Self-Regulation in the High School Mathematics Classroom

Rebecca Jackson

Michigan State University

Introduction

"Study for my test? You can't study for a math test."

"Ms Jackson, I do so well on homework assignments but always bomb the quizzes and tests. I am just not a good test taker."

I frequently hear comments like those above in my high school mathematics classroom and often have wondered how I might change these attitudes and opinions. It is difficult to regulate motivation and study behavior outside of the classroom. However, because test taking is an essential part of a mathematics classroom, I decided to look for alternate methods to address these issues, by looking for concrete ways to measure intangible items like motivation and perceived ability. I started by recognizing the possibility that students often overestimate their readiness or preparation for a math assessment. There are many possible factors for this including poorly written assessments, students copying assignments, or a genuine lack of understanding, but I decided to focus on students self-regulation or their ability to become more aware of what they are learning and how they are learning it.

My research will focus on determining whether implementing self-regulation techniques, such as asking students to make comments and correction on their work, will improve student calibration or the degree to which students' judgments about their capability or performance actually represents their level of understanding. To look at potential methods to teach and inspire students to become better self- regulators, I will try reflective journaling and required quiz and test corrections. To assess students' calibration accuracy I will implement a questionnaire for students to rate their confidence levels after specific assessment pieces. Finally, I will look for correlations and trends in self-regulation and self-efficacy or awareness of

mathematical performance using the above data, alongside student surveys, personal notes, and interviews, identifying effective, or not so effective techniques in improving students' attitudes and opinions about mathematics.

Literary Review

An ever-present goal of education is to produce life-long learners who are able to regulate their own learning by setting goals, evaluating progress, and making necessary changes to achieve these goals (Dembo & Eaton, 2000). This self–regulation has been shown to result in an improved academic performance, as well as being tied to self-efficacy and more accurate calibration (Labuhn, Zimmerman, & Hasselhorn, 2010). Much research has been done to refine the use of self-regulation. Information on exactly what self-regulation entails, the role the classroom teacher plays, examples of effective implementation, its relationship to calibration accuracy, and potential research pitfalls are noted below.

Self-regulation, or the ability of students to become more, "metacognitively, motivationally, and behaviorally responsible for their own learning," has the ability to improve student acquisition of knowledge and skills, and begins with evaluation (Labuhn et al., 2010 p. 174; Dembo & Eaton, 2000). Much like an athlete watching film or a dancer looking in a mirror, students can begin to observe their classroom performance with recordings such as journal entries and reflections, or by closer analysis of prior homework, quizzes, and tests. Students' careful monitoring and awareness have shown to be essential components in self-regulation, but feedback from others has shown to positively influence self-regulation as well (Stone, 2000; Dembo & Eaton, 2000; Labuhn et al., 2010). This leads to our next discussion on the role of the teacher in student self-reflection

A teacher has an important role in promoting self-regulation in the classroom. In fact, self-regulation has been shown to be most effective for students when they are given instruction on the cognitive processes and strategies necessary (Stone, 2000; Kistner et al., 2010). Kistner et al. (2010) was interested in the quality of strategy instruction and studied whether *implicit*

implementation, where a learning environment that supported self-regulation was created, and modeled, but never specifically mentioned, or *explicit* implementation, where a teacher explains the meaning and importance of strategies, was more effective. The study showed that explicit strategy instruction demonstrated a significant positive correlation to increases in understanding, while implicit strategy instruction did not (Stone, 2000). The teacher also typically will initiate feedback, which provides the learner with information about how well they are performing, influences how tasks are reviewed, as well as how progress should be monitored. Stone (2000), found that process feedback, or information about learning strategies that were used, or could have been used, were best for helping students with self-regulation, rather than feedback only about one's performance.

The idea of calibration, or the, "measure of how accurately individuals assess their confidence in their own knowledge," (Stone, 2000, p. 437) is closely related to self-regulation. Like self-regulation, many students lack the appropriate skills to estimate their performance accuracy, which often leads to overconfidence (Stone, 2000). This overconfidence is related to lower achievement due to lack of appropriate time, effort, monitoring, and self-regulation (Stone, 2000). A study by Labuhn et al. (2010) asked students to answer eight math problems and then rate the efficacy of their solutions using a scale with 1 meaning 'definitely not confident' to 9 meaning 'extremely confident' (Labuhn et al., 2010). Students were then given varied forms of feedback and then reassessed. Results were computed by subtracting their performance score (1-9) from their self-evaluation score. A negative value represented under-confidence and a positive value over-confidence. Results indicated that students who received feedback showed higher calibration accuracy, less bias (over/underestimation), and were often dissatisfied,

although this last point should not necessarily be considered problematic as it often motivates students to improve on subsequent trials (Labuhn et al., 2010).

Other methods have been used to study students' self-regulation and calibration. Pape, Bell, & Yetkin (2003), implemented a journal-like form called, "The Strategy Observation Tool." This was a structured format for observation and monitoring, which was intended to raise student awareness and create habits for documenting their strategies. (Pape et al., Appendix A & B). This study demonstrated the continuous nature of development of student self-regulation, as well as the importance of specificity and contextual foundation in instructional strategies (Pape et al., 2003). By the end of the implementation year, students' statements were demonstrating an understanding that effort leads to success and lack of effort to failure (Pape et al., 2003). This recognition was an important step in advancing students' self-regulation in the utilization of strategies with which they experience the most success (Pape et al., 2003). Labuhn et al. (2010) also described a monitoring procedure called graphing that "referred to recording and graphing a sequence of completion scores and drawing lines connecting the scores to establish a trend" (p. 177). This process improved self-regulation by creating a visual for individual monitoring and was associated with significantly higher levels of awareness learning progress, as well as improvements in actual learning (Labuhn et al., 2010).

Student motivation and the ability to learn and use self-regulatory skills are important factors in the improvement of academic achievement and increases in self-efficacy (Dembo & Eaton, 2000). Research has demonstrated why action research in methods of improving self-regulation and calibration accuracy is important in classrooms today. The following sections describe how I will implement a series of self-regulation techniques (surveys, journals,

portfolios, questionnaires) to improve student awareness, in hopes of developing enhanced student achievement and self-efficacy in my classroom.

Description of Research Context

The following study will take place in Geometry classrooms at Woodhaven High School. Woodhaven High School is a suburban district, south of Detroit, that educates over 1,300 10^{th} – 12^{th} grade students. The estimated ethnicity breakdown is 73% white, 13% Black, 7% Hispanic, 5% Asian, and 3% American Indian, with approximately 17% of students eligible for free lunch and 4% eligible for reduced lunch.

The Geometry classrooms where the study will occur typically consist of 28-34 students of mixed genders, races, and abilities. The course is intended for tenth grade students, but there will be some variation due to advanced students taking Geometry in ninth grade at the Middle School, as well as failures in previous attempts at the course. The course is divided into two 12-week trimesters, consisting of 70-minute class periods. A student's teacher can vary from one trimester to the next. Students in my Geometry classes will be selected to participate in the study. They will be given a letter of informed consent (Appendix A) to be completed by themselves, as well as a parent/guardian.

The study will take place over the course of the 12-week trimester, and some students will benefit from back-to-back sessions of the study, as they will be in my classroom for part A and B of the course.

Students will be given notebooks to record many of their reflections, as well as typical classroom resources like paper, textbooks, and pencils. Technology resources like calculators, document cameras, online gradebooks, and a Promethean ActivInspire board will also be available for students.

Methods/Treatments

In order to study the effect of self-regulation on calibration and self-efficacy I recognize the importance of using multiple methods of implementation to strengthen the reliability and validity of my research. As stated by Calhoun (1994), "by using multiple sources [of data collection] we can strengthen the clarity and depth of our understanding, while we minimize the weaknesses of any single source" (p. 60). Much of the research will be done qualitatively, as I develop and implement conventional data sources such as student journals, surveys, interviews, and observations. To supplement this qualitative data, I will use some quantitative research to give a numerical value to students' perceptions, as well as look at scores and percentages from quizzes and tests. Throughout the research process I will work to explain and persuade students to understand the reason for the "extra" work, and hope to win over their interest. If my students can embrace the aims of my research, they will produce more valid and reliable data, making meaningful contributions. A detailed outline of how the various data collection methods will be utilized follows.

Student Surveys

I have always distributed student questionnaires on the first day of a trimester as a way to learn a little about the students in my classes. To initiate student opinions, I will add a few questions about students' attitudes, perceptions, and beliefs about their past work in math courses (see Appendix B). Some will be open ended like, "What is the most important thing I should know about your past experiences in math class?" while others like, "I am able to accurately predict my performance on math quizzes/tests," or "I get stressed when I have to do my math homework," are on a rating scale ranging from strongly disagree to strongly agree. These

questions have been carefully selected to ask about similar ideas in multiple ways, as well as to avoid making students' feel like they need to answer in a desired fashion. This cognizance will help maintain reliability and validity throughout the surveys. The same questions will be asked of students mid-course, near an assessment, (day 30-35), and at the conclusion of the course (day 55-60). I will analyze student responses for positive, negative, and neutral feeling about mathematics and see how these attitudes changes over the trimester. This rating scale has potential benefits for students who have and have not been exposed to my implementation techniques, as each trimester I have some new and some repeat students. I will be able to see if there is a ceiling for individual attitudes, perceptions, and feeling and how these elements may fluctuate as the year progresses.

Journals/Portfolios

In preparation for my research I am going to purchase three-ring notebooks (journals) for each student. These journals will serve a central role in my study as they will not only be a platform for students to reflect on their mathematical performance, but also will be used to collect artifacts of student performance, increasing awareness of commonalities and trends. The journal will be organized by chapter, with the first few pages being devoted to comparative data. A more detailed descriptions of this organization follows.

- *Comparative Data*: All numerical quiz and test scores will be recorded on a page in this section. I will also have students use graph paper to plot their scores, connecting points from consecutive quizzes/tests to promote student awareness and reflection of changes and trends.

- *Collect Quizzes and Corrections*: After each quiz, I will require students to select AT LEAST five questions with incorrect answers to correct. They will be instructed to fold a page of their journal lengthwise, creating two columns. In the column on the left they will rewrite the problem and show the necessary work to correct their earlier mistake. In the right-hand column they will be required to produce a 2-3 sentence narrative regarding what went wrong when they initially did the problem. Then, they will staple it to the quiz and put it into their journal, preserving this information for future use.

- *Student Reflection:* At least once a week, and always after chapter tests, students will be asked to reflect in their journal on elements of a specific lesson, the overall instruction used for a chapter, how they might adjust their role as a student, or other elements of their classroom experience (see Appendix C for sample questions).

Clipboard Notes

To help increase my awareness of students' attitudes and statements that are relevant to self-regulation, self-efficacy, and calibration, I plan to add a daily log on my attendance clipboard (see Appendix D). This will be an informal way for me to document events in my classroom, without making judgments or forming opinions. It provides a quick and easy way to jot down anecdotal statements or actions of students that might be relevant later in my research or reflection, without interrupting the minute-by-minute happenings of the classroom. When it comes time for data analysis and personal reflection I can use these notes to support data trends or abnormalities.

Assessment Questionnaire

Most of the departmental chapter tests administered consist of an even balance of multiple choice and free response questions, while quizzes are predominately free response. To take a closer look at students' calibration levels, I will integrate a 1-10 rating scale for students to identify their confidence in their answers on quiz and test items (see Appendix E). Immediately following certain questions on these assessments, I will publish an additional piece asking, 'How confident are you that you solved the above problem correctly?' Students will be given a rating scale of 1 = 'definitely not confident' to 10 = 'extremely confident' to rank their confidence level (Labuhn, et al. 2010). I do not want to overwhelm students with this type of question, as they might not take it as seriously, so I will place confidence questions after 3-5 problems on quizzes, and 7-10 problems on tests. To improve reliability and validity I must account for a range of topics and types of questions, as well as avoiding grouping questions that may influence student confidence ratings, so I will systematically integrate the confidence rating scale questions throughout the assessment, rather than bunch them together. I will also use the standards and benchmarks for each unit to guarantee the confidence questions follow all topics covered.

Exit Interviews

At the end of each 12-week trimester, I will randomly select students from different subgroups to interview on their experience with self-reflection. I will use a voice-recorder to document the interview, allowing flexibility to interact with my interviewee, and having a verbatim account to use for analysis. We will use their journals and pre- and post-course surveys as starting points for these unstructured interviews, so that the interview focuses on students'

perceptions and interpretations of classroom events, rather than what he or she thinks I want to hear (self-fulfilling prophecy). I will create an interview guide, with specific topics from the trimester, reflection items on student tasks, and other probes like, 'Why?', 'How did you know?', or 'Why is that important?' to analyze their work. I will also experiment with avoiding validation of students' responses with statements like, "Good" or "That's Right", and try things like "That's interesting", or "Does that make sense to you?" This will help the discussion stay on track to collect relevant information without forcing desired responses, allowing for improved validity and reliability.

Analysis

The analysis of student work will consist of a combination of quantitative and qualitative data. This is a useful combination, as it allows teacher-researchers to interpret the events of the classroom (qualitative) alongside concrete data that is the reality of what is being investigated (quantitative), helping to avoid bias and increase the reliability and validity of the study (Capobianco, Horowitz, Canuel-Brown, & Trimarchi, 2004, p.51-52)

Quantitative Data

The majority of the quantitative data will come from students' ratings of their performance compared to their actual performance. My analysis is comparable to what is described by Labuhn et al. (2010), where students' performance scores are subtracted from self-evaluation scores, resulting in what was termed a "bias" score. Performance scores for the overall performance on the questions preceding the confidence rating scale will be normalized on a one to ten scale, to correspond with the self-evaluation scale. These bias score values could range from +9 to -9where a positive score indicates overconfidence and underperformance and a negative score represents underconfidence and overperformance. For example, a student whose scored correctly on 3 questions, but expressed a confidence level at a 5 would receive a bias score of +2 (5-3). Over time I would analyze changes and trends in the data, hoping that student bias levels would get closer and closer to zero, showing an improvement in student calibration. This data would be collected from all students in the course, as its systematic nature would allow for relative ease in collection of a large group.

Students will also be keeping track of their performance on assessments in the journals by recording their scores and graphing the results. This provides a visual for their scores, which

will help students recognize where improvements or declines have occurred, and hopefully encourage further self-regulation.

Qualitative Data

Qualitative data collection will be integrated into numerous elements of the research. First in the student journals, I will be able to collect data from students' corrections, as well as their reflective entries. The quiz corrections will help students and myself recognize frequently made errors in work, as well as common areas that students "think" they understand, but are in fact mistaken. This improves awareness, and potentially calibration levels. The journal entries can be analyzed for student opinions, individual improvements, and identifying trends that all may help understand why classroom events happened in a certain fashion. At the beginning I would circulate as students are working on their journals, and randomly select 5-10 journals per class, per week, to more closely analyze. As the trimester progresses, I would take more stratified samples based on factors like gender, bias score, and overall percentage.

While I analyze the student journal entries and quantitative bias scores, I will have my clipboard notes to refer back to if I observe any notable changes or spikes in results. These quick observations can help in my own reflection on the classroom practices implemented and their success or failure.

At the end of a trimester I will sit down with data from my pre-, mid- and end-of-year surveys and look more closely at changes in students' attitudes and confidence levels. I will look for improvements as well as regressions, and the reasons students attribute to such changes. I will look for trends in positive, negative, and neutral attitudes that can guide modifications and instruction for the future trimesters.

Finally, when conducting interviews with a randomly selected group of students, I will be able to use the recorded data for analysis. This data can be used in numerous ways, all allowing for reflection of overall effectiveness and what has stood out most in the mind of students. Due to the unstructured nature of the interviews, there might be some variation on topics, but it could be analyzed for commonalities in terms of likes and dislikes, changes in attitudes, or suggestions for further research.

References

Calhoun, E.F. (1994), *How to use action research in the self-renewing school.* Alexandria, VA: ASCD.

Capobianco, B., Horowitz, R., Canuel-Browne, D., & Trimarchi, R. (2004). Action Research for Teachers. *Science Teacher,* 71(3), 48-53.

Dembo, M.H., & Eaton, M. J. (2000). Self-Regulation of Academic Learning in Middle-Level Schools. *The Elementary School Journal*, *100*(5), 473-490.

Kistner, S., Rakoczy, K., Otto, B., Dignath-van Ewijk, C., Büttner, G., & Klieme, E. (2010). Promotion of self-regulated learning in classrooms: investigating frequency, quality, and consequences for student performance. *Metacognition and Learning*, *5*(2), 157-171. doi:10.1007/s11409-010-9055-3

Labuhn, A.S., Zimmerman, B.J., & Hasselhorn, M. (2010). Enhancing students' self-regulation and mathematics performance: the invluence of feedback and self-evaluative standards. *Metacognition and Learning,* 5(2), 173-194. doi: 10.1007/s11409-010-9056-2

Pape, S. J., Bell, C. V., & Yetkin, İ. (2003). Developing Mathematical Thinking and Self-Regulated Learning: A Teaching Experiment in a Seventh-Grade Mathematics Classroom. *Educational Studies in Mathematics*, *53*(3), 179-202. doi:10.1023/A:1026062121857

Stone, N. (2000). Exploring the Relationship between Calibration and Self-Regulated Learning. *Educational Psychology Review*, *12*(4), 437-475. doi:10.1023/A:1009084430926

Appendix A

A notification of participant rights included in the letter of informed consent for participants and/or guardians follows. The first paragraph outlines the study and will be used to obtain consent to conduct research in my school, by providing this information to building and district administrators. Participants are notified of their rights in paragraph two. The form below is structured for parents/guardians, but students will be given the same form to sign, indicating their desire to be a participant as well.

September 7, 2011

Dear Parent/Guardian:

My name is Rebecca Jackson and I am a graduate student from the School of Education at Michigan State University, as well as your child's mathematics teacher for this trimester. My advisor, Dawnmarie Ezzo, and I would like to include your child, along with his or her classmates, in a research project on self-regulation in the mathematics classroom. We do not anticipate any risk greater than normal life and your child may benefit from this research by learning more about using self-regulation techniques to improve self-efficacy and achievement in the classroom. If your child takes part in this project, periods of your child's regular math class will be spent learning self-regulation techniques like reflective journaling and error analysis. For part of the study your child may be audio taped during interviews conducted at the end of the trimester. If you do not wish for your child to be interviewed, s(he) can still participate in the study.

Your child's participation in this project is completely voluntary. In addition to your permission, your child will also be asked if he or she would like to take part in this project. Only those children who want to participate will do so, and any child may stop taking part at any time. The choice to participate or not will not impact your child's grades or status at school. The audiotape and all other information that is obtained during this research project will be kept strictly secure and will not become a part of your child's school record. The audio tape will be kept in a locked file cabinet and will be accessible only to Dawnmarie and myself. The audiotape will be transcribed and coded to remove children's names and will be erased after the project is completed.

The results of this study may be used for a dissertation, a scholarly report, journal article, and/or conference presentation.

In the space at the bottom of this letter, please indicate whether you do or do not want your child to participate in this project. Ask your child to bring one copy of this completed form to his or her teacher by September 30. The second copy is to keep for your records. If you have any questions about this research project, please feel free to contact us either by mail, e-mail, or telephone.

Sincerely,

Rebecca Jackson
734-783-3333 ext 2822
jacksor@woodhaven.k12.mi.us

Dawnmarie Ezzo, Research Supervisor
517-432-3373
dezzo@msu.edu

****

I do/do not (circle one) give permission for my child _____ (name of child) to participate in the research project described above.

_____Date _____Parent's signature

I do/do not (circle one) give permission for my child _____ to be audio taped and possibly included in a video clip that would be used for educational purposes.

_____ Date _____Parent's signature

If you have any questions about your rights as a research participant please contact Michigan State's Human Research Protection Department, 517-355-2180, or irb@msu.edu.

Appendix B

Student Information Sheet

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

Name: _____ Course: _____

Home Phone: _____ Birthday: _____

Email: _____

Math History

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

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

Circle what best describes your attitude, perception, or belief

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

Strongly Disagree Disagree Neutral Agree Strongly Agree

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

Strongly Disagree Disagree Neutral Agree Strongly Agree

3. I look forward to my math classes.

Strongly Disagree Disagree Neutral Agree Strongly Agree

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

Strongly Disagree Disagree Neutral Agree Strongly Agree

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

Strongly Disagree Disagree Neutral Agree Strongly Agree

6. I only do math because I have to.

Strongly Disagree Disagree Neutral Agree Strongly Agree

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

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

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

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

Other Information

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

What are your favorite/least favorite subjects and why?

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

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

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

Appendix C

Sample Journal Reflection Question and Prompts

- What feature of [this assignment] pleased you most?
- What aspect of [this assignment] would you change?
- What new learning or skill was demonstrated by [this assignment]?
- Based upon what you learned with the piece of work, what will you do differently next time?
- The thing I need to remember with this kind of problem is _____
- What method(s) did you use to solve this problem? Why were they successful or unsuccessful?
- Were you frustrated with this problem? EXPLAIN why or why not?
- What do you like about math? What don't you like about math?
- Tips I would give a classmate to solve this problem are _____
- When I hear someone say math is fun, I_____
- What did you do to study for your most recent math quiz/test?
- Explain how you feel about mathematics now compared to when you started this class.
- What is the most significant thing you learned this week? What questions are still unanswered?
- What was your grade on the last quiz/exam? If you were not satisfied with your score, what can you do to improve? If you were happy with your score, what did you do well?
- You know several ways to _____ (solve equation, factor, etc.) Which method is your favorite? Why?

Appendix D

Daily Observation Log

To help focus attention on awareness of students' attitudes and statements potentially related to self-regulation, self-efficacy, and calibration

---

Date: _____

Date: _____

Date: _____

Appendix E

Following predetermined assessment questions students will be asked to rate their confidence using the questions below.

How confident are you that you solved this problem correctly?

1	2	3	4	5	6	7	8	9	10
Definitely Not Confident				Neutral					Extremely Confident