement to progress.

Providing Information and Support for Success

The second theme that resulted from analyzing the data about how teachers determine feedback was that determining feedback means providing students with the information and support they need to succeed. While some of the actions are visible like

the previous theme and subthemes that were found for research question #2, some of these actions are more of an awareness or focus for driving decisions related to instruction and feedback. Two of the subthemes – determining feedback means (a) giving helpful information that will support student understanding and development and (b) encouraging students and providing positive support – are very similar to themes discussed earlier, but will be revisited briefly. It is reasonable for these two themes to be present for research question #2 and research question #2a. This is because the complex coding query for #2a returned the intersection of “feedback” and corresponding subcodes with “processes” and “values” and their respective corresponding subcodes and the complex coding query for #2 returned the intersection of “feedback” and corresponding subcodes with “deciding” and “values” and corresponding subcodes (among others). Since “deciding” is a subcode of “processes” and “values” was included for both, it is reasonable for these two subthemes to be present in the findings for both research questions.

The earlier discussion regarding the findings for research question #2 revealed that teachers consider what information will help students improve or continue being successful, as well as consider how to encourage students. That discussion emphasized the *thinking* behind determining feedback, while the current discussion focuses on the *acts* involved in providing feedback and what determining feedback *means*. Again, it is reasonable for these two ideas to reappear since thinking about what information and content and/or emotional support to provide would likely be followed with the act of providing that information and support. Evidence was provided earlier to support the idea

that teachers consider what information and encouragement to support students and teachers' narratives were full of examples of providing this support as well. P4 explained a system they use to ensure they're providing each student with the support they need:

I use lots of checklists, so I know with equations, for example, "Okay I know you can solve one-step equations with addition and subtraction, but we're still working on multiplication and division" and this other person, you know, the next student I can say, "All right, we've pushed through you know, two-step equations and you're ready to start multi-step" and so it gives me a visual of where each student is and that way I can give them feedback, but also push them, you know, at their level, wherever they are (P4).

P2 was quoted earlier as evidence that teachers consider students individual needs and the quote lends itself to the current discussion as evidence for the specific actions teachers implement to support students at different levels. P2's feedback to students is crafted according to what each student needs to hear so they can revisit the content at the particular point that will help them progress from their current understanding in the content:

... with a kid who's made careless errors like, "Okay, go back and check your calculation." My kid who I could tell they didn't understand the algorithm, "Hey, go back and redo that Desmos we did, go back and look at your notes." I might give them an easier problem, "Solve this problem and bring it back to me so that I can see how you did it" (P2).

This individualized feedback is considered to be more effective because of its focused nature in supporting students exactly where they're at (Brookhart, 2008; Black & Wiliam, 1998; Hattie & Timperley, 2007). Teachers also discussed providing encouragement and positive support in similar ways.

Providing encouragement and positive support was discussed earlier as a consideration when determining feedback but, as with content information, teachers also discussed ways that they implemented positive support. Knowing individual students' emotional needs around receiving feedback was heavily discussed as a consideration and P3 provided commentary on how they implement that practice:

[Y]ou cannot approach every single one of them, like eighth grade generic student. So, I make just informal notes in my head. It's nothing formally written down, but I know I try to know how I can approach a student. I, I try to know what can get a little laugh. I try to know what can diffuse a situation. I try to know what's normal and what's unusual.

When teachers keep these mental notes about students, they can access them at particular points when preparing to give feedback and can then provide individualized feedback that meets students where they're at on a personal and emotional level. P3 added a second piece about how they're sensitive to timing needs:

[M]iddle schoolers can be very fickle and difficult sometimes. Well, that's not the day for feedback... I wait for a day where they're going to be hopefully receptive to that... because I know that my chance of success of getting through is, is much better on that day.

In addition to knowing how to approach students, teachers provided examples of ways they encourage students who are struggling, especially with confidence in abilities:

I will make kind of a rudimentary bar graph, like, "Hey, for this particular test, we had, you know, 15 B's, only 2 A's, 13 C's and so on. So, you know, see where you are on here before, you know, you decide whether you should be so hard on yourself". Unfortunately, a lot of it just comes down to like, they internalize that percent grade so much (P1).

[I'll] say, you know, "look, you did all of this and clearly you understood all of this. And yesterday I know you didn't, you know, yesterday here's where you were and today you were able to do this with no problem" (P4).

When discussing feedback practices, teachers provided these examples of communicating positive messages to students about their potential, which are important for students to hear (Black & Wiliam, 1998; Rubie-Davies, 2006). Many of these comments of encouragement emphasized a focus on improvement and growth towards the learning goal, which aligns with effective feedback practices (Brookhart, 2008; Hattie & Timperley, 2007; Sadler, 1989). This focus made up the third subtheme to present within the current overarching theme.

Teachers often mentioned relating feedback given to the students to the learning targets students were working towards and explained that it helps students understand what it is they're working towards:

I think the student needs to understand where they are... and what the goal is and whether they're falling short or whether they're achieving (P3).

[F]eedback, just lets kids know what they achieved or mastered, um, what it is that they set out to do (P2).

In addition to maintaining a focus on the target, teachers also discussed emphasizing the improvement process and “build[ing] an improvement cycle” so that students see that growth is just as important as scores (P3). P4, who teaches a remedial math class, was especially supportive of this perspective: “[E]verything I do is feedback, which is nice because I don’t have to worry about relating it to a grade, it’s just improvement, improvement, improvement”. While the rest of the teachers in the study teach typical math classes where grades are expected to be assigned, there was a clear focus towards balancing grades with creating an environment that values the improvement process, including the small improvements along the way. It was revealed through the teachers’ narratives that the focus on improvement is used as a way to encourage students and support their self-beliefs in their ability to succeed in math. This focus supports the overarching theme that determining feedback means providing students with the information and support they need to succeed. Additionally, this approach presents some values that teachers commonly hold that demonstrate how deeply rooted the concept of feedback is within the act of teaching.

Determining Feedback is Engrained within Teaching

The two primary themes and corresponding subthemes just discussed covered the majority of the themes that resulted from the data analysis for research question #1. However, 17 themes remained and while attempting to organize, it became clear that as a whole, the themes exemplified the teaching profession as much as they did the feedback process in a classroom. The theoretical construct, determining feedback is inherent to and engrained within teaching, was developed after considering how intertwined feedback practices are to teaching practices. There were numerous instances in the data where teachers were describing scenarios in which the interconnectedness of the teaching practice and feedback processes were very visible. For example, when asked to describe how they use the results of assessments, P3 explained the following:

I have to say it's probably it's probably fairly informal. I mean, it's informal, but it's highly relied upon and by that I mean, I gather information, I use it... issues that are continuing to cause problems continue to be brought up in different ways in, in future either warm-ups or class discussions or feedback... I would work it into station work. I just, wherever I'm putting problems in front of the student, in whatever context or format I would continue to drill down into those issues where I have gotten that sort of feedback that I know that there's an issue with you know, that particular problem.

P3 is describing the process of providing practice of challenging problems to students and feedback is provided as needed within this process. The “as needed” quality of these processes often influence teachers to adjust their plans for instruction and feedback:

[S]ometimes you can see like they're defeated and I'm wondering like, oh, coming back... what should we do? Should we launch right into wherever we left, what I was planning for Monday? Do we need to kind of do a reset and, uh, take it easy, kind of thing? So, I think the body language is important as I kind of you know, walk through the room and see how they're doing... if it's the recurring scenes or it's the, "Hey, we don't get this this one, we don't get this", so I'm like, "oh, okay, okay, okay, you know, up here, let's do number seven together" (P1).

This segment illustrates the flexibility that is needed within both teaching and providing feedback, and this ability to adapt and adjust was one of the supporting themes for the theoretical construct (see table 4 for additional supporting themes).

Table 4

Theoretical construct related to determining feedback developed through organizing themes

Theoretical construct: Determining feedback is inherent to and engrained within teaching
Supporting themes:
<div> Determining feedback means... <div> being intentional <div> looking for opportunities within routine processes (e.g., receiving grades) for students to develop understanding <div> planning ahead to incorporate check-ins with students <div> adapting/adjusting <div> being ready to explain specific cases <div> using tools and technology </div> </div> </div> </div> </div> </div> </div>

communicating
dedicating time
being timely
using appropriate measurements to assess students
making decisions about grading/evaluating
working within required grading structures
relating feedback to a grade/evaluation
marking student work
considering where in the learning process you are
referencing expectations
supporting students' autonomy

Note. This table provides themes developed through data analysis that were remaining after all others had been organized by hierarchy. The theoretical construct was developed when it was determined that these themes fit together as a whole.

Within the two quotes just presented, there is also evidence of communicating, being intentional, dedicating time, and considering where in the learning process they are.

These skills and approaches were themes resulting from data analysis focused on feedback and they are skills and approaches commonly demonstrated by teachers. This apparent inherent nature of the presence of feedback within teaching suggests the need to fully understand feedback processes and ensure teachers know how to implement effective feedback practices in their classrooms.

General Discussion

The goal of this study was to better understand how middle school mathematics teachers determine and communicate the feedback they give to their students in response to learning activities. Current research and literature provide guidance for teachers to develop effective feedback for students (Brookhart, 2008; Clarke, 2000; Harks et al., 2014; Hattie & Timperley, 2007; Krijgsman et al., 2019; Moylan, 2013). However, evidence also suggests these effective feedback practices are lacking in today's mathematics classrooms (e.g., Bature & Atweh, 2020; Haara et al., 2020; Hartland, 2020; Monteiro et al., 2019; Rathje, 2018) and that teachers experience a lack of support in implementing effective feedback practices (Rathje, 2018; Shrum, 2016). The data resulting from the current study provides insight into teachers' thoughts and actions related to determining and providing feedback to students, which may contribute to determining how to better support teachers in learning and implementing effective feedback practices in mathematics classrooms.

The data reveals that feedback is a multifaceted process that middle school mathematics teachers are concerned with on a regular basis. Teachers demonstrated a focus on strategies, activities, content, sensitivity to students' needs, awareness of learning goals, and providing as much individual attention as is possible. Since feedback is not a commonly instructed upon topic in teacher preparation programs (Rathje, 2018; Shrum, 2016) much of the skills and knowledge involved in implementing feedback with these foci in mind is learned through teacher experience, often with some guidance from colleagues or mentors. With recent attention to the importance of the feedback in the

classroom (e.g., Boud & Molloy, 2013; Carless, 2006; Van Der Kleij & Adie, 2020) and so much involved in this single aspect of the teaching and learning process, it is arguably an area worth investing in to ensure teachers are appropriately trained to implement effective feedback practices and best support students. This is especially true for mathematics classes in which discouragement and lack of motivation are often present (Heyd-Metzuyanim, 2015; Morgan et al., 2015; Newcombe et al., 2015) and traditional feedback practices appear to remain (Bature & Atweh, 2020; Haara et al., 2020; Hartland, 2020; Monteiro et al., 2019; Rathje, 2018). The data from the current study exposes some important aspects of the feedback processes middle school mathematics teachers are involved in which may help in determining how to best support teachers in learning effective practices.

The teachers' narratives revealed how deeply engrained feedback is within teaching practices and this may be a starting point for supporting teachers. Instead of viewing feedback simply as strategies or processes that teachers utilize to convey how students perform, it may be beneficial to train teachers with a lens that views feedback as a natural part of the teaching and learning process. Teacher excerpts in Fonseca et al.'s (2015) study demonstrate a new awareness of the presence of feedback within teaching following a workshop in which teachers learned feedback strategies that emphasized teacher-student relationships, reflection, and progress. It is of course important to ensure teachers understand the variety of methods available for delivery and feedback formulation that the current study's data revealed, but presenting these strategies within a mindset that emphasizes feedback as a way to relay information, support students, and

promote progress may help teachers in providing feedback that is specific and supportive for students' success. In addition to revealing a general approach to feedback that may support teachers' implementation of effective feedback practices, the data also revealed a couple of themes that offer insight to teacher practice.

Two themes appeared multiple times during the discussions focused on results from analyzing the data regarding how teachers determine the feedback they give. These themes were centered around providing helpful information and providing support that meets students' needs. While there is much evidence from the teachers' narratives to show the teachers in the study work to implement these practices in their classrooms, there are also some important points to consider within each theme. The first theme – providing helpful information – is important to reflect on because of the subjective nature of “helpful”. While mathematics teachers generally possess a sound understanding of the math they are teaching, they hold a trained-perspective of the concepts that students do not (Brookhart, 2008; Sadler, 1989). This can create challenges if teachers are providing information they see as helpful to students who do not understand the information they are receiving. Examining students' perspectives of feedback and what they deem as “helpful” would be beneficial in understanding how teachers can prepare and present feedback that students feel they can use. Brookhart (2008) emphasized the importance of using appropriate language and mentioned grade-level as an indicator for determining what context is appropriate for students. However, large variations can exist in individual classes and this requires the teacher to know students' individual levels in order to provide feedback that is appropriate for each child. P4's practice of asking the student

questions to better understand their thinking in order to address misconceptions is an invaluable practice that teachers could be encouraged to use as they get to know their students and their individual levels. This individual attention relates to the second theme that appeared multiple times, which was providing support that meets students' needs.

The theme of knowing students and meeting students' needs around encouragement is a topic that has recently received more attention (e.g., Sakiz et al., 2012; Tennant et al., 2015; Young et al., 2011; Wentzel et al., 2018). Programs that emphasize supporting positive behavior and building relationships with students have been incorporated into schools and teachers have received support in implementing programs in their classrooms (Tyre & Feuerborn, 2021; Weist et al., 2018). However, teachers still report challenges with positive support programs (Tyre & Feuerborn, 2021) and building relationships (Duong, et al., 2019). If knowing students' individual abilities, perceptions of concepts, and emotional needs around receiving feedback are important for determining feedback, but teachers are still struggling with building relationships with students, a lack of implementation of effective feedback practices seems logical.

Providing appropriate support for teachers in teacher preparation programs and professional development that focus on better knowledge of students' needs and abilities, as well as how to prepare feedback in a way that aligns with students' current understanding is an important stepping stone to ensure teachers are implementing effective feedback practices in mathematics classrooms.

The current study revealed data that provided insight to important workings within the feedback processes that take place in mathematics classrooms. By considering

these findings and reevaluating teacher preparation programs and professional development, it may be possible to support teachers in learning effective feedback practices and support students' success in middle school mathematics classrooms.

Educational Implicants, Limitations, Future Research, and Conclusions

Educational Implications

Data gathered through interviews with teachers provided insight to teacher experiences with feedback as they assess student learning and develop feedback to present to their students. The data revealed that feedback is a complex process that middle school mathematics teachers are concerned with on a regular basis. Teachers demonstrated a focus on strategies, activities, content, sensitivity to students' needs, awareness of learning goals, and providing as much individual attention as is possible. Since feedback is not a commonly instructed topic in teacher preparation programs, much of the skills and knowledge involved in implementing feedback with these foci in mind is learned through teacher experience, often with some guidance from colleagues or mentors (Rathje, 2018; Shrum, 2016). With recent attention to the importance of the feedback in the classroom (e.g., Boud & Molloy, 2013; Van Der Kleij & Adie, 2020) and so much involved in this single aspect of the teaching and learning process, it is arguably an area worth investing in to ensure teachers are appropriately trained to implement effective feedback practices. This is especially true for mathematics classes in which discouragement and lack of motivation are often present among students (Heyd-Metzuyanim, 2015) and traditional feedback practices appear to remain (Hartland, 2020; Monteiro et al., 2019). Data from the current study exposes some important aspects of the

feedback processes middle school mathematics teachers engage in, which may help in determining how to best support teachers in learning effective practices.

The teachers' narratives revealed how deeply ingrained feedback is within teaching practices and this may be a starting point for structuring teacher preparation programs and professional development. Instead of viewing feedback simply as strategies or processes that teachers utilize to convey how students perform, it may be beneficial to train teachers with a lens that views feedback as a natural part of the teaching and learning process. Presenting methods for delivery and feedback formulation within a mindset that emphasizes feedback as a way to relay information, support students, and promote progress may help teachers in providing feedback that is specific and supportive for students' success. In addition to revealing a potentially beneficial general approach to feedback, the data also revealed factors related to feedback development that could be organized into documents to serve as guidance for teachers to consider when developing feedback for students.

Analysis for research question #2 resulted in the overarching theme, determining feedback means considering how to make feedback effective. The four developed subthemes within this theme state that when determining feedback, teachers consider (a) what information will help the student improve or continue being successful, (b) how to encourage students, (c) logistics around providing feedback, and (d) goals for student learning. These subthemes could be organized into a checklist or rubric for teachers to keep in mind as they develop feedback for students. While the presence of these themes within the data shows these are concepts teachers may be aware of, keeping track of these

different facets of feedback can be challenging when managing 20-30 students during a class period and considering feedback for 100 or more students. Checklists and rubrics can serve as visual reminders for busy teachers as they work to provide their students with feedback that will help them progress in their learning. These checklists and rubrics could be especially helpful for new teachers who are focusing on building the foundations of their practices during the first few years. Additionally, new teachers, whether first-year teachers or new to a school division, are often paired with mentor teachers to ensure a smooth transition to the county and equip teachers with teaching strategies the county embraces (Ewing, 2021; Schatz-Oppenheimer, 2017). Mentor teachers could utilize these checklists and rubrics as discussion points and encourage the use in developing effective feedback practices.

Understanding these experiences provided valuable insight that could be used to further develop teachers' feedback practices, for both new and veteran teachers. These insights could be used to reframe the attention to feedback within the teaching community and create the resources discussed to support the development of effective feedback practices. While the current study has its limitations, which will be discussed next, there is also room for continued research and development of effective feedback practices within classrooms as there is a clear value for student learning and success.

Limitations

Several limitations have been identified within the current study. First the small sample size reduces the amount of data that was able to be collected. Additionally, all teachers in the study were employed in the same teaching division, which limits the

perspectives of feedback processes if certain expectations of feedback are expressed within the teaching division. Second, the data is reliant on self-reporting, which poses threats to accuracy of the data. Anonymity was expressed to encourage truthful and accurate representations of experiences with feedback development.

Future Research

Following this study, additional research should be conducted to identify variations in teachers' experiences with feedback. Since this study focused on middle school mathematics teachers, further research should explore teachers of other subject areas and teachers of other grade levels. Additionally, further research should include larger samples and multiple school divisions, which could present differing views of feedback dependent on school division. Understanding differences in different divisions may present experiences or practices that could be incorporated in divisions that don't use those practices. It may also be beneficial to investigate principals' perspectives of feedback to understand what messages are being relayed to teachers regarding feedback practices. Lastly, as was mentioned earlier, it would be beneficial to explore students' perspectives of feedback to understand what they view as "helpful" so that teachers can keep those points in mind while developing feedback.

Conclusions

For many middle school mathematics students, feedback from teachers can be an uncomfortable and discouraging experience. Fortunately, research has been revealing the strategies and approaches teachers can use to implement effective and support feedback practices in classrooms (Black & Wiliam, 1998; Brookhart, 2008; Hattie & Timperley,

2007; Sadler, 1989). While this literature is available, it seems these practices have not yet made it into the majority of mathematics classrooms (e.g., Bature & Atweh, 2020; Haara et al., 2020; Hartland, 2020; Rathje, 2018) and it appears the hang-up may be related to a lack of relaying the information to teachers and ensuring they receive support while learning how to implement the practices properly (Rathje, 2018; Shrum, 2016). The current study provides insight to how teachers determine the feedback they do give and also raises additional questions about how teachers can determine the best information that is most helpful for students at a given time. Additional research may support future work in supporting teachers in implementing effective feedback practices, but changes to teacher preparation programs and professional development are also needed to incorporate an emphasis on feedback as an essential process within the teaching and learning process. While additional work is needed to ensure middle school mathematics students are receiving truly supportive and helpful feedback, it is clear that teachers are working and using the skills they have to provide students with support that can help them succeed.

APPENDIX A

Feedback Interview Protocol

STUDY RESEARCH QUESTIONS:

1. How do middle school mathematics teachers determine feedback they will give students in response to learning activities?
 - a. What do middle school mathematics teachers consider when determining feedback for students?
 2. How do middle school mathematics teachers communicate feedback to students?
-

Begin with the script below and then ask the questions in the order they are presented. Be aware, before the interview, of italicized directions to be prepared for those directions as they approach.

Thank you for taking the time to meet with me today. I really appreciate you giving me your time and insight for this interview. Before we begin, do you have any questions about the informed consent form that you completed?

Address any questions the participant has, using the actual form they signed to clarify.

Once questions are addressed, or if they have no questions, continue to the interview.

To be sure I have an accurate record of our conversation, I am going to record our interview using the Zoom recording feature and will be recording a backup on my phone as well. Is this okay?

If the participant objects, explain that unfortunately I can't continue the interview. If this is the case, thank the participant for their time and end the interview. If the participant agrees to the recordings, thank them and continue.

Today is (DATE/TIME) and I am speaking with (PARTICIPANT). I am going to be asking a few general questions. If there's anything you don't feel comfortable answering, that is not a problem; just let me know and we can skip past that question.

1. Tell me about your teaching experience.
 - a. How many years have you been teaching?
 - b. What grade levels and mathematics areas/foci have you taught?
2. What various types of methods do you use to assess abilities during learning activities?
 - a. How do you determine which methods are appropriate for different phases within a unit or topic?
 - b. How do you select questions or prompts that appropriately assess your students' abilities?
 - c. Walk me through an example of a recent assessment.
3. How do you use the results of those assessments?
4. What do you consider your biggest challenges around assessment?
5. How have your assessment practices changed over time?
 - a. What motivated those changes?
6. Tell me about the role of feedback in your classroom.

- a. What methods do you use to give feedback to students? And/or how do you communicate the feedback to your students?
- b. What do you hope for regarding the role of feedback in your classroom?
- 7. What expectations do you have regarding how students use feedback?
 - a. How do students know what to do with the feedback you give them?
 - b. *(If they've taught different grades)* How does the students' abilities influence how you give the feedback?
- 8. What do you consider your biggest challenges around implementing feedback in your classroom?
 - a. Can you give me an example of that?
- 9. How has your approach to feedback changed over time?
 - a. What motivated those changes?
- 10. What plans, hopes, or goals do you have for developing your teaching that may be connected to assessment and feedback practices?
- 11. What advice would you give to beginning middle school math teachers about providing feedback?
- 12. What else would you like to share about your approach to feedback or use of feedback with your students?

Thank you so much for all of your insights regarding these questions. I truly appreciate your time and responses. If you have any questions in the future, please feel free to email me. Thank you again!

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