Formative Assessment in the High School Mathematics Classroom

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Introduction

In the classic assessment model, students have a sequence of chapter test grades that create their learner's profile. It does not share specific information about areas of strength or weakness. There is limited incentive for low achievers, as many often write off the class or have no idea how they could possibly improve their grade. They are not good at math and just cannot wait for the course to be over. What if there was a new assessment model that focused on students' current course knowledge, a model that provided students clearly defined measureable goals with tangible and immediate rewards? Would it be possible for students to come into an assessment day, eager and excited to show off the learning they have gained since the last assessment?

Effective mathematics education is currently dominated by the importance of teachers demonstrating student learning growth, supported by rigorous curriculum requirements and standards-based grading. Unfortunately, there is little in terms of recommendations or advice on how to help all students reach the same "finish line" when they are all starting from different points. One classroom practice that repeatedly appears in research supporting student growth, confidence, and motivation, is formative assessment. Therefore, my research will focus on determining whether implementing new formative assessment strategies, centered on a modification of Dan Meyer's *Comprehensive Assessment Tool*, alongside student surveys and questionnaires, will improve student performance and subsequently attitude, confidence, and persistence in problem solving.

To improve my formative assessment techniques, I will select the critical concepts from a unit, providing students with a specific set of expectations for their learning. Students will be given repeated assessments over concepts, charting their own growth on topics, remediating

when necessary, until they are satisfied with their performance. To assess students' motivation, attitude, and perceptions about mathematics, I will implement questionnaires and surveys, looking for trends and progress after the assessment changes.

Literature Review

Raising standards and subsequent student performances have become national priorities in education, but suggestions of how to directly help inside the classroom, the black box, as described by Black and Wiliam (1998), have been missing. One element of the teaching, formative assessment with feedback has shown to be a powerful tool to support student achievement and motivation (Nolen, 2011). Formative assessment, when delivered correctly, should provide information that can modify thinking or behavior that can be used by teachers and students to help improve learning and performance (Black & Wiliam, 1998; Shute, 2008). It should not only communicate values and standards of the content, but show students how their current performance level compares to the desired level (Black & Wiliam, 1998; Shute, 2008). This can be done with supporting materials, concrete rubrics, retests or rewrites, and teacher examples. There has been much discussion and research on the different ways formative assessment can look, how to administer it so it is most effective, its role in assigning grades, and its importance in student motivation.

Formative assessment can take on many different forms. It can be used to verify response accuracy or show correctness (Shute, 2008). It may go further and explain the correct answer by addressing what was discussed, what errors occurred, and making suggestions for improvement (Shute, 2008). Comments may be intended to prompt change or not, serve as suggestions for future thought, vision, or conceptualization (Shute, 2008). Teachers may choose

to simply give students hints toward a particular response or work through part of a problem, leaving the final steps for students (Shute, 2008).

There are several key features of formative assessment. It is essential that students possess a list of the specific goals/standards that will be assessed, as well as a reference level or exemplar for their desired performance level (Nicol & Macfarlane-Dick, 2006). This allows students to compare their current performance levels to a specific goal or standard rather than to the performance of their peers. Also, this information gives both the student and teacher a clear indication of the appropriate actions that will lead to the closure of the gap between the current and desired performance (Nicol & Macfarlane-Dick, 2006; Shute, 2008).

Another important feature of formative assessment is its ability to increase the reliability and validity of grades (Allen, 2006). The primary goal for educators should be for students to learn the academic content knowledge. Formative assessment alongside specific standards and goals allows for an objective grade calculation that recognizes true academic achievement (Allen, 2006). Research has shown that numerical scores and grades alone can be counterproductive, as students often overlook comments when a specific score is given (Black, Harrison, Lee, Marshall, & Wiliam, 2004). This is why feedback must tell students how they can improve their work and cause reflection. Their scores must be less of a comparative judgment, but rather a distinctive step in the process of learning (Black et al., 2004)

Formative assessment not only provides feedback while students are learning, but also considerers how to motivate student learning and encourage self-regulated learning (Allen, 2006). For formative assessment to be most like a teacher (Nicol & Macfarlane-Dick, 2006; Shute, 2008), students must learn it is worth their time to persist and that they all can achieve in their learning efforts by acting on feedback, improving understanding and performance (Black et

al., 2004, Nicol & Macfarlane-Dick, 2006; Nolen, 2011). There are not winners and losers, but instead opportunities to apply criteria to understand how work may be improved, reworked, or reassessed (Black et al., 2004). Formative assessments must focus on growth and feedback rather than grades or comparison (Nolen, 2011). Research has shown that feedback plays a critical role on learners' motivational beliefs, self-esteem, and development as self-regulated learners (Black et al., 2004; Nicol & Macfarlane-Dick, 2006). Formative assessment, when executed correctly, creates a task-oriented system that attributes performance to effort and learning (Black et al., 2004). This performance-based feedback has been shown to increase motivation and persistence, while being perceived by students to be more effective and fair than typical reward behavior like praise or grades (Nolen, 2011).

Formative assessment is an effective classroom procedure that gives students an opportunity to take charge and enhance their learning, allowing for improvements on each subsequent assessment. At first it may seem like an overwhelming task, but starting small, working with others, and looking to administrators for support will improve the ease of implementation (Black et al., 2004). The following sections describe how I will implement a modification of Dan Meyer's *Comprehensive Assessment Techniques* alongside student surveys and questionnaires to improve formative assessment and feedback, in hopes of increasing student self-regulation, motivation, and persistence in problem solving.

Data Collection

Description of Research Context

The following study will take place in an Algebra 2 classroom at Woodhaven High School. Woodhaven High School is a suburban district, south of Detroit, that educates over

1,300 10^{th} – 12^{th} grade students. The estimated ethnicity breakdown is 73% white, 13% Black, 7% Hispanic, 5% Asian, and 3% American Indian, with approximately 17% of students eligible for free lunch and 4% eligible for reduced lunch.

The Algebra 2 classroom where the study will occur consists of 28 students of mixed genders, races, and abilities. The course is intended for eleventh grade students, but there are 3 sophomores, 24 juniors, and 1 senior, due to advanced students taking Geometry in ninth grade at the Middle School, as well as failures in previous attempts at the course. This course is the second part the Algebra 2 curriculum and is a 12-week trimester, consisting of 70-minute class periods. A student's teacher can vary from one trimester to the next, but 26 of the 28 students had the same teacher for the first 12-week trimester of the course. All students in the Algebra 2 course will be selected to participate in the study.

The study will begin on the first day of the new trimester, as students will be given the questionnaire on attitudes, perceptions, and beliefs (Appendix A). Then, as students are given the syllabus and pick-up their textbooks, they will receive their concept checklist (Appendix B). This document, which will be unfamiliar to all students, outlines the most important topics for the unit. During the first week students will also take a *Need for Cognition Assessment* developed by Cacioppo and Petty (1982). (Appendix C) Over the course of the 11-day unit, students will take numerous concept assessments, receive feedback, and get reassessed on the assigned topics. Students will take a summative test at the end of the unit, which is a common practice in the Woodhaven High School Mathematics Department. This assessment cycle will continue for the twelve-week trimester. At the end of the trimester students will be re-administered the questions about their attitudes, perceptions, and beliefs about mathematics, as well as the *Need for Cognition Assessment* to look for changes, patterns, and trends.

As in any research study there are some limitations in this study. The most salient is time. Students will have a limited amount of time to generate data before the initial collection is due. Next, the initial round of data may be slightly skewed, as the students and teacher will be unfamiliar with the interventions. Also, the true spirit of the assessment is that students will not have summative "Chapter Tests" at the end of units, but unfortunately the high school mathematics department requires students to be tested using common assessments at the end of the unit. This cumulative assessment will force students to rush on their final assessments on the later standards, losing some of the test and retest value of a quality formative assessment. Finally, collecting comparative qualitative data is also limiting. My administrators are always looking for qualitative data or results, but these students and their final growth compared to previous years' students or other classes will be difficult to quantify.

Methods/Treatments

Dan Meyer's Comprehensive Assessment Tool

The foundation for all data collection was based on Dan Meyer's *Comprehensive Assessment Tool* (Meyer, 2007). This began with the creation of a concept checklist for the unit (Appendix C). This lists the ten concepts for which I want students to be able to demonstrate understanding. Each standard has five "bubbles" that students will fill in, much like a thermometer, as their knowledge level increases through progressive assessments. Every few days, students will be given a series of concept assessments (Appendix D & E) covering three to six of the concepts from the checklist. Each question is worth four points where a four is perfect and a zero is not done at all. Students will record their scores on their concept checklist while I record them in my grade book. After students have been assessed on a standard a second time, I will change the point value to five. Then, if students have earned a four on both assessments I

will change their overall score to a five and they will not have to be assessed on that topic again. If they have not yet received two 4-scores, they may continue to reassess that specific standard before or after school until they are satisfied with their score. Further information on this scoring method can be found at http://blog.mrmeyer.com/?p=346. Student examples can be found in Appendix F.

Student Surveys

I have always distributed student questionnaires on the first day of a trimester as a way to learn about the students in my classes. To initiate student opinions, I will add a few questions about students' attitudes, perceptions, and beliefs about their past work in math courses (see Appendix B). Some will be open ended like, "What is the most important thing I should know about your past experiences in math class?" while others like, "I am able to accurately predict my performance on math quizzes/tests," or "I get stressed when I have to do my math homework," are on a rating scale ranging from strongly disagree to strongly agree. These questions have been carefully selected to ask about similar ideas in multiple ways, as well as to avoid making students' feel like they need to answer in a desired fashion. This cognizance will help maintain reliability and validity throughout the surveys. The same questions will be asked of students at the conclusion of the trimester. I will analyze student responses for positive, negative, and neutral feelings about mathematics and see how these attitudes changes over the trimester. Student examples can be found in Appendix G.

Need for Cognition Survey

This was a survey created by Cacioppo (1982) to assess students' need for cognition or, "the tendency for an individual to engage in and enjoy thinking" (p.116). It was developed to ask questions about thinking and problem solving from many different approaches, discouraging

student bias, and giving valid and reliable measures about how students feel about their ability to be thinkers that persist in problem solving. The survey will be given to students again at the conclusion of the trimester. I will analyze student responses for positive, negative, and neutral feelings about thinking and problem solving and look for trends and changes from the beginning of the course. Student examples can be found in Appendix G.

Analysis

Due to timing limitations, my data collection is not complete, but it is worthwhile to discuss what can be seen so far and what will be analyzed in the future. One of the essential elements of formative assessment was that it allow for students to compare current performance to a specific set of standards, with clear indication of what must be done to achieve a specific goal. So far the outline of specific standards and subsequent assessments has been beneficial. Over two-thirds of students demonstrated growth after the second round of testing (see Appendix H) and the general attitude of the class was more relaxed and intent on improving from an earlier performance. It was encouraging to hear enthusiasm from students about a "non-perfect" score. Another essential feature of this formative assessment was that it provided information about areas that I need to remediate with students. For example, the average class performance decreased by almost half a point on Standard 3, so I altered the week's lesson plans to review that standard. Also, Standard 4 had the lowest first-test score of any standard so far and I am not sure if that means bad questions were used or remediation is necessary. I will analyze these standards carefully after the next assessment to see what my next steps for improvement should be.

The majority of comparative data for students' surveys will not be collected until the end of the trimester in late February. My initial analysis of the student survey showed there was a large range when it came to students' attitudes, opinions, and beliefs about mathematics. Noticeable trends on the initial assessment were that most students agreed that they would keep trying in math, even if it is hard for them and that many students were neutral or disagreed with the statement that they put their best effort into studying for mathematics. When looking at the *Need for Cognition* survey, I was encouraged to see 22 of 27 students with positive scores (Appendix H). The formative assessment procedures in place emphasize that it is worth students' time to persist in learning, and that all students can be successful if they act on feedback and work to improve on prior performances. The concept checklists provide a visual for students to see individual growth rather that comparative data. Research supports that this type of feedback has been shown to increase motivation and persistence better than typical reward behavior like praise and grades, so I hope to see improvements in confidence, effort, interest, and cognition levels by the end of the course.

Actions, Reflections, Conclusions

Early implications of the execution of Dan Meyer's *Comprehensive Assessment Tool* seem to be effective as a formative assessment technique. Overall students seem to have improved attitudes and enthusiasm for assessments and I feel that I am able to focus on specific material that needs attention based on student work--the true definition of formative assessment. I will be interested to see how students' enthusiasm level changes over time. Will they continue to come in for extra help and retests as the trimester continues? Also, I am curious as to how my administrators will view this assessment tool as a tangible model for student growth. Is this the

hard data they are looking for that demonstrates growth in my subject area? Could this model be adapted in determining my highly effective evaluation status?

While implementing the formative assessment changes I also recognized areas where caution is needed. First, the assessment questions are simply on skills, which are not very "Common Core" in nature. It will be essential to include *Smarter-Balanced* questions in other parts of the classroom assessments. Next, I am only implementing this model for one class, but wonder how my time commitment would change with more sections. Right now it is at least as manageable as the old system. Finally, to reach ultimate effectiveness it would be essential for other math teachers to be involved. I must consider what it would take to motivate other math teacher to work collaboratively to change their formative assessment methods as well.

All in all, my implementation of Dan Meyer's *Comprehensive Assessment Tool* as proved to be a worthwhile formative assessment strategy for improving student performance and attitude in mathematics. I plan to continue using and modifying it to meet my classroom needs.

References

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Appendix A

Student Information Sheet

First, I would like to take some time to get to know you…..

Name: _____ Course: _____

Home Phone: _____ Birthday: _____

Email: _____

Math History

Who was your math teacher and what was your math class last year? What school did you attend?

What is the most important thing I should know about your previous experiences in math classes?

Circle what best describes your attitude, perception, or belief

1. I keep trying in math, even if the work is hard for me to do.

Strongly Disagree Disagree Neutral Agree Strongly Agree

2. I get stressed when I have to do my math homework.

Strongly Disagree Disagree Neutral Agree Strongly Agree

3. I look forward to my math classes.

Strongly Disagree Disagree Neutral Agree Strongly Agree

4. I worry that I will get poor grades in math.

Strongly Disagree Disagree Neutral Agree Strongly Agree

5. I am interested in the things I learn in math.

Strongly Disagree Disagree Neutral Agree Strongly Agree

6. I only do math because I have to.

Strongly Disagree Disagree Neutral Agree Strongly Agree

7. I often try to think of different ways to solve math problems.
Strongly Disagree Disagree Neutral Agree Strongly Agree

8. I always put my best effort into studying for math quizzes and tests.
Strongly Disagree Disagree Neutral Agree Strongly Agree

9. Learning math is important because it will help in the work I want to do later.
Strongly Disagree Disagree Neutral Agree Strongly Agree

10. I am able to accurately predict my performance on math quizzes/tests.
Strongly Disagree Disagree Neutral Agree Strongly Agree

Other Information

What do you enjoy doing outside of school? (i.e., extracurricular activities, sports, clubs, hobbies, etc.)

What are your favorite/least favorite subjects and why?

Think of how you feel when you are in one of your favorite classes or with one of your favorite teachers. How I can excite or motivate you to feel this way about my math class? *(at least 2 examples or ideas!)*

Do you have a job? If so, where and about how many hours do you work each week?

What can I do to help you succeed in my class? Do you have any special needs or requests (i.e., sitting close to the board, medical issues, homework help, etc.)?