Does Continuous Self-Assessment Help to Improve Students' Understanding of Mathematics?

Kelly Elliott  
*St. John Fisher College*

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Document Type
Thesis

Degree Name
MS in Mathematics, Science, and Technology Education

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DEDICATION

I dedicated this thesis to my husband, David, for all of his support and help along the way. I appreciate all of his help with all of the household chores and cooking when I was too busy with school to do them myself.
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Does Continuous Self-Assessment Help to Improve Students' Understanding of Mathematics?

Does continuous self-assessment and alternative assessment help to improve students’ understanding of mathematics? This question was addressed at a summer conference that was put on by Rick Stiggins and the Assessment Training Institute. One of the main topics at this conference was how to get students to self-assess their work. Assessment is reported as one of the most complex and important tasks of teachers (Webb, 1992). Because self-assessment is often a neglected but an important area of the assessment process, it will be the focus of this research.

The reason why assessment is such a concern for me is because I often hear my high school students say, “I am not a good test taker.” Also, assessments take up a good portion of my teaching and planning time. I wanted to research assessment in mathematics to help students truly understand what they are learning. Assessment is continuous; it occurs as the teacher processes information on what students know. Teachers then use this information to guide instruction. All students come to school with certain mathematical concepts already formed. The role of the teacher is to build on that knowledge so that students gain increasing mathematical power. A teacher’s role is no longer that of a conveyer of knowledge, but that of a guide and a facilitator for student growth.

I currently teach mathematics to students where math is not their best subject and thus seem to do poorly on tests. I want to help the students that feel hopeless with the current mathematical situation. I don’t want them to stop trying. I believe that students decide if success is within their reach and how to go about attaining it. When I ask my students about their study skills, most students said they didn’t study. I want to have my
students self-assess their knowledge for each unit to determine the information they need to study. Also, I want students to self-assess before and after taking a quiz or exam. Based on the literature about Brown's Test Aftermath (2005), I want to give my students an opportunity to improve their test grades and learn how to write mathematically. Most students do not self-assess their knowledge in any class, especially mathematics, and rarely do they write about mathematics. It is important to give a student the opportunity to practice, refine, and master a task that we as teachers want them to do (Wiggins, 1993). I believe that Test Aftermath encourages students to reflect on their actual mathematics performed on the test.

The aim of assessment should be to educate and improve student performance. Research has suggested that students who are able to evaluate their own thinking and learning processes have a high achievement (Kulm, 1994). Many of my students say that they don't know what to study for a math test or how to study. It is my hope in doing this research that I will be able to find a direct correlation between students' self-assessment and their awareness of the areas they still need to work on. I also hope that it will guide them as to what they should study for an assessment. By having students complete the Test Aftermath, I am allowing them the opportunity to self-assess their performance on the test and show me that they know their material. I do realize that it will take repeated practice of the Test Aftermath before they get it right. I am hoping that with each submission the students will improve on their mathematical discourse. I have also joined a learning team through my school on assessment. We are using the book, Classroom Assessment for Student Learning, put out by the Assessment Training Institute as our guide. According to Arter, learning teams share lessons learned in the classroom; they
share successes and discuss strategies that resulted in student learning as well as share
difficulties and determine why they arose and find solutions (2001). This learning team
will allow me to hear other colleague’s ideas about assessment and create a discourse on
the broad subject of assessment. I also believe that being on a learning team might give
me some new ideas or suggestions on assessments. So far my learning team has provided
me with a forum for learning, planning, testing ideas and reflecting together. I hope to be
able to learn from my research that if students are self-assessing their performance, it will
help them to be a more successful student.
students that finding a correct answer or becoming an expert test taker is important (Kulm, 1994). Prior to this year in New York State, students were assessed in mathematics in grades four, eight, and ten. Now students will be tested every year starting in the third grade until eighth grade and they again in tenth grade. As of June 2008 students will be tested in mathematics in grade nine.

In today’s accountability climate, it’s easy to think of assessment as a process by which we document student achievement. There are many different governmental agencies devoted to assessing our nation’s students. In particular is the National Assessment of Educational Progress (NAEP). NAEP was mandated by Congress in 1969 as a project of the federal government to gather data to document what students in the United States know and are able to do. Since 1969 the NAEP has administered math tests nine more times to students in grades four, eight, and twelve (Lambdin & Lynch, 2005). These tests inform the nation on students’ math processes, math abilities and math content. Very rarely do these assessment grades make it back to the actual classroom teachers. This is frustrating to all educators because national and state assessments should support the learning of important mathematics and furnish useful information to both the teachers and the students. According to the National Council of Teachers of Mathematics (NCTM), “Assessment should not merely be done to students; rather, it should be done for students, to guide and enhance their learning” (2000, p. 22).

There is also a lot of pressure put on teachers from school districts to teach to the test. Stake (1995) argued, “we usually limit our thought of mathematical achievement to those things covered by certain goals or particular chapters or teaching a specific grade in a specific school” (p. 181). He also stated, “in spite of math’s reputation as highly
integrated, that it is a succession of prerequisite learning, the topics of math are quite
dissociated” (p. 181). According to administrators, board members, supervisors, and
superintendents, how well your students do on state standards reflects on your teaching
ability. This, however, is not supported by the literature. Silver & Kenney (1995) argue
that teaching to the test diminishes the value of the information obtained from testing.
The more teachers are focused on raising test scores, the more instruction is distorted and
the less credible are the scores themselves. This causes the tests to become indicators of
the amount of instructional time and attention paid to the narrow range of skills and
competencies assessed.

Classroom teachers make frequent decisions about students and their learning. These decisions are influenced by information obtained from formal and informal
assessments of students. Why it is then that assessment is often thought as synonymous
with paper and pencil testing? Assessment includes information about students and their
classroom environment. Glatthorn, Bragaw, Dawkins, and Parker (1998) agree that
assessment is an interaction between teacher and student, with the teacher continually
seeking to understand what a student can do and how a student is able to do it, thus using
this information as a way to guide instruction. According to the research the first purpose
of assessment is for it to be used as a tool by teachers, to provide evidence and feedback
on what students know, are able to do, and what they understand. The teacher is the
closest to student performance. They observe it daily, and assess it constantly to make
instructional decisions. Researchers are very doubtful that any external measure can tell
us a fraction of what a teacher assess during the process of instruction. Mathematical
assessments should reflect a clear conception of what mathematics is and how to use mathematics for problem solving.

Alternative (Authentic) Assessment

Far too frequently we think of testing as an end-of-unit or end-of-course activity whose primary purpose is a basis for assigning course grades. Alternative assessments should be rich enough to challenge students to reason, think, and go beyond what students expect they can do. According to Kulm (1994) authentic tasks should allow the application of a wide range of approaches and strategies. They should give all students a chance to demonstrate some knowledge, skill, and understanding of mathematics. Alternative assessments provide opportunities to gain insight into students' broad knowledge and understanding of mathematics, not just skills and procedures (Kulm, 1994). According to Romberg and Wilson, Lajoie defines the seven principles of authentic assessment as:

1. It must provide us with multiple indicators of the learning of an individual in cognitive and conative dimensions that affect learning.
2. It must be relevant, meaningful, and realistic.
3. It must be accompanied by scoring and scaling procedures that are constructed in ways appropriate to the assessment tasks.
4. It must be evaluated in terms of whether it improves instruction, is aligned with the NCTM standards, and provides information on what the student knows.
5. It must consider racial or ethnic and cultural biases, gender issues, and aptitude biases.
6. It must be an integral part of the classroom.
7. It must consider ways to differentiate between individual and group measures of growth and to provide ways of assessing individual growth within a group activity.
(Romberg & Wilson, 1995, p. 10-11)

Assessment of mathematics learning should first and foremost be anchored in important mathematical content. It should reflect topics and applications that are critical to a full understanding of mathematics as it is used in today’s world. The National
Research Council (1993) believes that assessments should reflect processes that are required for doing math: reasoning, problem solving, communication, and connecting ideas. When complex learning is evaluated, the assessment results for levels of understanding applications and interpretations are likely to be retained longer and will yield a greater transfer value than assessment results at the knowledge level (De Lang, 1995).

Most of the authors (DeLang 1995; Kulm 1994; National Research Council-Mathematical Sciences Education Board 1993; Webb 1992) agreed that the creation and selection of tasks is critical to the assessment process; in particular they must reflect important aspects of mathematics, which a student has learned. Alternative assessments seek to improve and expand teacher's instruction and evaluation of students through broader types of questioning and multiple assessment approaches. The goal of alternative assessment is to improve students' attitude toward mathematics. Kulm's research on alternative assessment found that it is important to start at the beginning of the school year, to involve the students in the planning as much as possible, to be flexible and ready to adapt or revise if an assessment does not work, and to be persistent. If a teacher or student is not comfortable with a new technique or if it is not working for whatever reason; throw it out! He believes that new assessments take time. They can be unsettling for many students because they are not used to being assessed in this way. But, the rewards in seeing students learn to understand what they are doing and begin to become confident in their mathematical abilities makes the effort worthwhile (1994).
Types of Alternative Assessments

There are many different types of alternative assessments, such as journals, portfolios, questioning techniques, rubrics, observation instruments, and practice tests. Research has found that journals are a good way to develop a dialogue to enhance student-teacher discourse. The teacher can give the students probing questions, such as “Today in mathematics, I learned...” or “Of the math we’ve done lately, I’m most confused about...” (Silver & Kenney, 1995, p. 64). Although time consuming, student responses are a valuable source of information that allows teachers to know how students are thinking and feeling about math class and their experiences within the class.

Portfolios provide multiple examples of student work from the beginning of the school year to the end to show students mathematical improvements. Portfolios typically include a sample work with a description of results of a practical or mathematical investigation, descriptions of the problem solving process, reports on investigations of mathematical ideas, and responses to open-ended questions, or homework problems (Silver & Kenney, 1995). According to the research, when using portfolios, it is important to encourage students not to put it together at the last minute; it should be an ongoing process. Teachers should set up checkpoints for the students along the way. Portfolios should also include documentation of revisions done to work throughout the year. One idea would be to include a pre-assessment survey from the first day of class. Then students can reflect on what they thought they knew about math in the beginning of the year compared to what they have learned throughout year (Simpson, 2005).

Observing students doing mathematics can provide insight into students’ understanding and misunderstandings. This is the most basic classroom process for
gathering assessment information about students. It helps teachers decide whether to move forward in a lesson, give more time for completion, provide additional examples, or give different explanations of the content. Silver & Kenney suggested using an annotated class list to record observations quickly and efficiently. An annotated class list is a roster of student names with a space to the right of each name for recording a variety of attributes such as mathematical understanding or misunderstandings, attitudes toward math, and areas where a student excels or needs assistance (1995). Another way is to make a topical list with a set of predetermined categories that the teacher checks off during observation. These are a few examples of unobtrusive ways teachers can watch and listen to students as they explain their mathematical thinking and work in groups.

Practice tests are used as an effort to improve student learning and grades, and to help reduce test anxiety. If students frequently took practice tests, they would learn more, self-efficacy would increase and grades would improve (Snooks, 2005). It is logical to think that familiarity with various kinds of test items will improve student learning. Students believe that practice tests are a beneficial review strategy. Stiggins has found that a pre-test a few days before the actual exam helps students identify remaining weaknesses for last minute study (2004). According to Snooks, more than 90% of students reported that practice tests helped them study for examinations (2005). Benefits of practice tests include an increase in student learning which translate into better grades. Knowledge and skill increase because students have demonstrated them on the practice test. Students also receive immediate feedback so they can better focus their studying. According to the research, a test is authentic when the students know as much as possible in advance and the test is based on predictable skills and situations. Snook
has a variation of a practice test where students first take the exam alone and then they get into their cooperative learning groups to discuss the questions with their group members. Finally, as a whole class, all questions are discussed. Snooks believes that this process helps promote critical thinking, question-analysis, and test taking skills. She has also found that class discussions of practice tests often reveal some of the student’s misunderstandings on issues (2005). Wiggins had a differing view on practice tests. He thought it was more beneficial to have students bring in an index card filled out as the student sees fit. Wiggins believes that this study tool helps student sharpen and focus their studying. It can also provide the teacher with an additional assessment because they can see if the student knew what facts, figures, and formulas were of most help as resources (1993).

Studies estimate that formal tests occupy 15% of student’s time. Math and Science teachers, however, have a tendency to rely even more heavily on paper and pencil tests (Silver & Kenney, 1995). Test anxiety is perhaps the greatest factor in producing poor attitudes toward mathematics (Kulm, 1994). The anxiety and fear held by most people is a clear indication of traditional testing. Kulm believes this is due to rote and abstract teaching approaches, compounded by tests that induce further anxiety. Poor performance on assessments often leads to low self-esteem, anxiety and avoidance. Research shows that anxiety interferes with learning and a student’s performance. Grade anxiety tops students list of school related stressors (Snooks, 2005). Schwartz has a few suggestions to help reduce test anxiety: students should get an overview of the material and content on which they are being tested; before starting a test, the student should write down any definitions, theorems, or formulas that will be needed; students should scan the
entire test before they start to work and use a variety of strategies to solve problems; remember that a picture is worth a thousand words; check your answers if time allows. Students should learn to review for the next test by studying previous tests to gain an understanding of their previous mathematical errors and carelessness (2004).

Preparing for a test is a matter of knowing how to attack the subject matter and developing a system for studying effectively and efficiently. Each of us has entered many classrooms not knowing the specific questions that were going to be asked on a test. The tests were secret until the day of the test. This was how most of us were assessed. The specific questions that will be on a test are usually secret, known only to the test maker. Unfortunately, the scoring criteria and standards are secret also. The students typically are kept unaware of the scoring criteria being used to set standards (Wiggins, 1993). Can we say that this is fair if the student has no prior knowledge of the questions, no opportunity to use resources, and no opportunity to ask questions? This is opposite of alternative assessments and the resources that people in the real world have available to them. Why is it that teachers don’t give students access to a representative set of possible test questions?

Testing companies and agencies describe the type of questions that they ask and provide samples for review in their review books. There are many review books for the SAT’s, the ACT’s, and the Regents Exams. If this is deemed fair practice, why should teachers not offer the same opportunities for students to practice some of the particular questions (Wiggins, 1993)? A diligent student can rehearse the tasks effectively even if in the real test the facts, problems, or contexts are varied. This rehearsal is what coaches of athletes, performing artists, and teachers of medicine do (Wiggins, 1993). Would it
not help the student to inform them of the range of tasks that they must be good at to pass the course? Once the students know this, the responsibility becomes theirs. Teachers can be coaches to students teaching them how to self-assess and perform well enough to pass an assessment with flying colors. This is Wiggin's aim to empower students and teachers instead of merely checking up on them and keeping them in line.

Student Generated Assessments

When teachers communicate early with students about alternative assessment goals, they can involve them in the planning and implementation of new approaches for assessment. One way to do this is to have students generate their own test questions. Teachers can encourage students to participate in the assessment process by having them generate and solve problems for class, for homework, and for tests. When teachers give students this mathematical empowerment by participating in the assessment process, it gives the student greater responsibility for their own learning (Odafe, 1998). La Lopa (2005) agrees that when students help develop an evaluation tool as part of their grade; it helps them work through all six cognitive levels of Bloom's Taxonomy. The six cognitive levels of Bloom's Taxonomy are: knowledge, comprehension, application, analysis, synthesis, and evaluation. Students use the knowledge level when they recall evaluation tools used in previous classes. Comprehension is used when students summarize tasks they have seen before and/or when they explain them to others. Students use application when they are taking information acquired in previous settings and applying it to the task. Analysis is used when students compare and contrast the requirements with the evaluation tool they are developing. Synthesis is used when the
students have created a new evaluation tool. Lastly, evaluation is used when students are required to choose among alternatives and judge whether or not they have produced an acceptable assessment question (2005). Because the students use all levels of Bloom’s Taxonomy, there is a broad range of challenges that create a deeper understanding of what was required of them. Allowing students to participate in developing assessments help them to see what the important topics are throughout a unit and why they are important.

The teacher’s role in giving this responsibility to students is to give students test-item guidelines with a description of the type of questions that students can create. Questions should measure an understanding of concepts, skills, and generalizations. Odafe believes that students do a better job contributing to test items if they work cooperatively in small groups. The students however, must prepare questions on their own first and then bring their questions to the group for discussion. Before students work in cooperative groups, teachers should go over cooperative learning skills, the content to be tested, and the construction of the test items. To ensure that everyone in the group participates and to involve all the members of the group, Odafe (1998) does not let the students elicit teacher input until no one in the group can find an answer. Also, the group notifies the teacher that everyone has agreed on the questions and everyone understands them. The teacher will then randomly ask a group member to explain the question to him or her (1998). The teacher should include at least one question from each group on the test. The teacher reserves the right to edit the question while preserving the ideas. Odafe has had positive results with this type of assessment. His students were eager to take the test, which is rare. According to Odafe, the students felt like they were part of the class
and important because they helped out in the test development. Students claim that contributing to the test items forces them to review the content of a unit and itemize the most important facts, concepts, and skills (Odafe, 1998). By including students in the assessment process it gives them an idea of what to study for. This process also tests the students’ knowledge of material while preparing the questions and it gives the students a chance to work together and share their knowledge. By preparing the questions, it automatically forces the students to study and feel more relaxed because they know what will be covered on the test (1998). According to the research, students want to take responsibility for and ownership of their learning. This allows them to be creative, yet at the same time contribute to the assessment process.

Cooperative Learning

Cooperative Learning refers to the process of students’ working together in small groups using social skills and achieving academic objectives. According to Kulm, recent research on learning, including that of higher order thinking in mathematics, is the effectiveness of small group instruction (1994). Effective group work not only helps to make students more productive citizens, but it also helps them to learn mathematics. If cooperative groups are set up correctly, students understand that in order to reach their academic goals, other group members must also meet their goals. It is also helpful if roles such as a leader, a manager, a reporter, and an organizer are assigned. According to Steinbrink and Jones, there are five key elements to cooperative learning. These elements are: face-to-face interaction, a focus on collaborative social skills, positive interdependence, monitoring academic progress, and individual accountability (1993).
These five elements must permeate all lessons to ensure the effectiveness of cooperative learning. When students know that a certain behavior is expected and that their work as a member of a group will be assessed, many of the concerns about group work are alleviated.

One way the research suggested to use cooperative learning was to review for a test. This involves forming cooperative learning teams and providing them with review materials that focus on specific concepts and skills to be evaluated. Researchers hypothesize that this type of review produces significant gains over traditional test review methods. In their research, Steinbrink and Jones found that consistently the test mean score gains were more than ten points. More importantly, the majority of the gains in achievement occurred for students who previously scored in the lower half of the class (1993). Mixed ability groups were comprised of three to five members. Typical teams should consist of one high achieving student, one to three average students, and one below average student. These teams should be used for a whole semester in order for members in the group to become familiar with each other and feel comfortable sharing ideas and to develop a sense of loyalty. Each group should be provided with a set of focused study items that support the unit activities. These focused study items stress specific knowledge, skills, and understanding needed to respond correctly to corresponding test items. The review team then locates responses to the study items. As they do this, they clarify concepts and skills through interaction. Each team member should be able to respond correctly to specific items. Once the groups are done with their review, the teacher can summarize, answer any questions the groups may have, and restate and expand key concepts identified in the study items.
The primary goal of using review teams is that each member will master the knowledge and skills represented by the study items. Another way to involve review teams is to have them participate in competitive review games using the focused study items (Steinbrink & Jones, 1993). These review games add an element of fun and team competition to the test-review process. Research shows that when students realize they can improve their test scores, they cooperate in completing the test-review team tasks. Steinbrink and Jones found that the lower and average student will improve their test scores significantly, while higher achieving students will maintain their achievement levels while developing a sense of social responsibility and desirable leadership skills (1993). Students enjoy intensive review sessions where they interact socially and academically.

Another way to use cooperative learning is by giving group exams. Before this is done, Castor suggests getting the students used to group exams by doing a non-graded trivia quiz. This demonstrated to the student how much better they can score as a group, compared to individually (2005). Students first receive an individual copy of the exam to take. The students are encouraged to mark their answers on the test booklet so they know their answers when they meet in groups. After students turn in their individual exams, students retake the test in groups. Individual exams are graded while team exams are taken. This provides the teacher with information about an individual’s gap and confusion in learning to that point. The major part of their grade will depend on individual achievement thus ensuring individual accountability. Groups should not have more than three members to ensure maximum participation. During group exam sessions, students discuss and justify their answers to the exam questions. Castor
observed that students discussed questions more in depth when there was a greater discrepancy in the group’s answers. Students who supported their answers through referencing examples discussed in class, textbooks, notes, or prior knowledge were more persuasive to their peers, than students who were less than concrete in supporting their answers (2005).

Kulm had a differing view on administering group exams. He believed that pairs of students should work together to complete the test. Once the pair agreed on their answers to produce a single paper between them, they would join another pair of students in the class to form a group of four. This group of four would typically be the same group that has been working together on different learning activities leading up to the test. The four students compare and discuss their papers and produce one paper to hand in, reflecting their group effort. Each member of the group then signs the paper verifying that they agree with the answers and they understand them (1994).

Most of the research on group exams agreed that the individual scores should be weighted more than the group score to discourage free loading. Castor advised that 75% of the students’ grade is from the individual exam, while 25% is derived from the group exam. A danger in having the larger percent come from the group work could be that students would come unprepared for the test and depend on the group score to raise their grade (2005). In the rare case that an individual’s score was higher than the group score, they were not penalized. Castor suggested doubling their individual score so that the student would not feel dragged down by the group (2005).

According to the research, the benefit of using group exams is that students are motivated to prepare for the exam. Since this is an active learning strategy, the students
learn the material more deeply and are learning from each other. Castor has found that students frequently debate their answers to exam question which forces them to think about why they believe their answer is correct (2005). Students also have a chance to discuss things that were unclear to them on the test. Students teach each other by explaining and justifying their answers, which in turn furthers their own understanding. At the end of the group exam, the students know what they know with confidence and the teacher knows what gaps or misconceptions remain that need addressing.

One flaw that I see in the research is that students in the group tend to decide their answer by majority rule. This leaves out students that might be thought of as not smart or are not assertive or confident enough to share their opinion, possibly making them feel alienated. Also, one member of the group, probably the student thought to be the smartest, could be teaching the concepts to the other members of the group. All of the research found for this type of alternative assessment was done in college classrooms. It may not work as well in a high school setting. A smart group member may take over and not give any one else a chance to speak. They may also not want to waste their time explaining why an answer is right to the other group members.

Self-Assessment

Research has suggested that students who are able to evaluate their own thinking and learning processes have higher achievement (Kulm, 1994). Research has also shown that mathematical knowledge alone is not sufficient to ensure the development of higher-order thinking and problem-solving abilities. Developing self-assessment skills is an ongoing process throughout a student’s school career, becoming increasingly more sophisticated and self-initiated as a student progresses. When students are asked to
analyze their problem-solving processes, there is a measurable effect on performance. Students base the way they think about their mathematical abilities on their beliefs and attitudes about math. By helping students look accurately at their own mathematical thinking process, teachers can enhance awareness of their abilities and improve their feelings toward the subject (Kulm, 1994). The literature says that maximum learning comes from productive interactions between teachers and students. Conversations among a teacher and students about assessment tasks and the teacher’s evaluation of performance provide students with necessary information to assess their own work. The more students invest in their own learning process, the more they will learn. As teachers, we must build classroom environments in which students use assessments to understand what success looks like and how to do better the next time. Engaging students in assessment analysis activities helps support student learning and develop students who think thoughtfully and critically about how they learn mathematics. We must help students use ongoing classroom assessments to take responsibility for their own academic success.

Goal setting is a system of self-assessment that lets students keep track of where they started and what they have accomplished, thus increasing accountability for follow through. Goals for students need to be specific and meaningful and give an intended learning target for them to reach. Students can either confer with another person in class or with the teacher to set long or short term goals for learning. Stiggins, Arter, and Chappuis believe that the purpose of setting goals is to guide students to the next steps in their learning within the framework of content standards (2004).
Goal setting is a step in student-involved assessment because when students regularly identify their strengths and areas of improvement, they are primed to describe the next step in their learning. The student goals should include a statement of what the student will learn or get better at, along with an action plan to show how they will do this. Students should also include identifying assistance whether it is another student, parent, or teacher. Lastly, they should include a time frame to set a limit to make a realistic plan and get motivated to start working. It is important to let the student decide when they will have demonstrated the level of achievement (Stiggins, Arter, Chappuis, & Chappuis, 2004).

Teachers can supply students with a folder to put their evidence of obtaining their goals from the beginning, progressing toward the goal, and goal attainment. This folder will allow students the time they need to periodically reflect on their progress toward their goals and to collect evidence. By having students do this, it teaches them to take ownership of improving themselves mathematically. Goal setting defines another form of alternative assessment because a properly designed task should not only motivate students by providing them with short term goals toward which they work, but also provide feedback concerning the learning process (De Lang, 1995).

Feedback

As stated by Wiggins, “if assessment is to improve performance, not just audit it, the techniques of measurement must be accompanied by quality feedback provided to learners” (1998, p.43). The aim of assessment should be to primarily educate and improve student performance. When students are not informed of their errors and
misconceptions, let alone helped to correct them, the assessment may have both reinforced misunderstandings and wasted valuable instructional time. Feedback for students provides information to aid them in seeing inappropriate strategies, thinking or habits. Feedback is an essential part of any completed learning. Feedback is done and given on a daily basis, not to just students, but musicians or athletes, to help them improve and become better at what they do.

Constant isolated drill work and testing without concurrent feedback sends the message to students that answers are isolated from actual effects, causes and purposes (Wiggins, 1998). Wiggins stated, “Praise keeps you in the game; real feedback helps you get better” (1998, p.46). Feedback tells a student what they did or did not do and enables that student to self-adjust. According to Lajoie there are two types of feedback, dynamic feedback and adaptive feedback (1995). Dynamic feedback is where feedback is given to the learner suggesting ways to improve themselves and opportunities to reach their potential. Adaptive feedback is how learners can self-assess from their test results. This helps to improve the learner’s motivation and sense of self-efficacy (Lajoie, 1995). The word assessment is a form of the Latin verb, assidere, to “sit with” (Wiggins, 1993). The person who “sits with you” is someone who “assigns value” or the assessor. After an assessment one “sits with” the learner to give feedback. Feedback is something we do with and for the student, not something we do to the student.

Feedback provides the student with direct, usable, insight into their current performance based on tangible differences between current performances and hoped for performance (Wiggins, 1993). To the student a score on a test is encoded information. In one study done by Webb, it was found that if teachers gave the answer key after a test,
it results in significantly higher test performance. Researchers agree that the best feedback is highly specific, directly revealing of what actually resulted, clear to the student, and available or offered in terms of specific targets and standards. The reason feedback is so helpful is because it causes the learner to attempt to improve something specific. Feedback is information about how a person did in light of what he or she attempted. Feedback also confirms or disconfirms the correctness of actions. When feedback is specific and relates to learners intent, the learner does not feel anger, fear, or loss of self-esteem.

Self-Assessment After Tests

According to Stiggins, “only students who learn are those who want to learn. The responsible party is each individual learner” (2001, p.36). Researchers in this area agree that you can enhance or destroy students’ desire to succeed in school more quickly and permanently through your use of assessment than with any other tools you have at your disposal. Fear, anxiety, apathy, a lack of interest and settling for minimum standards are predictable outcomes when students are not given a greater responsibility for their own learning. Odafe believes that students who are afraid of tests perform below their capabilities because they are not given sufficient responsibilities in assessing their learning (1998). A lot of learning can derive from taking a test, but even more can be achieved when learners take part in deciding how to evaluate their answers to the test. It is extremely important for students to understand that they cannot succeed unless they face the fact that they are going to fail sometimes. No one is an expert the first time they
try something. There is always a learning curve that starts out low and progress upward with the more practice and feedback you receive.

Achacoso defines metacognitive awareness as teaching students to analyze their test performance to help them better assess the understanding of their own cognitive process (2005). This is helpful in self-regulated learning. It is respectful to allow people to explain themselves when we think they have erred or when we do not understand their answer. Tests that provide no opportunity for students to supply a rationale for answers reveals that what students think and why they think are unimportant. Yet most tests provide students with nothing more than a score.

It is important to give students the opportunity to practice, refine, and master a task that we wish them to do (Wiggins, 1993). Research suggests that to help students understand their performance on an exam, give them a questionnaire when the test is completed. The questionnaire should ask students to predict their exam score, rate their effort in studying for the exam, and ask which were the easiest and most difficult aspects about the exam and why. In order to help students take the questionnaires seriously, let them know that they have everything to gain and nothing to lose by being honest. When the graded exam is given back, have students look over their responses to the questionnaire after they have seen their score. On the same questionnaire, have students compare their score with their prediction and decide if the prediction was correct. Ask students if they would make any changes in strategies or perhaps the amount of time they spend studying for the next exam. Lastly, ask for any suggestions that would help the class prepare for the next exam (Achacoso, 2005). This will allow students to see how their effort and their study strategies used were directly related to their performance. The
teacher can ask the class to reflect on the plans used, outline alternative solutions and discuss possible extensions to the problems.

Asking students to explain their methods for solving a problem and evaluating the explanation by linking it to standards serves a useful purpose. Over time, this evaluation process helps students understand that mathematics has a unifying logic, rather than being a set of disconnected rules and procedures. According to Kulm, he adds a question to every word problem on his tests. The question is, “Do you think your answer is reasonable? Explain why or why not” (1994, p. 163). Kulm will give a student points for answering the question incorrectly, if the student can tell him why their solution was wrong.

In the literature there are different approaches to student error analysis after a test. The first approach is from Wiggins. He suggests after teachers have graded the test to ask students to evaluate their own performance. Wiggins believes that each student should submit a written assessment of their test performance with corrections of all errors. Students should pay particular attention to the type of errors they made to determine if they were conceptual errors or procedural errors (1998). Teachers found this method extremely useful because the students self-assessed their reasons for errors. This created a student-teacher dialogue that was invaluable in drawing a clear picture of what students were thinking when errors were made. Students did find this task to be demanding (Wiggins, 1998).

Brown found a way for teachers to incorporate more writing in a mathematics class and to augment the student’s assessment process in a way that facilitates student self-evaluation, enhances learning, and supplies student feedback (2005). Brown calls
this process, the Test Aftermath. This exercise, Brown believes, not only promotes learning but also provides a non-threatening environment for students to express their feelings and attitudes. Students are asked to take their test home, examine their work and complete the Test Aftermath. Before students did this, Brown modeled a generic example from the previous year so that his students could see how to fill out the Test Aftermath. He found the greatest success for completion and honesty when this was assigned as homework because the students were engaged and gave a much more thoughtful examination of their scored tests without their peers nearby (Brown, 2005). Brown believes that this task encourages students to reflect on actual mathematics performed on the test. He will not accept statements such as, “I am a terrible test taker,” or “I ran out of time at the end” for reasons they got a question wrong (Brown, 2005, p.70). Instead, students are to focus on assessing their own mathematical performances. As they do this, students should consider the reasons they were or were not successful on certain test questions. More importantly, they engage in an important aspect of mathematical communication- constructing a coherent, fluent written summary, using appropriate mathematical language and terms. This task provides an opportunity for students to show what they know, but it also serves to calm those who are feeling frustrated by the results of their tests. Brown’s students appreciated the second chance to validate their understanding or to conquer at least one problem from the test without time constraints or tension of the test setting. His students found it to be both rewarding and empowering (2005). Brown did say, though, it will take a few times of doing before students get it right with properly written feedback from the teacher. The overall substance of the student’s ‘Test Aftermath’ will improve with each submission as will
their fluency of mathematical discourse (Brown, 2005). As with most forms of alternative assessment, availability of time for evaluating student work is a concern. However, the time investment pays significant dividends because it helps to gain a wider view of the students’ understandings and disposition, which we cannot achieve, using paper and pencil exams. The Test Aftermath effectively supports a classroom culture in which coherent mathematical communication is expected.

Learning Teams

Learning teams are different from cooperative learning teams because they are generally a small group of professionals (teachers) who agree to experiment with new ideas and meet regularly for a specific period of time to share specific professional growth experiences, guided by focused goals (Arter, 2001). Although, there is very little research on learning teams, they are viewed as professional development for teachers. The literature on professional development for teachers repeatedly cites collaborative group work as the most powerful mechanism for professional development. Learning teams share lessons learned in the classroom. They share successes and discuss strategies that resulted in student learning as well as share difficulties and determine why they arose and find solutions (Arter, 2001). Learning teams provide a forum for learning, planning, testing ideas and reflecting together. Arter believes that, “for teachers to be successful in constructing new roles they need opportunities to participate in a professional community that discusses new teacher materials and strategies and that supports the risk taking and struggle entailed in transforming in practice” (2001, p. 55).

There should be no more than six members to a learning team and team members should have roles that rotate among each other. This helps the meetings run efficiently
and provide participation of all the team members. 75% of a member's time will be spent on individual study devoted to reading materials and practicing ideas in a classroom. Approximately 25% of the time will be spent in meetings reflecting on specific assignments, discussing and viewing videotapes, and reflecting on the implementation of ideas (Arter, 2001). Like the students, teachers are accountable for documenting their learning through self-reflection and tracking progress using growth-portfolios.

Learning teams are ideal for educators who want to learn about classroom assessments. When assessment systems are in place, student achievement in the current climate of standards-based education reform is improved (Arter, 2001). Improving student achievement and raising standards for students will not occur without ensuring that teachers and administrators know the difference between sound and unsound assessments, can select and develop high-quality classroom assessments, can adequately interpret and use assessment results, and can use assessment materials and procedures to involve students in their own assessment.

Conclusion

No Child Left Behind has given new requirements for teachers. Teachers are to help all students meet state standards and become competent learners. Given this mission, if some students regard standards as unattainable, they will feel hopeless and stop trying. Those who stop trying, stop learning. The connection among beliefs, attitudes, and performance is complex and changing. At times students may feel unsuccessful at a task because they have previously failed at similar tasks, producing a self-fulfilling prophecy. Those who stop learning fail to meet the standards that reflect the skills and knowledge needed by our society (Cooper, 2005). These are the type of
students that are the focus of the research and No Child Left Behind. No one wants the students to feel frustrated and stop trying. Stiggins believes that students decide if success is within their reach and how to go about attaining it (2004).

Teachers diagnose student needs, allocate time, design and implement instructional interventions, judge student work and assign a grade. By trying these alternative assessments, teachers will allow students to feel that success is within their reach. If teachers choose tasks that call only for a right or wrong answer, students will be less likely to believe that teachers really value the process over the product, rather than requiring students to articulate their thinking. To counteract this hopelessness, teachers should want to build learning environments that help all students believe that they can succeed at hitting the target if they keep on trying. The literature has shown many different ways to use classroom assessments to keep students confident that the achievement target is within their reach. Hopefully this can reveal a student’s individual strengths as well as areas that need further development.

NCTM’s principles and standards for school mathematics challenge mathematics teachers to generate and implement classroom activities that enable all students to “communicate their mathematical thinking coherently and clearly to peers, teachers, and others as well as use the language of mathematics to express ideas precisely” (2000, p.23). NCTM encourages the use of writing prompts as means of alternative assessments and urges “assembling evidence from a variety of sources is more likely to yield an accurate picture of what each student knows and is able to do” (2000, p.24). According to the NCTM, assessment should become a routine part of the ongoing classroom activity rather than an interruption (2000). Through student involvement in classroom
assessments, teachers are able to focus students on a clear path to ultimate success. The research shows that if teachers can engage students in continuous self-assessment over time, they can keep them believing that success is within reach if they keep striving.

Traditional forms of assessment (quizzes, exams, and problem sets) are still important mechanisms for finding out what students can do mathematically and will always be part of a mathematics course, but now we can add to the traditional ways by using alternative assessments also. The literature describes an expanded view of mathematical assessment for students, one that embraces qualitative methods, goal setting, observations, as well as teacher opinion. Alternative assessments allow students to have a greater capacity to describe important aspects of mathematical knowledge. According to Steinbrink and Jones, Harry Wong best summarized up learning when he stated, “Learning has nothing to do with what you cover. Learning has to do with what you are able to get the student to accomplish” (Steinbrink & Jones, 1993, p.307).
METHODOLOGY

The following provides the profile of the school district, the students involved, and the environment in which the data was collected. This will help me determine if continuous self-assessment and alternative assessments help to improve students’ understanding of mathematics. Research has suggested that students who are able to evaluate their own thinking and learning processes have higher achievement. The goal of having students become self-assessors of their own learning is to improve students’ attitudes toward mathematics. My plan is to use lesson study, team teaching, and my own individual involvement.

The location where the research was gathered is a small city school district in Finger Lakes Region of Upstate New York. There are both very wealthy and poor families within the school district. There are 4,291 students enrolled in the district. In the ninth grade there are 377 students enrolled and in the eleventh grade there are 338 students enrolled. In the high school there are a total of 1,390 students, 13.5% of the students have a special education classification at the high school. Within the district there are 406 students that receive a free meal and 233 students that receive a reduced meal plan. The high school makes up 14.8% of these students receiving a free and reduced price meal. Each period within the school day is forty-two minutes long and there are nine periods in a day.

My research was done in either my Algebra 1ABC or in algebra/trigonometry classroom. The Algebra 1ABC class is a first year class, out of a two-year curriculum, preparing students to take the New York State Math A Regents in June of their second year. It is a co-taught class with a special education teacher in the classroom. In my first
period class there are six female students and twelve male students. Of these students fifteen have an IEP and two have a 504. In my ninth period class there are six female students and eight male students. All but one of these students have an IEP. Algebra IABC meets for one period every day and two periods every other day.

The algebra/trigonometry class is a third year course that counts towards a student’s last year of math required for graduation. It is an alternative to the New York State Math B class. There is no Regents exam at the end, just a cumulating midterm and final made up by the teachers on the team. In my fourth period class there are eleven female students and nine male students. Of these students two have a 504. In my sixth period class there are fourteen female students and four male students. Of these students one has a 504 plan. Algebra/trigonometry meets everyday for one period.

A number of materials were used to collect my research. Based on Stiggins (2004) literature I understood how important it was to have the students self-assess themselves and their work. I realized that in my current classroom, I was not doing this. The first tool I used for my research was a questionnaire to fill out after a big quiz and/or a unit test. An example of the questionnaire is in Appendix A of the paper. There is also an example of a student survey filled out in Appendix B. The questionnaire asked students to predict how they did right after the test and asked them to think about how much time they spent preparing for the assessment. Then the following day they were to fill out the second half of the questionnaire after they have seen their graded assessment. This is where I hope the real self-assessment will take place because students are able to compare how they think they did with how they actually did. It allows them to look at what they did to prepare for the assessment, and after seeing their results decide if they
should try something different in preparing for the next assessment. I first gave the
questionnaire to just my Algebra 1ABC classes beginning with the unit three assessment;
typically their quiz and test grades are lower than my Algebra/Trigonometry classes. I
did not give this out to my Algebra/Trigonometry class until their fifth unit assessment.

For the second self-assessment I had the students in my Algebra 1ABC class
complete was an itemized checklist of their major quiz. A copy is attached in Appendix
C of the paper. There is also an example of a student checklist completed in Appendix D.
This checklist has a section that lists where each question on the quiz and where it came
from, whether it is in their class notes or lab. When the students receive back the graded
major quiz, they can go across the list and if they got the question right, they would check
either the 'lucky guess' column or the 'I knew it' column. If a student got a question
wrong, they would check off the 'simple mistake' column, the 'misread the question'
column, or the 'I don't understand it' column. I hope that by students' doing this it
allows them to identify remaining weaknesses to study for the unit exam. According to
Snooks (2005), students who self-assess receive immediate feedback so they can better
focus their studying. I allow students to complete major quiz corrections in class. I allow
approximately 10 minutes of my class time for this to be filled out. My hope is that
students will see where their mistakes were, and be sure to emphasize those lessons/labs
when studying for the unit exam. So far I have only done this with my Algebra 1ABC
class because they have a graded major quiz that is very similar to their unit test. I did
not do this for my algebra/trigonometry classes, because they have two pre-tests, one of
which is done in class and one that is done for homework. Neither of these are graded,
except for a homework grade, so I don't think I would be able to get a lot of student
involvement. Though, I did give them a checklist for their midterm after taking a practice midterm.

The third self-assessment I used came from Brown (2005) called the Test Aftermath. I am only using this in my algebra/trigonometry classes because I think that they are mature enough to appreciate the work that is involved. I don't believe that my Algebra I ABC classes would have fully understand what was required of them or take the time to complete it honestly. A copy of the Test Aftermath description, examples, and rubric are in the Appendix E section. Also, an example of a students completed Test Aftermath with the rubric and a copy of the test is in Appendix F. I explained the process, the examples, and the rubric using handouts and an overhead. I originally gave it to them for homework the day that we reviewed their unit four exam, like Brown had done in his literature. I continued to give this to my students this way up through the unit six exams. For the unit seven exams I gave them half a period in class to complete it to get more student involvement.

Based on the literature by Achacoso (2005), using these different types of assessments will help students be metacognitively aware. Achacoso defines this as teaching students to analyze their test performance to help them better assess the understanding of their own cognitive process. The more students invest in their own learning proves, the more they will learn. I want to help my students use ongoing classroom assessment to take responsibility for their own success. I am hoping that this will create a student-teacher dialogue that draws a clear picture of what students were thinking when errors were made. After using all of these self-assessments before and after to see if their assessment grades improved. I will use the major quiz checklist with
the students and compare the students major quiz grade with their unit test grades. This will tell me if the students had studied what they missed on the major quiz checklist to improve on similar type of questions on their unit test. I also hope to get a better idea of how my students studied through the self-assessment questionnaire, and learn the processes my students used to study to see if the process worked for them.
RESULTS

I started my research by first handing out a self-assessment questionnaire to my Algebra 1ABC classes. The self-assessment questionnaire can be found under Appendix A. I gave my students this questionnaire to fill out directly after they were finished taking the unit exam, to have students write down how they thought they did. The following day, I explained the idea of self-assessment then I handed back the graded unit exam and their questionnaire. I gave the students ten minutes to look through their exam and then complete the rest of the questionnaire. We then spent another ten minutes discussing their predictions and feelings towards how they did on the unit exam. I did this for units two through four. I decided to only give out the second part of the questionnaire to the students for the unit four exam which was on polynomials.

The second self-assessment I had students complete was an itemized checklist of their major quiz. I also did this in my Algebra 1ABC classes for units three through five. I did this for unit five and for the midterm for my Algebra/Trigonometry classes. An example of the checklist can be found in Appendix C. In my Algebra 1ABC classes I first distributed this when I handed back the students graded major quizzes for unit three, which was on ratios and proportions. The major quiz is like a practice test for my students. The checklists listed each quiz question and showed which day’s notes or lab the question came from. I explained to the students how to fill this out using their major quiz as their guide. I also discussed how they could use this as a study guide. I gave the students approximately ten minutes to fill this out. The students filled out the checklist while going through their graded assessment. I gave this out to the students through unit
five. Table 1 shows the major quiz and unit three through five test averages for both periods of Algebra 1ABC.

Table 1

Algebra 1ABC Averages for Major Quizzes and Unit Exams Using the Checklist

<table>
<thead>
<tr>
<th>Period</th>
<th>Unit 3</th>
<th>Unit 4</th>
<th>Unit 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Major Quiz</td>
<td>Test</td>
<td>Major Quiz</td>
</tr>
<tr>
<td>One</td>
<td>54</td>
<td>65</td>
<td>44</td>
</tr>
<tr>
<td>Nine</td>
<td>50</td>
<td>61</td>
<td>50</td>
</tr>
</tbody>
</table>

In my Algebra/Trigonometry classes I gave the checklist to the students for unit five, which covered exponents. This exponential content is extremely difficult for students. I gave the checklist with the review to my Algebra/Trigonometry classes because, unlike my Algebra 1ABC students, they do not have a graded quiz. I gave them two reviews (practice tests), one of which we did together in class, and one they did for homework. I gave them the checklist for the review they took home as well as the answer key for the review. I did explain to my classes how to fill out the checklist using their review. I did not give them time to do it in class, but trusted them to do it independently. I received only five of the checklists back from students who completed it. Three students filled in the checklist in my fourth period class and two students completed it in my sixth period class. These five students' exam averages are shown in Table 2.
Table 2

**Algebra/Trig. Averages of Unit Exams for the Students Who Used the Checklist**

<table>
<thead>
<tr>
<th></th>
<th>Unit 1</th>
<th>Unit 2</th>
<th>Unit 3</th>
<th>Unit 4</th>
<th>Unit 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student A</td>
<td>77</td>
<td>74</td>
<td>93</td>
<td>92</td>
<td>60</td>
</tr>
<tr>
<td>Student B</td>
<td>93</td>
<td>96</td>
<td>91</td>
<td>99</td>
<td>65</td>
</tr>
<tr>
<td>Student C</td>
<td>77</td>
<td>77</td>
<td>103</td>
<td>100</td>
<td>96</td>
</tr>
</tbody>
</table>

| Period 6 |        |        |        |        |        |
| Student D | 80     | 49     | 93     | 63     | 70     |
| Student E | 59     | 74     | 93     | 97     | 97     |

I also gave the questionnaire to my Algebra/Trigonometry class for their midterm. The students had a practice part one and two for their midterm that they took over two days. The third day we went over all of the answers to the practice midterm and then I had my students fill out the checklist. Table 3 shows the unit exams averages for units one through six a combined average for all six units and the class average for each period on the midterm to compare each period's unit exam average against their midterm exam average.
The third and final self-assessment tool that I had students complete was the Test Aftermath. I handed out the Test Aftermath directions, the rubric, and examples of three point (the maximum) responses. I only used this in my Algebra/Trigonometry classes. I decided not to do this after speaking with my co-teacher in my Algebra ABC classes because we felt that they would not take the time to complete it seriously and honestly nor fully understand what was required of them. An example of the Test Aftermath can be found in Appendix E. I started to give my Algebra/Trigonometry classes the option to do this with the unit four exam on algebraic fractions and I have continued to use this the rest of the school year. I explained that the Test Aftermath was a self-assessment tool for them to receive back a maximum of nine points on their unit exam grade and that my goal was to get them to think and write mathematically. I explained the directions to them. I asked my students if they knew what a rubric was and the majority of them said that they use them in English and Social Studies classes, but they have never been evaluated on one in math. I showed them the rubric on the overhead and explained what was required of them and how the points were distributed. I then went over examples of

Table 3

<table>
<thead>
<tr>
<th>Period</th>
<th>Unit 1</th>
<th>Unit 2</th>
<th>Unit 3</th>
<th>Unit 4</th>
<th>Unit 5</th>
<th>Unit 6</th>
<th>Units 1-6 Av.</th>
<th>Midterm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four</td>
<td>73</td>
<td>72</td>
<td>84</td>
<td>89</td>
<td>75</td>
<td>63</td>
<td>76</td>
<td>78</td>
</tr>
<tr>
<td>Six</td>
<td>65</td>
<td>60</td>
<td>93</td>
<td>78</td>
<td>79</td>
<td>68</td>
<td>74</td>
<td>75</td>
</tr>
</tbody>
</table>
responses in which they could receive three points. Then, like Brown (2205) suggested, I gave it to them for homework.

The unit four exam on algebraic fractions average for period four was 89% and the average for period six was 78%. Out of twenty students that I have in period four, only two returned them. The first student originally scored 87% on his test and received eight out of nine possible points bringing the unit four exam score to 95%. The second student scored 68% on his test and received nine out of nine possible points, bringing the unit four exam score to 77%. Out of eighteen students that I have in period six, I received only three responses back. The first student originally scored 59% on her test and received four out of nine possible points, bringing the unit four exam score to 63%. The second student to complete the Test Aftermath scored 80% on her test and received eight out of nine possible points, to bring her unit four exam score to an 88%. The third student scored a 59% on her test and received a possible four out of nine possible points, to bring her unit four exam score to a 63%.

I again gave my students the option of completing the Test Aftermath for the unit five exam on exponents and on the unit six exam on circles. For the unit five exam: in period four, I received seven back out of twenty students and in period six, I received four back out of eighteen students. See Table 4 for the unit five exam results. For the unit six exam: in period four, I received four back out of twenty students, two of which had also done the Test Aftermath for unit five as well. In period six, I received five back out of eighteen, two of which had also done the Test Aftermath for unit five as well. In Table 5, I separated the students into categories based on who had completed the Test Aftermath for units five and six and who completed the Test Aftermath for just unit six.
Table 4

**Algebra/Trigonometry Averages for Unit 5 Exam using the Test Aftermath (T.A.)**

<table>
<thead>
<tr>
<th>Period 4</th>
<th>Unit 5 Before T. A. * (%)</th>
<th>Unit 5 After T. A. * (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student 1</td>
<td>93</td>
<td>95</td>
</tr>
<tr>
<td>Student 2</td>
<td>87</td>
<td>96</td>
</tr>
<tr>
<td>Student 3</td>
<td>62</td>
<td>65</td>
</tr>
<tr>
<td>Student 4</td>
<td>57</td>
<td>65</td>
</tr>
<tr>
<td>Student 5</td>
<td>89</td>
<td>93</td>
</tr>
<tr>
<td>Student 6</td>
<td>57</td>
<td>61</td>
</tr>
<tr>
<td>Period 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student 7</td>
<td>91</td>
<td>97</td>
</tr>
<tr>
<td>Student 8</td>
<td>65</td>
<td>72</td>
</tr>
<tr>
<td>Student 9</td>
<td>85</td>
<td>94</td>
</tr>
<tr>
<td>Student 10</td>
<td>57</td>
<td>62</td>
</tr>
</tbody>
</table>
Table 5

**Algebra/Trigonometry Averages for Unit 6 Exam using the Test Aftermath (T.A.)**

<table>
<thead>
<tr>
<th>Students that completed the T.A. for Units 5 and 6</th>
<th>Unit 6 Before T. A. * (%)</th>
<th>Unit 6 After T. A. * (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student 3</td>
<td>75</td>
<td>78</td>
</tr>
<tr>
<td>Student 5</td>
<td>72</td>
<td>77</td>
</tr>
<tr>
<td>Student 9</td>
<td>85</td>
<td>92</td>
</tr>
<tr>
<td>Student 10</td>
<td>35</td>
<td>41</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Students that completed the T.A. for Unit 6</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Student 11</td>
<td>58</td>
<td>63</td>
</tr>
<tr>
<td>Student 12</td>
<td>35</td>
<td>39</td>
</tr>
<tr>
<td>Student 13</td>
<td>98</td>
<td>100</td>
</tr>
<tr>
<td>Student 14</td>
<td>58</td>
<td>64</td>
</tr>
<tr>
<td>Student 15</td>
<td>72</td>
<td>76</td>
</tr>
</tbody>
</table>

The next time I gave the Test Aftermath, I decided to allow twenty minutes during class to complete it to get more students involved in this process. I also added a sentence onto the rubric under the three point column for each item, which stated that in addition to the previous criteria to get three points, now I expected the students to have at least two sentences containing the mistake that was made and an explanation of their reasoning to solve the problem. In period four there were three students taking the test in the math clinic because they were absent the previous day. There were two students absent. I received eight completed Test Aftermaths and I did not receive Test Aftermaths from seven students. In period six there were eleven students who completed it, two students that were absent, and six students who didn’t complete it. The students that choose not to do the Test Aftermath
were working on other work. They chose not to do it because they were satisfied with their grades on the exam. The students who chose to work on this during class were working diligently and were asking me many questions. A lot of these students were completing this for the first time. In Table 6, I separated the students into categories based on who had completed the Test Aftermath for units five, six, and seven, who completed it for units six and seven, and who completed it for just unit seven.
Table 6

Algebra/Trigonometry Averages for Unit 7 Exam using the Test Aftermath (T.A.)

<table>
<thead>
<tr>
<th>Students that completed the T.A. for Units 5, 6, and 7</th>
<th>Unit 7 Before T. A.* (%)</th>
<th>Unit 7 After T.A.* (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student 2</td>
<td>80</td>
<td>85</td>
</tr>
<tr>
<td>Student 3</td>
<td>71</td>
<td>78</td>
</tr>
<tr>
<td>Student 6</td>
<td>77</td>
<td>86</td>
</tr>
<tr>
<td>Student 7</td>
<td>62</td>
<td>68</td>
</tr>
<tr>
<td>Student 8</td>
<td>68</td>
<td>73</td>
</tr>
<tr>
<td>Student 9</td>
<td>80</td>
<td>89</td>
</tr>
<tr>
<td>Students that completed the T.A. for Units 6 and 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student 12</td>
<td>62</td>
<td>65</td>
</tr>
<tr>
<td>Student 13</td>
<td>96</td>
<td>99</td>
</tr>
<tr>
<td>Student 14</td>
<td>82</td>
<td>88</td>
</tr>
<tr>
<td>Student 15</td>
<td>71</td>
<td>77</td>
</tr>
<tr>
<td>Students that completed the T.A. for Unit 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student 16</td>
<td>55</td>
<td>62</td>
</tr>
<tr>
<td>Student 17</td>
<td>71</td>
<td>78</td>
</tr>
<tr>
<td>Student 18</td>
<td>62</td>
<td>65</td>
</tr>
<tr>
<td>Student 19</td>
<td>92</td>
<td>95</td>
</tr>
<tr>
<td>Student 20</td>
<td>94</td>
<td>100</td>
</tr>
<tr>
<td>Student 21</td>
<td>74</td>
<td>81</td>
</tr>
<tr>
<td>Student 22</td>
<td>55</td>
<td>57</td>
</tr>
<tr>
<td>Student 23</td>
<td>88</td>
<td>97</td>
</tr>
<tr>
<td>Student 24</td>
<td>62</td>
<td>69</td>
</tr>
</tbody>
</table>
DISCUSSION

This section reflects on the research, my self-assessment action research, and its influences on me as a future educator. From doing my action research I hoped to see a rise in student exam averages. The results, however did not always prove this to be the case. My research helped me to understand how students think and learn about self-assessment and mathematics. I do understand that when students are learning something new, the students themselves and the teacher should not expect to be an expert the first time around.

I decided to give out a self-assessment questionnaire to my students because according to Achacoso (2005), research suggests that this helps students understand their performance on an exam. It allows the students to see how their effort and their study strategies used were directly related to their performance. This was one of the major goals I wanted to achieve from having student self-assessment. I felt the self-assessment questionnaire was very useful and helpful the first time I gave it out. After the students filled out the second part of the questionnaire, we then had a discussion about what they found and how they might change their learning process in the future. Some observations that came up during the discussion were that students felt they did well on the exam although some students studied and some did not. The students that studied said that they did so anywhere from twenty minutes to two hours. They used flash cards, did practice problems, looked over their notes, homework, labs, and reviews, went over past quizzes, and one student even had her parents give her a mini-quiz with problems from the notes and homework.

After the students looked over the test, many students were close on their prediction, but a few of the students were off. We discussed why this could be and the overwhelming response was because they didn’t study. We talked about how a person could study for a
math test. Some suggestions that were brought up were to go to the math clinic to get extra help, make note cards, and look through notes, homework, labs, and quizzes to get an idea of the types of questions that were given. Other suggestions were to have someone in their family quiz them on questions from the review, formulas, and definitions that are needed for each unit. The responses I received were honest, thoughtful, and thorough with great examples how the students studied. The majority of the students did well on this unit two test.

The first time my Algebra IABC students took the self-assessment questionnaire for their unit two exam they were serious and thoughtful with their responses. The questionnaire can be found in Appendix A. This changed, however each time I handed out the questionnaire. Unit three was on ratio and proportion which is generally a harder concept for students to understand, compared to unit two which was on sum of angles in a triangle, two parallel lines cut by a transversal and the angles they form. Because of the difficulty of the third unit test, the students appeared frustrated with their poor results and consequently their responses were short and showed less thought and detail. The common response to why they did so poorly was that they did not study and I concur.

Because of their previous frustrations, I gave out only the second part of the questionnaire for unit four so the students did not make a prediction on how they thought they did on the exam. The students' responses this time were plentiful with ways to improve their grade and study habits. Many students thought that just doing their homework every night was a sufficient way to study for the exam. I explained to them that homework does give you good practice if you are doing it correctly, but this does not work if you are not doing your homework questions incorrectly, do not to go over homework questions in class,
and do not correct the problems when we go over them in class. To my disappointment, a lot of students were content to get a passing grade on the test and were satisfied with this grade even if they didn’t study. This seems to be true for the majority of the co-taught population from my discussions with other content teachers and special education teachers. As a teacher it frustrates me that they would settle for mediocrity because I believe that if they put in a little effort they would do better. Unfortunately, I haven’t figured out a way to convince my kids of this yet.

After giving out the questionnaire for three consecutive units, I felt students were discouraged too much when they thought they did well on an exam (the first part of the questionnaire) and then found out that they did not do as well as they had expected (the second part of the questionnaire). I infer that the students were disappointed with themselves for their performance on the test. The students were frustrated with themselves or me, therefore they didn’t want to take the time to complete the second part of the questionnaire honestly and thoroughly. Because of my research I now disagree with Lajoie’s research on motivation (1995) because I did not find through my research similar results. Lajoie said that adaptive feedback is how learners can self-assess from their results, which will help to improve the learner’s motivation and sense of self-efficacy. I did not find my students motivated after using this questionnaire. As a matter of fact, the majority of my students filled it out and did not refer back to it and consider what they wrote. After noting that a lot of my students’ responses were that they didn’t study and that they were happy with their grade as long as they passed, their feedback did not seem to improve their motivation. Wiggins (1993) discussed feedback as providing students with direct, usable insight into their current performance based on tangible differences between current performance and hoped
for performance. This was what I was hoping to accomplish by using the questionnaire, but I did not find this to be true for most of my students. Maybe if I had a class of students that were good in math, on the regular tract or in an honors class, and concerned about their grades this might be true. I found through my research that this was not true for my extended students in a co-taught classroom that do not like math and are not typically good at it.

The major quiz in my Algebra 1ABC classes is a practice test for their unit exam. My Algebra/Trigonometry classes were given two reviews which are practice tests for their unit exam. This checklist can be found in Appendix C. The first time I distributed the checklist to my Algebra 1ABC students and my Algebra/Trigonometry classes they really seemed to appreciate it. They thought this would be helpful for them to study from or at least know what section of their notes to review before their exam. The next couple of times I handed this out in my Algebra 1ABC classes, they were not as enthusiastic. I believe that the students that are self-motivated and want to excel used it and appreciated it.

According to my research, students believe that practice tests are a beneficial review strategy, which is why I do give them a practice test. Stiggins (2204) has found that a pre-test a few days before the actual exam helps students identify remaining weakness for last minute study. According to Snooks (2005), more than 90% of students reported that practice tests helped them study for examinations. I agreed with this research, so I wanted to try giving out a checklist that would have specific locations for students to go back and study for problems they did not get right on the practice test. I believe that this would help to give students immediate feedback as to where they could better focus their studying for the unit exam.
My action research has supported this hypothesis. As seen in Table 1, my Algebra 1ABC unit exam averages are higher than their major quiz averages for all three units when they were given a checklist. For the unit three exam period one’s average increased nine points, while period nine’s average increased eleven points. For unit four, period one’s average increased sixteen points and period nine’s average increased fifteen points. Lastly, for unit five, period one’s average increased one point and period nine’s average increased seven points. I believe that this increase in averages from the major quiz to the unit exam was in part due to the checklist but also because the major quiz is a pre-test to their unit exam. I gave my students a quick survey regarding the checklist to see what the students thought about it. Most students surveyed said the main reason why the checklist was helpful to them was that it showed them what questions they got wrong and then they knew what they needed to study for the unit exam. The students then went back to their notes and studied the right way to do the problem.

The first time I handed out the checklist to my Algebra/Trigonometry classes was for the unit five exam on exponents. The percentage returned from these classes was less than the Algebra 1ABC classes. I believe that this was because I did not give them class time to complete the questionnaire due to time constraints. I gave all of my students the checklist to take home with them to complete when they finished doing the second review. I did not have an extra period or half a period to devote class time to this because I had one more unit to teach before their midterm review and midterm. I received back only three checklists from students in period four and only two checklists back from period six. I gave my students a quick survey regarding the checklist to see what the students thought about it. Some of my Algebra/Trigonometry students did not use it in unit five because they said it was confusing.
that they were not a checklist type of person, it takes time to fill it out and they did not have
the patience, they didn’t feel like going back to the note packet to find where the question
came from because they are lazy and we review in class, they do not know how to study
math, they thought it would be a lot of work or they study in a different way than this. These
are all sound justifications for either using the checklist or not. Again, students all learn
differently, so what works for one student will not necessarily work for another.

The results of the student’s exam averages from the first five exams are in Table 2.
For students A and B, their unit five exam average went down considerably. Student C had
the third highest exam average out of the five exams. Student D also, had the third highest
exam average on unit five compared out of five exams. Lastly, student E average was tied
with the highest exam average out of the five exams. These results were not as positive as
the results I had in my Algebra 1ABC classes. Students C, D, and E used the checklist and
they reported that it helped them to be more successful than they could have been without
using it. However, the students that did do the checklist are the students that work the
hardest in class and really try to get good grades and want to succeed. Also, I believe that it
could in part to the content in unit five. Exponents are hard for students because there are a
lot of rules and formulas to remember, which would be difficult for the students that do not
study for mathematics. This is also the first time they are exposed to this material. Unit one
was an introduction to the graphing calculator which most of my students had not used
before. Unit two was on quadratics and radicals which is not a new concept. Unit three was
on functions which is not a challenging curriculum. Unit four was on algebraic fractions
which again is not a new concept.
I did not give out the checklist for unit six because so few students completed it for unit five and it would have to be assigned as homework because of the time constraints mentioned earlier. I wanted to make sure to give the checklist out for their midterm, though, because it covered so much information. I know from my own past school experiences that when I entered a classroom ready to take an exam and did not know the specific questions that were going to be asked, I was terrified. I did not want my students to have this same experience. After all, the New York State Regents, the ACT, and the SAT, describe the type of questions that they ask and provide samples for review in their review books. Odafe (1998) believes that students who are afraid of tests perform below their capabilities because they are not given sufficient responsibilities in assessing their learning. I did not want this to happen to my students, so I was gave a practice midterm checklist out to all of my Algebra/Trigonometry students. After the students took both parts of their practice midterm the next day we went over the whole practice midterm and I gave them approximately ten minutes in class to fill out the checklist. Snooks (2005), found that class discussions of practice tests often reveal some of the student’s misunderstandings on issues. I believe by going over the practice midterm, it helped students clarify their misunderstandings and then the checklist helped focused students in the direction that they needed to study.

The results for both periods’ midterm averages and the averages for each unit exam up to this point are in Table 3. The midterm averages were higher than each period’s one through six exam average. Period four’s midterm average was two points higher than the exam averages and period six midterm average was one point higher than their exam averages. The students said the checklist was beneficial for them because the midterm covered a lot of material, therefore they could see what units they were struggling with and
make sure they reviewed those units. The students were more excited to get this checklist because they said they felt overwhelmed by all of the material they have learned so far and they did not know where to start studying. This checklist helped to point them in the right direction.

The third and final self-assessment tool I used in my action research was the Test Aftermath. A copy of the Test Aftermath is in Appendix E. According to Brown (2005) this method facilitates student self-evaluation, enhances learning, and supplies student feedback. Brown believes that this task encourages students to reflect on the actual mathematics performed on the test. I decided to use this for my Algebra/Trigonometry classes only. I spoke with my co-teacher about using it in my Algebra IABC classes and we agreed that our class population processes slowly and the skills needed to complete this they have difficulties with, such as written expression and they would not fully understand what was required of them. The Test Aftermath is a tool that can be used to help eliminate some the test anxiety because students know that they will be able to receive points back on their exam if they did not achieve up to their standards. According to Kulm (1994), test anxiety is perhaps the greatest factor in producing poor attitudes toward mathematics. I wanted to try to alleviate this. Also, when students are asked to analyze their problem-solving process, there is a measurable effect on performance now and in the future. Tests that provide no opportunity for students to supply a rationale for their answers reveal that what students think and why they think are unimportant. Yet most tests provide students with nothing more than a score.

The first time I handed out the Test Aftermath was after the unit four exam on algebraic fractions. I went over the exam in class and then explained the Test Aftermath process by going over the directions, rubric, and models that would get three points for each
item for a maximum of nine points. I then gave the Test Aftermath out as homework to be due the next day in class. I was disappointed with the few number of students that completed this. This could be because the class average for the unit exam was so high. The class average for the unit four exam in period four was 89% and in period six was 78%. I was curious as to why I didn’t receive more Test Aftermaths completed. When I asked my students they said they were satisfied with their grade, they forgot about it, or they felt that it was too much effort to put in for nine points to be added onto their exam. One of the students who completed the Test Aftermath did really well on the exam (87%) and after completing the Test Aftermath the student received 95%. This student, though, always strives to get good grades and works very hard. The other students who completed it did not do as well on their exams; some did not even pass. One of the students from period six did so well on her explanation of item two that I added it to the example section on the Test Aftermath. She was proud that I did this because she did not typically do well in math, so she was honored that I would use her mathematical explanation as an example of great quality work.

I again went over the exam in class and gave the Test Aftermath for homework as Brown (2205) suggested. For the unit five exam on exponents I was glad to see that more students took advantage of completing this. Compared to only five responses the last time I distributed it, I received eleven completed Test Aftermaths. The results of these students’ grades before and after the Test Aftermath are in Table 4. In period four, three of the students had passed the original exam and three students did not. After completing the Test Aftermath all but one from period four passed, with anywhere from two points to nine points given back on the exam. In period six, two out of the four students had passed the original
exam. After completing the Test Aftermath, all but one passed. Period six received an average of 6.75 points back completing the Test Aftermath compared with period four, which received an average of five points back on their exam.

The students who received two, three, or four points back really did not take the time to read the rubric and the directions. Their responses for item one was very generic and I feel that these students did not use a lot of the mathematical terminology that they learned in the exponent unit. Also, some of the explanations of the problems students chose to show me (item two and three), were not true. They did not solve the problem correctly on the Test Aftermath. This is where I believe it would be beneficial for the students that typically struggle with math or did poorly on the test to get help completing this with me after school or during class. But, since this was the first time most of these students did anything like this in a mathematics class before, I did not expect them to all get nine points the first time they tried this.

I again went over the students' unit six exam in class and gave them the Test Aftermath to complete for homework. The unit six exam had the worst class averages for an exam that I had given so far this year. Period four's exam average was 63% and period six's exam average was 68%. Most students believe that this was the hardest unit we have had so far in Algebra/Trigonometry and the majority of the students were never exposed to these concepts before. I was surprised that a lot of students did not want to complete the Test Aftermath for unit six on circles. The majority of the students felt that because they failed their exam, even with nine extra points they would receive by doing the Test Aftermath, they would still have a failing exam grade. I explained to them that it would still help their overall unit average to have a higher test grade even though it may still be failing. Unfortunately,
they only saw their unit exam grade as still failing and therefore did not want to put in the effort. Another advantage I thought the students had was that they had a long weekend to complete it because of the Martin Luther King Jr. holiday but, even this did not entice them.

I received four completed Test Aftermaths from period four and five from period six. Out of these nine students who did this, four completed the Test Aftermath for unit five also. The results of these students' grades before and after the Test Aftermath are in Table 5. In period four, two of the students passed the original exam and two students did not. After completing the Test Aftermath, two out of the four students from period four passed, with anywhere from three points to five points given back on the exam. In period six, two out of the five students passed the original exam. After completing the Test Aftermath, all but two passed. Period six did receive an average of five points back completing the Test Aftermath compared with period four, which received an average of 4.25 points back on their exam. Again, their responses for item one were very generic, and these students did not use a lot of the mathematical terminology that they learned in the circle unit. Also, some of the problems students chose to show me they knew how to do for items two and three were explained incorrectly, even though they chose these problems to do because they "knew" how to do them. I also received a few responses for item two where students said that there were no problems that they did not prepare for that were not on the test. I believe that if this was true, then students would have done better than they did. Some of my students that were completing this for the second or third time were beginning to show an improvement. Student 10 from tables 4 and 5, which completed the Test Aftermath for the third time, was improving. She received three points for her response to item one because the response to her strengths and weaknesses were specific to the unit. This was the first time she received
three points on any item before. It appears that repetition of the process may be important to success.

After seeing these responses from the students, I decided to change all of the three point explanations in the rubric to include the sentence “there should be at least two sentences containing the mistake that was made and an explanation of your reasoning to solve the problem.” I added this extra sentence to the rubric because, in the previous Test Aftermaths I received, especially for items two and three, students did not have a mathematical explanation. A lot of students gave me a problem and solved it. This was not the complete outcome I had hoped for. I wanted the students to become accustomed to writing explanations of their thought process in mathematics. From this point forward, if a student did not write at least two sentences for any item, the most points that they could receive would be two points for each item.

For unit seven on the introduction to proofs unit, I decided to try something different. I actually had a half of period of class time to spare, so I decided to devote this class time to doing the Test Aftermath. This was a suggestion from my learning team because I was telling them how disappointed I was that I was receiving so few Test Aftermaths from students. This is where in my action research I disagree with Brown (2005). Brown found great success for completion and honesty when the Test Aftermath was assigned as homework. He believed that this was due to the fact that there are no peers nearby and that it gave students a lot of time to think about their responses and explanations on their scored tests. Unlike what Brown (2005) had observed in his literature, the students were not embarrassed doing this during class. They were not afraid to ask questions nor were they embarrassed about their grade. I realize this will not work for every unit because of time
constraints, but I believe this is beneficial for everyone to complete it during class. This is especially true for the first time so that a teacher is available for any questions the students may have or any feedback they can give so that the students are successful. Because this was the first time through for many students, they had a lot of questions to ask. I really had to clarify the directions and explain what I expected from the them in order for them to get started. This was especially difficult for them because most of them never had to write mathematically before this.

As seen in Table 6, there was more completed Test Aftermaths when the students could work on this during class. In period four I received nine completed responses and in period six I received eleven responses. Out of these twenty responses I received, ten were from students who had done the Test Aftermath previously. After completing the Test Aftermath, five out of the eight students from period four passed, with anywhere from three points to nine points given back on the exam. In period six, eight out of the eleven students had passed the original exam. After completing the Test Aftermath, all but two students passed. Period six did receive an average of six points back completing the Test Aftermath compared with period four, which received an average of 5.5 points back on their exam. These results from my research were very positive because the average number of points students received back from doing the Test Aftermath were increasing.
CONCLUSION

In the future, I would hand out the self-assessment questionnaire (Appendix A) to my students on the first exam of the year. The following day I would have a discussion of their answers, discuss study habits, and ways students could get extra help. On the day before their next exam, I would give back the questionnaire to the students to look at to help motivate them to do what they said they would do differently on the next exam. After that exam, I would have a short discussion with them to see if they used their suggestions and to see if they helped them. I will continue to give out the questionnaire for each new exam of the marking period. I believe that this would be more helpful rather than giving it out after each test. Typically students that were not happy with their previous marking period grade will ask me what they can do to improve their grade for the next quarter. I plan on showing them their responses from the self-assessment questionnaires to discuss with them if they are actually using their own advice. I will keep all of their questionnaires in a folder so that the students can refer back to them. This also allows me to go to individual students which are struggling and meet with them after school about how to help raise their grade.

I really enjoyed the checklist (Appendix C) and found it to be extremely beneficial to the students that used it and I will continue to use it in all of my classes. Through my research I have found this to be more helpful than the questionnaire. In the future, I will allow five to ten minutes for students to fill out the checklist during class. I believe that even if students just fill it out and do not use it to study with or if they just glance at it, they will know what questions they got wrong or guessed on, where those questions came from in order to have an idea of how they will perform on the exam.
I also found using the Test Aftermath (Appendix E) in my classes to be beneficial for both me and the students. I learned what students’ strengths and weaknesses were for future years so that I will be able to address them while I am teaching the unit and not after. It was beneficial for the student because they learned to write mathematically, learned how to self-evaluate their performance on an exam, and they received points back on their exam to improve their unit grade. The results improved after the students practiced completing the Test Aftermaths. I believe that when students regularly identify their strengths and areas of improvement, they are prepared to move to the next step in their learning. It also shows that the teacher cares enough to give the students a chance to explain their thought processes.

Grading the Test Aftermath takes a lot of time, but I feel that it is worth my time to help the students do better, correct their mistakes, and learn from them. As the research suggests, feedback is so important in the assessment process. One thing I am not totally in agreement with is giving one point for an item that is not correct. I have a difficult time accepting giving a point to a student who completes an item, but gets it totally wrong. On the other hand, this is why a student who makes no attempt receives no points.

The Test Aftermath is so successful because it provides students the opportunity to show what they know. Also, students appreciate a second chance to validate their understanding or to conquer one problem from a test without the time constraints or the tension of a test setting. I have learned from my research, just like Brown (2005), that it will take a few times of completing this and getting feedback from their teacher before students obtain the desired outcome. I have seen the students’ fluency of mathematical discourse improve with each submission. The time invested in doing the Test Aftermath with students pays off because teachers will gain a wider view of students’ understanding and disposition,
which cannot be achieved through a paper and pencil exam. Also, it helps the students learn
the material correctly for the questions they got incorrect.

What I have experienced through doing this research is what you can learn about a
learner’s study skills for mathematics and how motivated different students are to do well. I
also have experienced that you can learn so much about a learner’s mathematical knowledge
from just talking with them on their self-assessments. I do believe that self-assessment is a
tool which students can use to help improve their understanding of mathematics, if they
chose to use this tool. All students learn differently and different tools work for some
students and necessarily not for others. You can offer the tools, but the student makes the
ultimate decision whether or not to use the tools. I do believe that it is good to have different
tools that students see, try using, and then they can chose for themselves what will work. I
do believe that if students invest in their own learning process, the more they will learn.

As a teacher, I need to find ways to obtain a clear picture of my students’ level of
understanding and I believe that many of these alternative assessments will do this. A
possible idea for future research would be to try a few of the alternative assessments
mentioned in the literature review in my mathematics classroom. Students are not used to
having any other assessments other than exams in mathematics. I would like to change this
idea with my future students. I would like to try using portfolios to monitor my student’s
growth throughout the year. I also would like to try group assessments in my classroom. I
believe that this would take away some of the test anxiety students face. Also, I currently do
little cooperative learning in my classroom and would I like to do more of this. I believe that
you need to try out different assessments and determine which ones will be the most
successful for you and your students. Through future research I hope to have a whole
repertoire of alternative assessments and self-assessment tools therefore I can have my students choose which ones will work best for them. I also believe that students learn differently so you do have to try alternative assessments throughout the year to allow most students success in your classroom. We must build classroom environments in which students use assessment to understand what success looks like and how to be more successful the next time so that they can achieve their goals.

As far as self-assessment, I believe this is a great tool for students who are motivated to want to better their learning. I do not believe that this works for all types of students, however. You cannot force a student to do this. You can just explain to them the tools and give them an opportunity to use them. What works for some students may not work for all students. I will continue to use these self-assessment tools that I developed because even though I received both positive and negative feedback from my students and the results I obtained were not ideal, they did help some kids, which is all that matters to me. If I can help a few kids learn better than it is worth the effort for me as an educator. Also, I have already developed these tools to use by doing this research. I also believe that they might be more helpful to future classes I might teach. Each class is unique. Some are more motivated than others and the curriculum I teach may change. These self-assessments are good tools to have in my repertoire.
REFERENCES


Appendix A

Self-Assessment Evaluation

1. How did you think you did on your exam? Please predict your score.

2. How much effort did you put into preparing for this exam?

   1  2  3  4  5  6  7  8  9  10
   Low effort  Moderate effort  High effort

3. How long did you study for the exam?

4. List the specific strategies you used to study for this exam.

5. What did you find easiest for you on the exam? Why?

6. What was most difficult for you on the exam? Why?
After Your Exam Score:

7. Now that you have seen your exam, how do you feel about your performance? Was your prediction correct?

8. If you did worse than you expected, why do you think you did?

9. On the next exam in this class, would you change any of the strategies you used or the amount of time you spent studying? Please be specific.

10. Can you suggest anything else I as your instructor could do to help you to prepare for the exam? Please be serious and specific.
Appendix B

Self-Assessment Evaluation – Student Example

**Self-Assessment Evaluation**

1. How did you think you did on your exam? Please predict your score.
   
   *I think I did pretty good. Possibly an 80%.*

2. How much effort did you put into preparing for this exam?
   
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<th>4</th>
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<td>Low effort</td>
<td>Moderate effort</td>
<td>High effort</td>
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</table>

3. How long did you study for the exam?
   
   *About an hour.*

4. List the specific strategies you used to study for this exam.
   
   *This is a great idea! I had a parent quiz me, then made a little test and copied some problems off my notes.*

5. What did you find easiest for you on the exam? Why?
   
   *Both problems that equal each other and the ones that add up to 180*, because most of the knowledge on those problems came from our last unit, which we just solved for x.*

6. What was most difficult for you on the exam? Why?
   
   *Finding the missing degree on the 1st page b/c I really didn’t comprehend on that part.*
After Your Exam Score:

7. Now that you have seen your exam, how do you feel about your performance? Was your prediction correct?
   I feel pretty good about my performance. My prediction was correct.

8. If you did worse than you expected, why do you think you did?
   I didn't do worse than I expected.

9. On the next exam in this class, would you change any of the strategies you used or the amount of time you spent studying? Please be specific.
   I am going to look over the problems I got wrong. And look them over some more.

10. Can you suggest anything else I as your instructor could do to help you to prepare for the exam? Please be serious and specific.
    It'd be kinda cool, if you had a study group after school, so you could help us before the test.
2 point questions. Be sure to show all of your work.

1.) ABCD is a rectangle. If \( m \angle A = 2x + 2 \) degrees, find the value of \( x \).

- A.) 34°  
- B.) 45°  
- C.) 68°  
- D.) 79°

\[
2x + 22 = 180 \\
2x = 158 \\
x = 79°
\]

2.) What type of triangle is drawn below?

- A.) right isosceles  
- B.) acute scalene  
- C.) acute isosceles  
- D.) right scalene

3.) If the base angle of an isosceles triangle is 72°, what is the measure of the vertex angle?

- A.) 36°  
- B.) 54°  
- C.) 72°  
- D.) 108°

\[
72 + x + x = 180 \\
2x + 72 = 180 \\
x = 54°
\]

4.) What is the measure of \( \angle 1 \) in the following figure?

\[
-115 + x = 180 \\
x = 65°
\]

5.) Answer sometimes, always, or never. A trapezoid is a parallelogram.
2 point questions (cont). Be sure to show all work.

6.) Solve the following inequality \( 4x - 7 > 9 \).

\[
\begin{align*}
4x - 7 &> 9 \\
4x &> 16 \\
x &> 4
\end{align*}
\]

3 point questions. Be sure to show all of your work.

7.) \( AB \) intersects \( CD \) at E. If the \( m \angle AED = 5x - 8 \) and \( m \angle CEB = 2x + 10 \), find the value of \( x \).

\[
\begin{align*}
5x - 8 &= 2x + 10 \\
3x &= 18 \\
x &= 6
\end{align*}
\]

8.) Given \( \ell \parallel m \). If \( m \angle 1 = 4x + 3 \) and \( m \angle 2 = 2x + 15 \), find the value of \( x \).

\[
\begin{align*}
(4x + 3) + (2x + 15) &= 180 \\
6x + 18 &= 180 \\
6x &= 162 \\
x &= 27
\end{align*}
\]

9.) In isosceles trapezoid \( ABCD \), \( m \angle B = 5x - 3 \) and \( m \angle C = 3x + 9 \). Find the value of \( x \).

\[
\begin{align*}
5x - 3 &= 3x + 9 \\
2x &= 12 \\
x &= 6
\end{align*}
\]
10.) Solve and graph the following inequality.

\[
\begin{align*}
-\frac{7}{3} & \leq \frac{3x}{4} + \frac{28}{4} \\
-\frac{7}{3} & \leq \frac{3x}{4} + 7 \\
-\frac{28}{3} & \leq \frac{3x}{4} \\
-\frac{4}{3} & \leq x \\
x & \leq \frac{-4}{3}
\end{align*}
\]

11.) Find the value of \( x \) in the following figure.

\[
2x + 7 + 33 = 41x - 60 \\
7 + 33 = 2x - 6 \\
40 = 2x + 6 \\
34 = 2x \\
x = 17
\]

12.) In parallelogram ABCD, \( m \angle A = 5x - 7 \) and \( m \angle C = 3x + 5 \). Find the measure of each angle in parallelogram ABCD.

\[
\begin{align*}
x + 7 + 5x + 5 & = 180 \\
6x + 12 & = 180 \\
6x & = 168 \\
x & = 28
\end{align*}
\]

\[
\begin{align*}
5x - 7 &= 3x + 5 \\
2x &= 12 \\
x &= 6
\end{align*}
\]
4 point questions (cont). Be sure to show all of your work.

13.) If two angles are supplementary and one angle is 12 more than twice the other angle, find the measure of both angles.

\[ x + 2x + 12 = 180 \]
\[ 3x + 12 = 180 \]
\[ 3x = 168 \]
\[ x = 56 \]

14.) In triangle ABC, the measure of \( \angle A \) is twice the measure of \( \angle B \) and \( \angle C \) is 8 more than the measure of \( \angle B \). Find the measure of each angle in the triangle.

\[ x + 2x + x + 8 = 180 \]
\[ 4x + 8 = 180 \]
\[ 4x = 172 \]
\[ x = 43 \]

15.) In the following figure \( \overline{AB} \parallel \overline{EG} \). If \( \measuredangle ADC = 7x - 5 \) and \( \measuredangle EFD = 5x + 27 \), find the number of degrees in \( \measuredangle DFG \).

\[ 5x + 27 = 7x - 5 \]
\[ -2x = -32 \]
\[ x = 16 \]
**Self-Assessment for Unit 4**

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<th>Learning Target</th>
<th>Got It Right!</th>
<th>Got It Wrong</th>
<th>Need to Study</th>
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<td>Simple Mistake</td>
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<td>Day 6 &amp; Mixed Review</td>
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## Appendix D

### Algebra/Trigonometry Itemized Checklist for Unit 5 – Example of Student Work

#### Self-Assessment for Unit 5 Review 2

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<td>13 Day 18</td>
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</table>

Name: __________________________

I knew it  | Lucky Guess  | Simple Mistake | Misread Question | I don't Understand | Need To Study |
-----------|--------------|----------------|------------------|-------------------|---------------|
-----------|--------------|----------------|------------------|-------------------|---------------|
Appendix E

TEST AFTERMATH:

Directions: Spend some time looking over your test, and assess your performance by completing the following items. This assignment is due at the beginning of our next class. Please take time to seriously reflect on your work, and do your best to offer neatly organized responses. Each item is worth 3 points.

1. On a piece of notebook paper, write about your performance on the test, pointing out one or two specific strengths and one or two specific weaknesses in your mathematics. Be sure to focus on the mathematics concepts rather than your test-taking skills (for example – I am a terrible test taker), and identify those concepts using accurate math terminology.

2. As is the case with most tests, you probably prepared yourself to do some type of problem or exercise that did not show up on the test. Bummer! On your paper, demonstrate your understanding of a significant concept that was not included on the test by showing an example and working through it. Please explain your problem, strategy, and solution carefully so I am convinced of your understanding.

3. You are possibly experiencing some “feelings” concerning the test that you just got back. If you are like me, you may now realize that you “totally blew” a problem you should have been able to do, and you wish you could do it over. Well, here’s your chance. Please identify the problem you missed and show me that you really can do that problem correctly. Use your book and notes as needed, but try to do the work without the assistance of any other person – remember you’ve chosen a test problem you believe you could have done. Be sure to show or explain all work (or thinking) necessary in arriving at the correct solution.

*If you scored an “A” on the exam, item 3 is optional.*
**TEST AFTERMATH EXAMPLES:**

1. I was better at simplifying and finding areas than I was at finding the perimeter of triangles. One weak point I noticed on my test was finding the perimeter of triangles. I used \( a^2 + b^2 = c^2 \) rather than just simply adding the sides.

   I feel I did well on simplifying. I understand how to factor out problems and simplifying them. I also did well on finding areas because I knew the formula and plug in the numbers. I didn’t do as well as I hoped on the perimeter of triangles because I made it more complicated than it actually was.

   I was better at applying the mathematics to solving word problems or algebra equations than I was at the math terminology.

   One weak point I noticed on my test was following the directions carefully. This led to one error or rounding where I had rounded out to more decimals than needed.

   I feel I did well at circle terminology. I understand all the terms. I also did well with identifying triangles by their sides and angles. I also did well with lines, rays, and line segments...I didn’t do very good classifying quadrilaterals or finding the sum of measure of interior angles. Those I could improve on.

2. I was prepared for finding restrictions. An example would be \( \frac{x^2 - 1}{x - 1} \).

   \( \frac{(x-1)(x+1)}{x-1} = (x+1) \). Restriction: \( x - 1 = 0 \), therefore \( x = 1 \).

   For restrictions the denominator needs to be equaled to zero. Solve the problem first. Simplify, cancel if needed. Make the denominator equal to zero. Then Solve.

   I was hoping we would have to write an explanation of rounding on the test, but we didn’t so here it goes. (Tenth) Find a multiple of one tenth that the number is closer to. If it’s exactly half way between, (five in hundredths) then round up. Pretty good, huh? I didn’t even look in my math notes – I swear!

Arrange in order from smallest to greatest: 8.01002, 8.010019, 8.0019929.

We begin by looking at each of the place values. All three numbers have a zero in the tenths place. In the hundredths place there are two numbers with 1. Therefore we have found that the smallest number would be the one without the 1 in the hundredths place, which is 8.0019929. Next we continue moving to the right and come to the next place where there are numbers, which is the ten-thousandths place. Because there is a 2 in one and a 1 in the other ten thousandths place, this concludes that 8.01002 > 8.010019 so = 8.0019929, 8.010019, 8.01002.
3. I messed up on one problem that had to do with finding the perimeter of triangles. Perimeter is simply adding up sides. As I looked over my mistakes I realized that I made the problem look hard, when it really wasn't. I couldn't believe that I used $a^2 + b^2 = c^2$ to find the perimeter when that formula is to find the side of a triangle. Here is the question:

Juan is drawing a triangle whose side’s measure $\frac{x^2}{2x-4}, \frac{x^2-6x}{2x-4}, \frac{2x}{2x-4}$. What is the perimeter of Juan’s triangle, in simplest form?

Solution:

$$\frac{x^2}{2x-4} + \frac{x^2-6x}{2x-4} + \frac{2x}{2x-4} = \frac{2x^2 - 4x + 2x(x-2)}{2(x-2)} = x$$

I messed up on one of the problems that had to do with right triangles, if you tip the paper so the triangle is facing like your piece of paper you can clearly see if it's right or if it isn't and I even tipped the paper and I could clearly see that it was a right angle and a right triangle. So, I need to include triangle $E$ in my list of right triangles.

As I looked over my mistakes, I could've kicked myself. I made several mistakes that could have been avoided had I checked my answer. The one that bothered me the most was #4. I almost had the answer, but because I didn’t pay enough attention to the question, got them both wrong!

4a). 15% + 20% + 10% + 13% + 34% = 92%

100% - 92% = 8% were pencils.

I subtracted from 360*! WHOOPS!! DUH!!

4b). $\frac{15 \times 60}{100} = 9$ rubber bands

I even had this written out but went to the next question and never wrote down the answer! DUH!!
## Test Aftermath Rubric

### Teacher Name: Mrs. Elliott

### Student Name: 

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<tr>
<th>CATEGORY</th>
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<tr>
<td><strong>Item 1</strong></td>
<td>Mathematics strengths and weaknesses (1 or 2 of each) explicitly addressed using accurate mathematics terminology. Identified strengths and weaknesses should accurately correspond to the math objectives and student's actual math performance (as opposed to general test taking skills). There should be at least 2 sentences containing the mistake that was made and an explanation of your reasoning to solve the problem.</td>
<td>Mathematics strengths or weaknesses incompletely or vaguely addressed or multiple terms are inappropriately addressed using accurate mathematics terminology. The majority of stated strengths and/or weaknesses are incompletely or inadequately discussed, and cited strengths and/or weaknesses focus almost entirely on ideas unrelated to mathematics objectives of the test.</td>
<td>Mathematics strengths and weaknesses inaccurately discussed, and cited strengths and/or weaknesses correspond to the math objectives and student's math performance (as opposed to general test taking skills).</td>
<td>No reply or mathematics strengths and weaknesses omitted altogether.</td>
</tr>
<tr>
<td><strong>Item 2</strong></td>
<td>Problem or exercise is appropriate to previous instruction and objectives. Mathematics is thoroughly and correctly documented (problem, strategy, and solution). There should be at least 2 sentences containing the mistake that was made and an explanation of your reasoning to solve the problem.</td>
<td>Problem or exercise is appropriate to previous instruction and objectives. Mathematics is reasonably well documented with only minor, if any, mathematical errors (problem, strategy, and solution).</td>
<td>Association of problem or exercise to previous instruction and objectives is questionable or the mathematics is poorly and/or inaccurately documented (problem, strategy, and solution).</td>
<td>No reply or problem neither associated with instruction nor correctly completed.</td>
</tr>
<tr>
<td><strong>Item 3</strong></td>
<td>Mathematics is thoroughly and correctly presented (this includes explanation of correction, documentation of mathematics, and an accurate solution). There should be at least 2 sentences containing the mistake that was made and an explanation of your reasoning to solve the problem.</td>
<td>Presentation of mathematics (explanation/documentation) is reasonably thorough and solution is correct.</td>
<td>Presentation of mathematics (explanation/documentation) is poorly documented or solution is incorrect (ouch!).</td>
<td>No reply or poorly documented incorrect solution</td>
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### Appendix F

Rubric and Example of Student Work

#### Test Aftermath

85 + 9 = 948

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<td>No reply or poorly documented incorrect solution</td>
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</table>

Date Created: Nov 23, 2008 12:10 pm (CST)
1) One strength of mine is solving problems algebraically. Another strength is doing graphs using my calculator and labeling the axes. One coordinate and the lines. (ex: $y^1, y^2$) most students aren't good at this.

A weakness I have is making sure I go back and re-read the problem to make sure I answered what they were looking for. (ex: 13) Round answers to 3 decimal places. → 10.245 instead of putting 11 like I did.)

Another weakness I have is watching out for negatives. (ex: 11) $y^{\frac{1}{3}} = 3.1$ didn't keep it.

2) \((5x^2y^3)^2 \rightarrow \frac{25}{y^2} \rightarrow \frac{25}{x^4}\)

(Doing a problem without my calculator)
To do the problem you have to distribute the negative 2 to all pieces in the ( ), then to get rid of the negative you have to flip it so everything in the ( ) you have to put under 1 and anything that is positive already (in this case the $x^2$) goes on top, and the rest stays in the denominator.
3) \( y = a (1 + r)^t \)

\[ = 10000(1 + .06)^0 \]
\[ = 10000(1) \]
\[ = 10000 \]
\[ \approx 10000 \text{ (to nearest whole number)} \]

\( y = a (1 + r)^t \)

\[ = 75000(1 + .07)^{10} \]
\[ = 75000(1.07)^{10} \]
\[ = 147550.3518 \]
\[ \approx 147550.35 \]

13) \( 10.244769 \times 106 = 1.08237594 \)

10.244769 years

10.238 years

12) For 12, I thought you had to do the 4 first because it was annual interest and then multiply it by 10, but it's not compounded, they just wanted to know the amount it would be after 10 (excluding the 4).

13) For 13, I thought you had to round up to the next year b/c we had to do that on our homework, but it said to round to 3 decimal places.
Algebra Trig
Unit S - Exponents
Exam

Part I: Answer all questions in this part. Each correct answer will receive 2 credits. No partial credit will be allowed.

1. Evaluate $16^{3/4}$.  \[ \frac{4 \sqrt[4]{16}}{2^3} \]
   (1) $\frac{1}{32}$  (2) 8  (3) $\frac{1}{8}$  (4) 32

2. The expression $(-3x^2y^3)^3$ is equivalent to
   (1) $-9x^6y^9$  (2) $-3x^5y^6$  (3) $-27x^5y^6$  (4) $-27x^6y^9$

3. Simplify: \( \frac{3^{x+4}}{3^x} \)
   (1) $-81$  (2) 1/81  (3) 81  (4) $-1/81$

4. The graph of \( y = 2^x \) intersects
   (1) both the \( x \)-axis and the \( y \)-axis
   (2) neither the \( x \)-axis nor the \( y \)-axis
   (3) the \( x \)-axis, only
   (4) the \( y \)-axis, only

Name:  

[Diagram and handwritten notes]
Part II: Answer all questions in this part. Each correct answer will receive 2 credits. Clearly indicate the necessary steps, including appropriate formula substitutions, diagrams, graphs, charts, etc. For all questions in this part, a correct numerical answer with no work shown will receive only 1 credit.

5. Simplify and express with positive exponents:

\[
\frac{x^2}{x^2} - \frac{y}{x} \Rightarrow \frac{x}{y}
\]

6. Use your calculator to approximate \(19^{\frac{3}{2}}\) to four decimal places.

\[19^{\frac{3}{2}} \approx 7.1204\]

7. Solve correct to three decimal places:

\[6^{x+2} = 4^{2x-1}\]

\[x = 1.086\]

8. Simplify:

\[8^{\frac{2}{3}} - 4^0 \quad 4 - 1 = 3\]
Part III: Answer all questions in this part. Each correct answer will receive 4 credits. Clearly indicate the necessary steps, including appropriate formulas, substitutions, diagrams, graphs, charts, etc. For all questions in this part, a correct numerical answer with no work shown will receive only 1 credit.

9. a) Sketch the graph of \( y = 3^x - 2 \) on the grid provided. Be sure to label at least two key points.

b) What is the range of this function?

- Range: \( y > 2 \)
- Need your asymptote: \( +3/4 \)

10. Solve: \( 100^{x+2} = 1000^{x-1} \)

\[
\begin{align*}
\frac{10^{x+2}}{10^{x-1}} &= 10^3 \\
2x+4 &= 3x-3 \\
-2x &= -7 \\
x &= \frac{7}{2}
\end{align*}
\]

11. Solve: \( 2\sqrt[3]{y} - 2 = 4 \)

\[
\begin{align*}
2\sqrt[3]{y} &= 6 \\
\sqrt[3]{y} &= \frac{3}{2} \\
y &= \left(\frac{3}{2}\right)^3 \\
y &= \frac{27}{8} \\
y &= 3.375 \\
y &= \sqrt[3]{27}
\end{align*}
\]
Part IV: Answer all questions in this part. Each correct answer will receive 6 credits. Clearly indicate the necessary steps, including appropriate formula substitutions, diagrams, graphs, charts, etc. For all questions in this part, a correct numerical answer with no work shown will receive only 1 credit.

12. Jack bought a house on Howell Street for $100,000. It appreciated at 5% annually. Kate bought a house on Main Street for $75,000. It appreciated at 7% annually. After 10 years, who has the house worth more money, and how do you know?

$$\begin{align*}
\text{Jack:} & \quad y = a(1+r)^t \\
& = 100,000(1+0.05)^t \\
& = 121550.625 \\
& \times 10 \\
& = 1215506.25 \\
\sqrt{1215506.25} \\
& = 1315.50625
\end{align*}$$

$$\begin{align*}
\text{Kate:} & \quad y = a(1+r)^t \\
& = 75,000(1+0.07)^t \\
& = 98309.70075 \\
& \times 10 \\
& = 983097.0075 \\
\sqrt{983097.0075} \\
& = 991.509781
\end{align*}$$

13. Strong Bad purchases a diamond ring for Marzipan. It is worth $1000 originally, and appreciates at 7% annually. She will break up with him when the ring is worth $2000, but then take him back when the ring is worth $3000. After how many years will she leave him, and after how many years will she take him back? Round answers to three decimal places.

$$\begin{align*}
\text{For$2000:} & \quad 2000 = 1000(1+0.07)^t \\
\text{For$3000:} & \quad 3000 = 1000(1+0.07)^t
\end{align*}$$

She'll leave him after 11 years, and take him back after 17 years.