UNIVERSITY OF CALIFORNIA, SAN DIEGO

Mastery Learning and Self-Efficacy Intervention Curriculum

A first year paper submitted in partial satisfaction of the
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in

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by

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The *First Year Paper* of Carmen Lisa Restrepo is approved and it is acceptable in quality and form for publication on microfilm and electronically:

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Chair

University of California, San Diego

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DEDICATION

I dedicate this work to my son Jason, my family, and my loving partner René. I give special thanks to both my niece and nephew who always kept me focused in the present moment, for the present moment is all there is.

TABLE OF CONTENTS

List of Figures

List of Tables

Abstract of First Year Paper

Mastery Learning and Self-Efficacy Intervention Curriculum
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Doctorate of Education in Teaching and Learning
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The Mastery Learning and Self-Efficacy Intervention Curriculum targeted low performing *6th grade math* students *for instruction* to improve their academic achievement in mathematics and meet the increased demands of rising performance goals. The Mastery Learning and Self-Efficacy Intervention Curriculum focused on increasing students' perceived self-efficacy in math, enhancing mathematic performance, and improving metacognitive awareness.

I implemented the Mastery Learning and Self-Efficacy Curriculum over an *eight*-*week* period. The Mastery Learning and Self-Efficacy Curriculum incorporated

a variety of technology resources including computer-based learning programs, interactive math games, video recordings of students peer teaching, and podcasts. Daily classroom instruction included goal setting, progress monitoring, computer based learning programs, peer tutoring, small group learning, individual instruction, enrichment activities, and metacognitive lessons.

Evaluation methods for the curriculum included pre and post self-efficacy surveys, formative and summative assessments, and reflection questions to monitor metacognitive growth. Final evaluation results revealed that students made growth in all goals areas. The results confirm growth in students' perceived self-efficacy in math, improved academic performance, and an increase in their metacognitive awareness.

I. Introduction: Increasing Student's Self-Efficacy in Mathematics

More than 1,000 of California's 9,500 schools are failing based on the No Child Left Behind Act (NCLB). The NCLB law requires that every state set math and reading standards and by the year 2014, all students reach proficiency in math and reading (NCLB, 2001). Excluding any projected revisions of the NCLB law, state officials foresee that all 6,063 public schools serving economically disadvantaged students will require restructuring by 2014. Restructuring attempts to achieve rapid and substantial academic growth in schools where large populations of children are failing. *The number of failing schools in California is rising,* making it almost impossible to achieve the statewide NCLB goal. The increase in accountability for schools and districts to demonstrate academic growth and progress began with the California Public Schools Accountability Act (PSAA) of 1999 and the establishment the Academic Performance Index (API). The API is a numeric index that measures performance levels of local education agencies based on statewide testing. The API serves two purposes. First, it measures growth from year to year, and second it ranks schools annually according to schools with similar demographic characteristic. The API similar school rank shows how a school compares to 100 statistically matched schools with similar demographics. State rankings range from 1 to 10. Schools with a state API rank of 1 means that the school has an API score in the lowest 10 percent of all schools in the state. In contrast, a school with a statewide ranking of 10 means that the school has an API scores in the highest 10 percent of all schools in the state (California Department of Education, 2007). For over a decade, criticism of educators and districts originated from the release of API scores. Today, the topic of failing schools is widespread.

As a classroom teacher, I continuously look for new strategies to help struggling students. Through student observation in the classroom, I notice that students do not know how to help themselves learn. I see students give up when they begin to struggle. *In* order to provide students with strategies I have students keep a math notebook*, in which* students write down lesson notes and strategies that they may refer to as needed throughout the lesson. Math notes include worked-out solutions at varying levels of difficulty. Students' notebooks also include several homework examples, so they can quickly refer to them when working independently. I always spend extra time guiding students through the process of understanding the material and using their notes as a strategy for success. In addition to the guidance devoted to independent problem solving, I think aloud as I teach each lesson, so students can hear how my brain processes information as I work through a difficult problem. Nevertheless, when students begin to work independently many of them do not know how to progress to the next level of learning when they are stuck. Students seem to lack the scaffolding knowledge and confidence to persevere when they begin to struggle. Since many students do not understand their own leaning needs, they cannot progress to the next level of learning on their own. Without specific strategies and understanding of their own learning, students often give up without attempting to think through a problem on their own. Students appear to lack the metacognitive skills needed to assist their own leaning. When confronted, students often say that they do not know what to do, or they do not understand. When I ask students specifically what part of the problem they did not understand they often say, "Everything." I tell students that it is hard for me to help them, or understand where to begin when they say, “Everything,” so I ask students to identify one part of the problem they do not understand. For many students, identifying a single element of confusion is difficult. I have remedied the problem of student confusion by going through each problem systematically and asking students if they understood the first step of the problem. If the student replied, "Yes" then I would go to the next step in the problem and repeat the question. I would ask, "Do you understand this step of the problem?" The sequence of checking for understanding at each step of the problem continues until the student understands how to solve the problem from beginning to end. Students need a strategy for identifying their own learning barriers, so they can learn to persevere instead of giving up. Based on my observations of student need, I decided to implement a mastery learning, self-efficacy intervention program that includes teaching students skills to increases their metacognition awareness. The Mastery Learning and Self-Efficacy Intervention Curriculum focuses on increasing students' self-efficacy in math through metacognitive training and mastery learning techniques in a variety of standard based mathematical skills.

II. Need for Improvement of Mathematical Self-Efficacy

Across the nation, schools are struggling to meet the standards set forth by the No Child Left Behind Act (NCLB), which includes strict assessment and reporting criteria. Through NCLB, all schools are included in the state's accountability system. No schools or students are exempt. States must have standardized testing measures and appropriate data recording systems that can monitor and report student's progress over time. Test scores are in the public domain and disclose information about the scoring results of individual schools and all their subgroups. The California State Test (CST), which assigns an annual score under NCLB, judges and scrutinizes a school's value as an academic institution. The state views the annual standardized test score as the main criteria for a district's academic gains, progress, and instructional success.

CST Test Score Results

Currently sixth grade students in California *are given* the California Standards Test (CST) *to measure* their learning. The CST is a standards based norm-referenced test. The California Department of Education publishes the CST scores each year at the state, county, district and school levels. The CST scores for sixth graders in the 2006-2007 school year show that 58% of the students in the state are basic or below in Mathematics. At the district level, 60% the students in the East County Union School District (ECUSD) are basic and below in Mathematics. ECUSD scores are comparable to statewide scores. At East County Middle School (ECMS), only 25% of the students were proficient on the 2007 CST. The majority of the students, 75%, scored basic and below on the 2007 CST test. In my sixth grade classroom at East County Middle School, 78% of the students scored basic or below on the CST (California Department of Education, 2007). In comparison to the state scores, the students in my classroom are 20% lower than the average sixth graders across the state of California.

NCLB Performance Goals and Sanctions

The performance goals of NCLB state that by 2013-2014 all students will reach the minimum proficiency level in reading/language arts and mathematics (Sunderman, Kim, & Orfield, 2005). This is a far reach from where the scores currently stand at the state, district, school, and classroom levels. The stakes are high for schools to make adequate yearly progress. Acclaim and scrutiny are constant rewards and outcomes of a school's academic success based on released test scores and the school's Annual Yearly Progress (AYP).

Schools districts are systematically monitored for their adequate yearly progress, and sanctions are set in place and for those schools not meeting their AYP as outlined by NCLB. NCLB sanctions increase each year and include such items as: giving students and parents the option to transfer schools, supplemental services before and after school, implementation of new curriculum, replacing school staff, providing staff development, and hiring outside experts to monitor and assist in internal reorganization of the school.

East County Middle School

My school, East County Middle School (ECMS) has not made AYP under NCLB for five consecutive years. Last year, East County Middle School had a school wide AYP target goal of 26.5% in math. The AYP target goal for the current 2007-2008 school year is 35.2%, and the projected AYP target goal for the upcoming school year is 46%. Some of the current implementation strategies made at ECMS in order to improve student achievement include:

- An additional one and a half hours of math instruction for students who scored below basic and far below basic on the CST.
- Teachers' monthly participation in content meetings to collaborate on curriculum and delivery strategies.
- Mandated release time for mathematics teachers to visit other classrooms in order to improve instructional strategies.
- Professional development collaboration with San Diego State University in order to improve content teaching in mathematics.

The stakes for academic improvement are high. Based on the restructuring plan there are many strategies in place geared at improving students' success. However, several critical components are missing from the plan. First, students who need the most help are not attending the supplemental programs available to them. Therefore, the schools must find a way to offer them additional help within the school day. Secondly, 78% of my students are performing at basic and below based on the CST scores. More often than not, these students give up quickly on exams and general class work when they get overwhelmed with the task demands. My question is how can I get the low-performing students to persist when they are struggling with testing and general classroom work. If I can give students the needed strategies for success then perhaps students will persevere more when struggling. My desire is to accomplish this by increasing students' self-efficacy in mathematics.

The high stakes in achieving ECMS' AYP is another reason my research attempts are significant. If ECMS fails to meet the AYP in the 2007-2008 school year when it has already been "identified for corrective action," the possibility of restructuring is at our doorstep.

III. Review of Relevant Research and Literature

Social Cognitive Theory

The Social Cognitive Theory (Bandura, 1986, 2001; Ormond, 2003) operates from the premise that people neither strictly react to inner influences, nor are they strictly controlled by the external world. The Social Cognitive Theory is rooted in the view that individuals are actively engaged in a triad of influences, all of which play a key role in the development of human behavior (Bandura, 1986, 2001). A model of reciprocal determinism encapsulates the concept. The model, shaped like a triangle in Figure 1, shows three classes of determinants. These determinants (behavioral, cognitive and personal, environmental) are all reciprocal causes of each other according to Bandura.

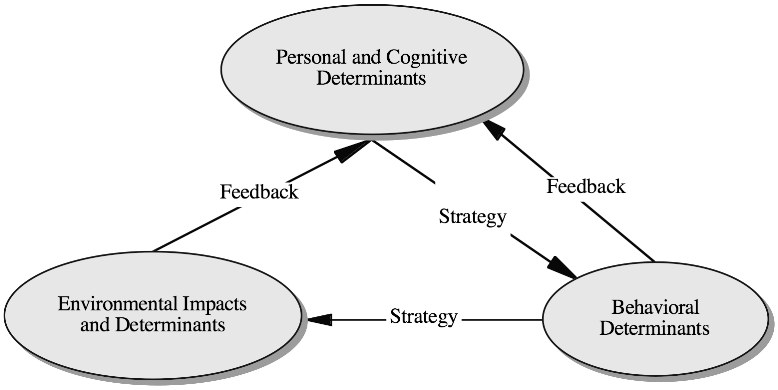


Figure 1. Triadic Model of Reciprocal Influences.

Figure 1 demonstrates, for example, the influence of implemented behavior strategies on personal and cognitive awareness. Successful implementation of strategies reciprocally effects self-evaluation at a personal level through feedback. A classroom example of this model occurs as students form collaborative study groups to prepare for a science exam. A few students decide that they learn better when studying with others (personal variable). The students decide to form a collaborative study group (behavioral variable). Students then select key ideas to review and each student becomes an expert on *his/her* selected topic. Experts take turns teaching their concepts to the other students in the group. Students discuss, clarify, synthesize, elaborate, develop common meanings, and a deeper understanding for the unit's key concepts. Students understand and connect the new knowledge to prior learning. Favorable test results (environmental variable) prompt students to form collaborate study groups for the next science exam. The example shows the triadic relationship between individual preferences, behaviors, and environmental outcomes. Similarly, Figure 1 also shows the effects of personal behavioral modifications on the environment and how feedback from such modifications directly affects personal self-regulation. For example, a student who decides to arrange a quiet study area to do homework could feel a sense of accomplishment and effectiveness while studying. The results lead to a continuous use of a quiet study area as an effective strategy.

Embedded in the Social Cognitive Theory is the fact that an individual's self-beliefs assist in their control of personal thoughts, feelings, and actions. In other words, how a person thinks, and believes affects how they will behave (Bandura, 1986). The Social Cognitive Theory explains why individuals possess and maintain particular behavior patterns (Bandura, 1997, 2001; Ormond, 2003). The Social Cognitive Theory states that the environment, the individual, and one's behavior are perpetually influencing each other. Environment provides individuals with models of behavior. Observational learning occurs when an individual observes the actions of others and then take into account all the reinforcements the second learner receives (Bandura, 1997, 2001; Ormond, 2003). An example of this occurs often when students takes risks in the classroom. The teacher requests that a student volunteer explain one approach to solving a problem. A brave student comes up to the front of the room and presents a solution approach. Regardless of the complete accuracy of the student's explanation, the teacher praises the student for both bravery and initiative. The teacher's validation of bravery and initiative to the first student *initiated* observational learning as other students in the class observed the reinforcement the first student received regardless of the accuracy of the problem solving strategy. Students are more likely to imitate behavior when they believe the results have a positive outcome. Increased adoption of an observed behavior occurs when the model resembles the observer. Another concept of the Social Learning Theory is behavioral capability. Behavioral capability means that if a person is required to perform a particular skill the person must have the knowledge needed to carry out the behavior. Behavioral capability promotes mastery learning because it focuses on specific skills and training need for an individual to reach mastery (Bandura, 1987, 1997; Ormond 2003).

Self-Efficacy

Bandura's Social Cognitive Theory is foundational to *the concept of "*self-efficacy.*"* Self-efficacy beliefs derive from "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). A sense of self-efficacy strongly influences an individual's personal choice and action and determines how much an individual will persevere and pursue certain tasks (Schunk, 1981; Zimmerman, 2000). The stronger the self-efficacy beliefs, the greater the challenge individuals are willing to undertake. Self-efficacy also influences the amount of time a person will spend on a task and the level of commitment they will have to that task. When individuals are familiar with a particular task and feel confident about performing it, they are accessing their self-efficacy beliefs that originated with the success (Pajares & Schunk, 2001).

Self-efficacy beliefs originate from four principal sources: an individual's performance, persuasion of various forms, physiological responses, and all experiences both personal and vicarious (Pajares, 1996). Learners adopt self-efficacy beliefs from observing a successful model and comparing their performance to that of the model (Pajares, 1996). Social comparison occurs when students evaluate their own performance by comparing themselves with others. Students increase their sense of self-efficacy when they observe a successful model similar to themselves because they often believe that they can perform just as well as the model. Comparing similarities to models accounts for a major source of information used in measuring one's self-efficacy beliefs (Schunk, 1987). In the area of mathematics, Schunk compared the effects of social comparison on self-efficacy and performance. Schunk (1983) provided 40 low-achieving fourth and fifth graders with instruction in performing division calculations. Four conditions were established in this experiment: 1) Students were given social comparative feedback on the average number of division problems successfully solved by peers. 2) Students received a stated goal for solving a set number of problems. 3) Students received both social-comparative feedback, and a stated goal. 4) A control group received neither treatment, social comparative feedback, or stated goals.

The study revealed that students receiving social comparison feedback had increased skill development, which improved their mathematical performance. Students who received stated goal feedback described increased feelings of math self-efficacy. However, presenting children with only a stated goal *did* not yield the same level of task achievement as those students receiving comparative feedback. Since all the students in the study were low-achieving students, who had previously struggled in their regular math, *they* may have concluded that the goals were too difficult since they *had* no comparisons on which to judge the reasonableness of the stated goal. Schunk (1983) found that specific proximal goals fostered self-efficacy beliefs. Schunk established that students who received multiple sources of self-efficacy information, social-comparative and goal feedback, showed greater skill and academic success in performing division calculations. Students developed positive self-efficacy beliefs by comparing the number of problems they solved correctly to the number of problems previous students solved. The study attempted to show how social comparison feedback and proximal goals in mathematical competency enhanced students' perceived self-efficacy. The results of the study imply that proximal goals setting and social comparisons positively influence students' self-efficacy beliefs.

Individuals use a variety of elements such as judgments of ability, previous successes, anticipated level of difficulty, the quantity of time and effort needed, degree of assistance, similarities to past models, trustworthiness of persuaders, and emotional factors to shape their self- efficacy beliefs (Schunk, 1995). Therefore, these factors variously determine what self-efficacy beliefs emerge for an individual.

Development of Self-Efficacy

The variety of experiences parents provide to infants and small children shape a child's self-efficacy beliefs. Initial experiences of self-efficacy sources are concentrated in the family. Parents can increase a child's sense of self-efficacy by providing a challenging environment that allows for both inquisitiveness and proficiency of tasks. Parents that provide varied experiences that allow for mastery develop a greater efficacious child than those who do not provide rich experiences for cognitive growth (Wigfield & Eccles, 2002). However, as the child grows, peers become a large influential source for self-efficacy development. Peers allow learners to develop a larger scope of discriminating factors regarding self-knowledge and ability. Peers also provide each other with evaluation and confirmation of comparative efficacy (Bandura, 1986, 2001; Ormond, 2003).

As students progress through the educational system self-efficacy beliefs tend to diminish due to the increased factors such as competition, norm-referenced testing, reduced teacher attention, and the pressure related to school transitions (Wigfield & Eccles, 2002). When students enter into middle school, a variety of new factors begins to influence self-efficacy. Students' social arena expands and they are introduced to peers they have not known in the past. In addition to this, assessments become normative and students get less teacher attention toward their achievement and academic progress (Midgley, Fedlaufer, & Eccles, 1989).

Self-Efficacy and Academic Contexts

Self-efficacy defines a person's perceived abilities within a specific domain (Pajares, 1996). Math self-efficacy is a specific assessment of an individual's confidence in his or her ability to successfully complete a task or problem (Hackett, 1989; Friedel, Cortina, & Turner, 2007). Therefore, students with a high math self-efficacy may not necessarily have a high writing self-efficacy. Students' levels of self-efficacy can also be skill specific. Skill specific self-efficacy implies that a student may feel efficacious when using one skill in a given domain, such as writing a science report and yet not feel efficacious with a different skill, such as writing about a theme from a story. For example, middle school students may have a high math self-efficacy for multiplying and dividing fractions, but a low self-efficacy for converting fractions to percents. More research is needed to determine whether self-efficacy spans across domains (Wigfield, Eccles, & Pintrich, 1996). Self-efficacy *beliefs have* potential to extend from one academic domain to another when skills in each domain overlap such as in math and science. A student with a high self-efficacy for interpreting data might have a high self-efficacy in both math and science since data interpretation is required for both subjects. Prior experiences influence self-efficacy and therefore, self-efficacy may transfer to a new domain when mastery of previous skills integrates into the new learning (Wigfield & Eccles, 2002).

Self-Efficacy and Goal Setting

Goal setting is a powerful tool to enhance a student's self-efficacy. Self-efficacy is frequently hypothesized to predict students' choice of activities, and their perseverance and efforts in pursuing such activities.

Shih and Alexander (2000) created a study to "assess the combined effects of goal setting and comparative information on students' self-efficacy and fraction skill in a Taiwanese classroom" (p. 537). The study hypothesized that: 1. Children in the goal setting group would achieve increased fraction compared to children in "no-goal groups" (p. 537). 2. Children in self-referenced groups would show increased fraction skill and self-efficacy compared to children in the social referenced groups. 3. In each goal-setting group, the children's goal setting behavior would vary as a function of comparison information. The results show that students receiving self-comparison feedback set higher goals compared to the students who received social comparison feedback. The study demonstrated a positive correlation between students' self-efficacy and goal orientation. "Goal orientation refers to a set of behavioral intentions that determine one's approach to engaging in learning activities" *(Shih & Alexander, 2000,* p. 537). Research evidence indicates that mastery goals, also called learning goals, support an extensive range of motivational variables that are conducive to positive achievement levels (Grant & Dweck, 2003). "A mastery goal orientation is defined in terms of a focus on developing one's abilities, mastering a new skill, trying to accomplish something challenging, and trying to understand learning materials" (Meece, Anderman, & Anderman, 2006, *p. 490*).

Mastery goals, or learning goals, that are clearly defined, short-term, challenging yet achievable heighten students' self-efficacy better than goals which are both long term and seen as unrealistic or unattainable (Zimmerman, Bandura, & Martinez-Pons, 1992). Students generally believe they can reach a goal when the goal offers understandable guidelines and a system for measuring progress. The awareness of progress reinforces self-efficacy and encourages students' desire to improve and persevere (Schunk, 1995).

Proximal goals enhance self-efficacy and intrinsic enthusiasm (Bandura & Schunk, 1981). Specific goals promote self-efficacy because evaluation methods and progress are easily measured and students can see their progress (Schunk, 2003).

Students must know that the goals represent those attainable by the majority of their peers. Schunk (1983) found that "providing children with specific, proximal goals, along with social comparative information indicating that the goals represent average attainment by other similar children, constitutes an effective means of fostering skill development and perceived efficacy for solving problems" (p. 82).

Strategies to Increase Self-Efficacy

Supporting students with strategies to help them be successful can also increase self-efficacy. Teaching students to persist in attaining their learning goals through self-monitoring improves their self-efficacy and readiness to take on greater learning challenges (Brophy, 1998; Brown, 1999). In addition to teaching self-monitoring strategies, teachers can support students by providing them with scaffolding strategies, and praise for their efforts (Brown, 1999). Scaffolding is a coaching strategy that assists learners by limiting elaborate details of the context until the learner can gradually perform complex content tasks on their own (Young, 1993). Scaffolding frequently occurs between a child and a caregiver, a student and a teacher, and novice and a more knowledgeable expert. Scaffolding allows learners to achieve their potential level of development by extending their abilities with supportive structures. Bransford, Brown & Cocking (2000) list a variety of scaffolding activities and tasks, which include:

- Interesting the child in the task
- Reducing the number of steps required to solve a problem by simplifying the task, so that a child can manage components of the process

- Maintaining the pursuit of the goal, through motivation of the child and direction of the activity.
- Marking critical features of discrepancy between what the child has produced and the ideal solution;
- Controlling frustration and risk in problem solving; and
- Demonstrating an idealized version of the act to be performed.

Scaffolding *works* best when the learner*s are* near their zone of proximal development (Vygotsky, 1978). Vygotsky (1978) describes the zone of proximal development (ZPD) as "The distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). When scaffolding is at the level of the ZPD, learners can comprehend, and absorb greater complex levels of learning. Scaffolding guides the learner toward a deeper understanding of more complex material, which later allows the learner to communicate their knowledge with others (Wink & Putney, 2002).

When students feel they have resources that support success they are inclined to feel more efficacious about working on a task. Self-efficacy is increased when students express in words the strategies they used to progress through a task. Verbal expression increases self-efficacy because it assists students in identifying key task components, helps them with decoding and retention, and provides a systematic means for task completion (Schunk, 1985). Students use language and verbal expressions to make connections between new concepts and prior knowledge. Verbal expression and communication are strategies for learning because students are able to negotiate and construct shared meanings and thus increase their own comprehension and understanding.

Social Aspects of Learning

Language is a tool for learning. According to Vygotsky (1978), the internalization of the cognitive process is primarily social. Learning first occurs socially as individuals interact with the environment and then *is* internalized as the learner constantly relates new incoming information to both their personal life and the real world. "The overall development scheme begins with external social activity and ends with internal individual activity" (Wertsch & Stone, 1985*, p.164*).

Interactive social opportunities are crucial to learning. Discussing new concepts with others assists learners in understanding and internalizing new information. Learning is not a transmission of knowledge, as many behaviorist and cognitive psychologist believe. Learning and solving problems occur between the learner and others. Peer and social interaction promotes cognitive development, and critical thinking skills (Bayer, 1990). Through discussions, the learner makes sense of discrepancies, confirms the similarities, and clarifies their confusion. Social conversations help learners construct meaning (Wink & Putney, 2002). It is important to consider the background knowledge of each individual when attempting to convey ideas, or construct meaning. Writing is one tool used to elicit prior knowledge and each individual's experience about a topic. One writing activity, called a focused free write, as cited in Bayer (1990), is a writing prompt that phrases a question in such a way that children can respond with any form of information including cultural, or everyday knowledge. Free writes provide a venue for the learner's individual knowledge to become public. An open discussion about individual and shared knowledge gradually creates funds of knowledge for the entire group. Funds of knowledge are cultural artifacts and bodies of knowledge that underlie household activities. They can include knowledge situated in a classroom, from one household to another, or to a greater community (Wink & Putney, 2002; Moll, 2002). Funds of knowledge created by groups *doing* activities can launch conversations about shared meaning as students begin to negotiate and make sense of the new information. Constructing shared meaning and understanding of knowledge leads to intersubjectivity. Intersubjectivity is a process by which students negotiate, create, and come to a consensus of shared meanings. Peer collaboration, and small group learning supports cognitive development because individuals can work together to solve problems as they begin to analyze, synthesize, and evaluate other points of view thus advancing their own cognitive development (Bayer, 1990).

Metacognition

Metacognition refers to the process of thinking about one's own thinking, and is described by Hartman (2001) as cognition about cognition. Metacognition is a higher order thinking process that involves an active awareness and understanding of one's own learning (Baker & Brown, 1984). Flavell (1979) describes metacognition as a self-monitoring process in which one has a conscious understanding how one learns, and at the same time has knowledge of one's lack of understanding. For Flavell (1979) and Gourgey (1998), metacognitive knowledge allows the learner to use available information and strategies to achieve a desired goal. According to Bransford et al. (2000), metacognition includes monitoring one's present level of knowledge and determining when knowledge is inadequate. Metacognitive strategies include regulating cognitive processes to master cognitive experiences and to assure the attainment of goals and objectives. Teaching students to self-assess and self-monitor their learning is an important part of metacognition instruction (Bransford et al., 2000).

Metacognition requires two basic components: knowledge of cognition and regulation of cognition (Jacobs & Paris, 1987; Sperling, Howard, Staley, & DuBois, 2004). Knowledge of cognition describes how learners understand their own learning and cognition. Understanding learning and cognition means learners not only know how they understand and process new information, but that they also understand their own learning process. Regulation of cognition describes how learners monitor and control their own learning (Schraw, 1998; Sperling, et al., 2004).

Knowledge of cognition includes three distinct types of metacognition: declarative, procedural, and conditional. Declarative knowledge pertains to knowing about the structure of things. For example, declarative knowledge about the scientific method includes knowing that part of the scientific method includes designing an experiment to test a hypothesis. Procedural knowledge includes knowledge about how to design an experiment, or create a hypothesis. Conditional knowledge focuses on the conditions under which one chooses to use a particular strategy, or the awareness of knowing why one strategy might be more effective in a given situation. In designing a science experiment, conditional knowledge includes knowing how to control for variables, and why controlling for variables is important (Schraw, 1998; *Schraw & Moshman, 1995*). Metacognitive regulation enhances performance in a variety of ways including increased use of focused attention, superior use of scaffolding strategies, and greater awareness of comprehension breakdowns (Schraw, 1998).

Mastery Learning

The most influential source of self-efficacy is the mastery experience (Bandura, 1986; Zimmerman, 2000). This finding suggests that in order to improve student achievement in school, educators should focus on enhancing students' academic efficacy beliefs through mastery (Bandura, 1986; Pajares, 1996). Mastery learning utilizes several approaches that optimize the program's success. These include: ongoing feedback, corrective action, and enrichment (Guskey, 1987, 2005).

In the mastery learning approach, students receive feedback as they progress through the learning process. Feedback is appropriate to the learning level of the students and provides direct comparisons between student progress and the learning objective. In addition to progress monitoring, supporting students with a means to correct errors and solve learning problems is key (Guskey, 1990, 2005). Furthermore, mastery learning includes enrichment activities for students who performed well through the first teaching lesson.

Mastery learning incorporates clear and consistent teaching and learning methods. The components include a learning objective, and student engagement, which involves feedback, and a means of evaluation (Guskey, 1990, 2005). The learning objective includes setting specific learning goals to reach the desired mastery. Student engagement involves having the student actively involved in the learning process through peer collaboration, modeling, and the correction of learning through feedback and formal assessments. Several arguments oppose mastery learning and claim that it has no advantages to students except for providing them with correct procedures and additional learning time (Slavin, 1987). Perhaps this is because there have been minimal research correlations between mastery learning model and higher academic achievement on norm-referenced tests. Mastery learning incorporates criterion-referenced test, so all students can reach the desired level of mastery. Bloom (1987) stresses that within a mastery learning class additional time for student learning is a key component of the mastery learning process.

Technology and Immediate Feedback

A current growth area in math education is the use of technology and web-based instruction. The advantage of using technology programs and web-based assessment to increase self-efficacy is *based on* the components of self-testing, self-regulation, and self-evaluation (Fleischman, 2001; Nguyen, Hsieh, & Allen, 2006). Immediate feedback not only provides students with a means for measuring progress, but it also assists them in solving specific learning problems. Research using web-based assessments found that students have an increased amount of enjoyment using computer and web-based programs and that immediate feedback improves students learning attitudes toward math (Nguyen, et al., 2006). In addition to this, students favored more time for practicing math and they felt more confident in their ability to learn math (Nguyen, et al., 2006).

Middleton and Murray (1999) conducted a study "to investigate how the levels of technology implementation by fourth and fifth grade teachers affected student achievement in reading and mathematics." A total of 1466 fourth grade students, 1108 fifth grade students, and 107 teachers from a South Carolina school district participated in the study. Teacher surveys included using the "Level of Technology Implementation" (LoTi) created by Moerch (1995) to measure teachers' current use of technology in the classroom. Middleton and Murray (1999) established teachers as "high level," or "little or no technology," and these levels were used to investigate how the teachers' levels of technology implementation affected student achievement in reading and math. Baseline student achievement was established by using the average scaled scores for reading and mathematics from the Metropolitan Achievement Test: Seventh Edition (MAT7). The MAT7 is norm-referenced standardized achievement test.

The study compared the technology levels of the teachers to the students' MAT7 results to establish if there was a significant difference between student's academic achievement and the technology levels of the teachers. The results confirm "student academic achievement was affected by the level of technology used by the classroom teacher" (Middleton & Murray, 1999).

Computer use in education is highly diverse and spans from simple word processing programs, skill-based learning, interactive gaming, to high-level interactive communication. Teachers using cutting-edge technology incorporate a variety of interactive learning tools in the classroom such as blogging, podcasting, iChat, and streaming videos to enhance and support students' academic achievement. Many of the current uses of technology instruction utilize verbal communication as a key component. Language plays a key role in learning, and students use language as a tool to make connections, negotiate meaning, and reform schemas from prior knowledge to new current ideas (Wink & Putney 2002; Bayer, 1990). Expressive language in both speech and writing allows the learner to "shape his ideas, modify them by listening to others, question, plan, express doubt, difficulty and confusion, experiment with new language and feel free to be tentative and incomplete" (as cited in Bayer, 1990). New technologies such as blogging, podcasting, and iChat offer students social interactions to collaborative ideas, problem solve, and establish shared meanings. Vygotsky (1978) believed that *individuals* learn through social interaction, and blogs are a tool for social communication. With blogs, students can reflect on their learning, process ideas through text, and receive feedback on their ideas and understandings. Feedback is key to mastery, and mastery of skills is one factor, which improves self-efficacy. When students receive corrective feedback on their problem solving ideas, they are able to take corrective action and modify their approach to improve performance. Successful performance increases perceived self-efficacy (Pajares, 1996).

IV. Review of Existing *Curricula in Mathematics*

Mathematics focuses on computational skills, automaticity of basic facts, and conceptual understanding. The interplay between conceptual understanding and automaticity is that one is highly dependant on the other. According to the National Council of Teachers of Mathematics (NCTM) standards for grades six to eight, students must recognize and use connections among mathematical ideas (National Council of Teachers of Mathematics, 2007). Students must understand how ideas connect and build upon each other, and students must apply mathematics in contexts outside the instructional domain. When students struggle with automaticity of facts, it is harder for them to focus on conceptual understanding. An example of this occurs when students begin learning about fractions. Students who master finding the least common multiple know their basic multiplication facts well. They understand the relationship between the answers of the multiplication tables and finding the least common multiple, or LCM, of two or *more* numbers. However, those students who struggle with multiplication do not see the connection between the answers to the multiplication tables and finding the LCM because the memorized facts are not readily available to them as a comparison in their minds. The concept of correlating the two does not occur automatically. Students must take a more calculated and systematic approach, which hinders their ability to grasp the concepts at the speed needed for comprehension.

Memorization of facts begins early on in grade school and the NCTM standards for grades Pre-K-2 states that students should be able to compute fluently (NCTM, 2007) Students begin memorizing basic addition and subtraction facts and gradually move into multiplication, division, and progress into specialized formulas for area, perimeter, circumference and volume. Automaticity of these basic skills is critical for student success. Academic demands on students increase as they advance through the elementary school years. Students begin to fall behind their peers if they have not mastered basic facts and key skills from previous years. The achievement gap continues to increase as a student progresses through the grades.

Teachers spend an extraordinary amount of time assessing and building on students' prior knowledge in order to scaffold their learning and target *their* zones of proximal development. Teachers in turn teach skills in a variety of contexts, so students can actively involve themselves in the learning process. Teaching concepts using real life applications is vital to a student's deeper understanding of the concepts and material. Students must understand when, where, why, and how to apply their newly learned skills in solving novel problems (Bransford et al., 2000). Teachers become frustrated when their efforts have minimal results on student achievement and *student* ability to transfer knowledge. Students need time to review conceptual errors and make changes in order to gain mastery with a skill. The majority of the curriculum products and district timelines do not allow adequate time for teachers to make assessments, reteach, correct for errors, and allow students times to make adjustments in their understanding based on the feedback. Many curricula allow little time for mastery. The time limitations to reteach, provide feedback, and allow for error corrections are a major concern within today's classroom.

In accordance with the premise that additional time is key for mastery learning, last year I requested an additional class period to teach math to struggling students. I debated the fact that students who needed additional learning time were not attending zero period, or after school tutorials. I also argued that students received additional time for language arts and spelling, but not for Math. The principal granted my request, and *during the 2007-2008 school* year I *taught* an additional class period each day targeting low achieving students. Bloom (1987) states that mastery learning may not benefit the top ten percent of a class, but the remaining ninety percent will definitely make gains from the procedures.

Current Curricula

Three distinct *curricula* will be presented in the following section, *A+ LS* Software, a computer based program, *Excel Math*, a spiral approach to learning, and *Mathematics: Concepts and Skills* (2001) by McDougal Little, a standard district adopted text. Each curriculum has a unique approach to learning and all have valid concepts and applications to students' understanding. I choose to review *Anywhere Learning System* software (A+ LS Software) because of the immediate feedback it gives students as they work through the lessons. I choose to review Excel Math for both its spiral effect for constant review and its immediate feedback through the "Check Answers." All curricular approaches not only have positive aspects, but also *have* gaps in meeting student's needs. However, with a combination of approaches, curriculum guidelines can adapt to meet need*s* of diverse learners.

Anywhere Learning Systems, A+ LS Software

Districts are beginning to turn to computer-based software to assist them with ongoing assessment, analyzing student results and offering feedback to both the teacher and the student. One such program is Anywhere Learning Systems, A+ LS Software. A+ LS is a computer-based program that takes students through guided lessons, offers them practice time, and assesses student results through a formative test. The guided lessons begin with general rules and procedures for solving a given problem. These lessons also take students through a variety of approaches such as solving basic fact computations to understanding word problems in order to facilitate conceptual understanding. When students are finished with the lesson they advance to the practice phase. Throughout the practice and assessment stages students are given immediate feedback by the program on their progress within the practice session and through the final the assessments. The teacher sets the assessment and progress criteria. Students can only progress through the next stage once they have mastered the concept to a certain degree of accuracy. Teachers can individualize student lessons manually by selecting the type and quantity of problems each student must complete under a specific standard. A + LS software allows teachers to view reports outlining the progress data for each student. Students can also view their personal progress. Once again, continual progress monitoring and specific feedback is key to student progress and mastery. When students understand their errors and *are* allowed time to make corrections the focus on their growth is a motivating factor. Success and mastery of skills not only improves self-efficacy beliefs, but also improves achievement. Research connects self-efficacy to academic motivation, increased learning, and student achievement (Bandura, 1996).

Excel Math

Excel Math *(2007)* by AnsMar Publishers *I*nc. is another program that offers continual ongoing feedback and progress monitoring for students, which includes an extensive process of introduction, reinforcement, and assessment. Excel Math, a worksheet based program, is a K-6 Math curriculum that uses a spiral approach in which each lesson builds upon the previous unit of learning. Excel Math, a worksheet based curriculum, uses a spiral structure that reviews prior instruction while introducing new daily skills. The spiral structure of Excel Math brings students to mastery and long-term competency through the continued practice and reinforcement of basic skills. The program also incorporates immediate feedback via the feature "Check Answers." This feature allows students to check the correctness of their answers, adding the sum of a set of four problems and comparing their answer to the program's answer. The feedback from Check Answers offers students a means to monitor their own progress because students know immediately if their answers are correct. Students complete Excel Math worksheets independently. Teachers monitor progress through individual skill errors students make. The downfall of Excel Math is that it does not provide many multi-step word problems. Excel Math's word problems are single step *algorithms, which result in* little authentic learning. While Excel Math does not provide students with the opportunity to engage in authentic learning, Excel Math is ideal for students needing to master basic skills. As we have seen, continued success and mastery of skills increases self-efficacy beliefs (Zimmerman & Cleary, 2006), and Excel Math is a skill-based program that focuses on assessment and feedback to reach mastery.

Mathematics: Concepts and Skills by McDougal Littell

The textbook East Valley Union currently uses at the middle school level is *Mathematics: Concepts and Skills* (2001) by McDougal Littell. The text includes pacing and assignment guides, general support materials, specialized materials for second language learners, technology resources and mathematical background notes for the teachers to help develop students' conceptual understanding and reasoning skills. The pacing and assignment guide for the first chapter calls for 14 days of instructions, one day for review and one final assessment day at the end of the chapter. The outcome is a three-week unit with no additional days allotted to re-teach, or assist students in correcting their errors. The current practice in the classroom correlates identically to the publisher's pacing guide. Within the publisher's guidelines, progress monitoring in the form of quizzes are within the same period of a new lesson. Teachers are at the mercy of time to incorporate ongoing quizzes and still maintain the teaching guide pace. Although assessment and ongoing feedback are key factors that promote student competency and mastery, the rapid pacing of Littell's text undermines mastery success.

East Valley's district *m*ath pacing guideline is relatively similar to the prescribed pacing guide by the McDougal Littell text. Teachers are required to teach through the first four chapters within a 12-week period, or one trimester. The pacing guide allows only three weeks per chapter. According to the publisher's pacing guide, teachers should be able to get through chapter four in sixty-four days with only one day per chapter allotted for assessment. The publisher provides ongoing assessments every other lesson, but the pacing guide does not allot additional time to administer the assessments, or provide feedback. The East Valley Union's trimester is 60 days, or 12 weeks in length. Two days are lost for holidays, Labor Day and Veteran's Day. Teachers must teach a sixty-four day trimester program in fifty-eight days, and still include time to review key concepts and vocabulary terms from previous lessons and chapters. Teachers must also find time to complete ongoing assessments, provide feedback, allow students to correct and understand errors, as well as providing additional support and resources for the students who scored below basic and far below basic. In order for students to gain mastery, which is a main contributor to increasing student's self-efficacy beliefs, ongoing feedback and assistance in correcting errors is critical (Schunk & Meece, 2006). Neither the publisher's pacing guide, nor the district's pacing guide allows additional time for feedback, re-teaching, or correcting of errors. *Yet a*dditional time for feedback, reteaching, and correcting errors is key for student success. Getting through all the material in the allotted amount of time is the final goal of the district because it implies that teachers taught all the necessary standards. Curriculum is needed that meets the district's pacing guide and benchmarks, while still meeting the needs of the students by allowing them more time to master and understand concepts in a way that meets their learning needs.

Bloom (1987) stresses that within a mastery learning process, additional time for student learning is key. The current curriculum does not take into account the additional time needed for students to achieve mastery in any given skill. In attempts to provide more time for learning, schools have implemented zero periods, which are classes offered before school to target the below basic, and far below basic achievers. Below basic and far below basic students are those students who score below 300 on the California Standards Test, or CST. The problem with this is that the school cannot mandate that students attend a zero period class unless they are marked as retention candidates. Tutoring is also available for students after school, but schools cannot mandate attendance for low achieving students.

In order for students to reach mastery, they must have clear components such as learning objectives, student engagement, feedback, and a means of evaluation (Guskey, 1990). Slavin (1987) confirms findings that mastery learning is best for low achieving students. Intervention classes, targeted for below basic and far below students, are ideal for a focused mastery learning approach.

I developed the Mastery Learning and Self-Efficacy Intervention Curriculum (ML&SEI) to increase students' self-efficacy in mathematics, improve academic achievement in math, and increase students' metacognitive awareness. The curriculum includes a variety of self-efficacy intervention strategies, which include past performance and mastery, social comparisons, modeling, performance based feedback, and goal setting (Schunk, 1990). The mastery-learning portion of the curriculum attempts to increased students' academic achievement in math. The mastery learning model includes pre-tests, ongoing formative assessments, corrective feedback, enrichment activities, and post-tests (Guskey, 2005). Students set specific goals for each unit, and monitor their achievement through ongoing formative assessment. Enrichment activities provide students with greater opportunities to challenge their knowledge once they have reach mastery. The ML & SEI curriculum provides students with metacognition training to help them self-regulate and monitor their own cognitive process. Metacognitive training assists students in having a conscious understanding *of* how they learn, and at the same time having knowledge of their lack of understanding. According to Bransford et al. (2000), metacognition includes monitoring one's present level of knowledge and determining when knowledge is inadequate. Through metacognitive thinking, students can determine which skills need further study and which strategies work best for acquiring academic success. The ML&SEI curriculum is a supplemental curriculum designed to meet the growing academic performance demands of No Child Left Behind (NCLB). Although the results of the program will be immediate, the anticipated long-term success l*ies* in the *future test scores released f*rom the Standardized Testing and Reporting Results (STAR).

V. Mastery Learning and Self-Efficacy Intervention Curriculum

The ML & SEI curriculum focuses on improving student achievement by providing students with specific intervention strategies in mathematics, self-efficacy, and metacognition. Increasing students' self-efficacy in math requires that they somehow alter their perceptions of competence governing a particular area. Altering perceived self-efficacy requires specific intervention strategies. Key intervention strategies included in the ML & SEI curriculum include peer and teacher modeling, social comparisons, and successful performance on standards-based skills. The ML & SEI curriculum offers continuous feedback, varied instructional methods, and provides enrichment activities that offers in depth investigation of the standards. Continuous feedback such as daily informal assessments guides students toward reaching their goals. The teacher uses ongoing daily assessments to make the necessary instructional modifications for students. Students take weekly formative assessments and check progress toward their goal based on the assessment results. Students complete the learning unit by taking a final summative assessment.

Varied instruction plays an essential role in mastery learning. When students fail to master the material after the initial lessons then the teacher must defer to alternate lesson ideas and methods to assist the students in achieving mastery. Alternate teaching methods and instructional strategies include guided video lessons, math manipulatives, peer teaching, computer based instructional programs, and one-on-one guided instruction. Students reaching mastery participate in enrichment activities. Students reach mastery when they score 80% or higher on unit exams.

Enrichment activities include a variety of projects and activities that include but are not limited to model building, data collection and analysis, real world problem solving, peer teaching, podcast creations, and video productions.

Goals of ML & SEI

Many times, low achieving students abandon efforts to persevere when struggling with new concepts. *One characteristic of l*ow achieving students *is their* lack *of* metacognitive knowledge*, which would* help them progress to the next learning level *by providing a way to reflect on their learning processes*. Not only is it difficult for low-achieving students to progress to the next level of learning on their own, they also lack the discernment to judge the reasonableness of their answers. Low-achieving students often feel perfectly confident working through a variety of math problems and yet have no concept that their answers are entirely unreasonable. With the achievement gap growing between minorities, disadvantaged students, and their white counterparts teachers must think outside the box in order to target the specific needs of each student and bring them to the next level of academic growth. I developed the ML & SEI curriculum with the desire to give students an increased sense of academic strength. I *set* minimal levels of mastery in mathematics *so that students could experience mastery, and expected that* their *sense of* master*y, which was a new experience for them, would* increase their perce*ptions of their* self-efficacy. Increased levels of perceived self-efficacy may improve their ability to persevere when approaching challenging tasks. I want students to feel confident about their skills and abilities in mathematics. Thus, the first goal of the ML & SEI curriculum is to increase student's math self-efficacy. Self-efficacy intervention strategies entwine the entire curriculum and include activities that reinforce peer modeling, social comparisons, goal setting, and successful performance. Peer modeling and social comparison are achieved through video taping of students, student-created podcasts, and peer tutoring.

The second goal of the ML & SEI curriculum is to increase academic performance in mathematics. Mastery learning supports successful performance of key standards as students work independently and cooperatively with their classmates. Mastery learning also supports students in monitoring ongoing performance and advancement toward their goals. The mastery learning method focuses on continuous formative assessments, instructional variety, ongoing progress monitoring, and enrichment activities that nurture a deeper understanding of the curriculum.

The third goal of the ML & SEI curriculum is to increase student awareness of metacognition. Metacognition assists students in thinking about their own learning process. It also helps students self-reflect on their learning and teaches them self-regulating strategies. Metacognition training provides students with the skills needed to scaffold and advance their own learning. Metacognition is key to bridging the gap between students who give up easily and those who become self-regulating independent learners.

Most ML & SEI units last two to three weeks. The ML & SEI curriculum fits around a teacher's individual parameters of time and needs. Each unit can be a set number of weeks, or fluid, so students can progress at their own pace. Teachers can use the ML & SEI in addition to the district's approved curriculum. ML & SEI can serve as a supplemental program, an intervention strategy, or an after-school tutorial program.

The curriculum begins with an online pre-survey on math self-efficacy. Pre and post self-efficacy surveys consist of ten questions geared at the specific standards addressed in each unit. Students rate themselves on a scale of 1-100 where one represents not confident at all and 100 represents certainty of successful performance. Students take the unit pre-test immediately after they complete the pre self-efficacy survey. The initial pre-test guides the teacher's instruction and directs students in narrowing their academic focus for mastery. Students complete the pre-self-efficacy survey and the pre-test either before beginning the unit, or on the first day.

The second day of the unit the teacher and students review the pre-test results and students graph their test results and then complete a goal setting form. Goal setting forms target the standards that students need to master based on the pre-test results and the unit goals set by the teacher. Goal setting forms include a target date, specific goals for the student, guiding elements that assist students in reaching their goal, and evidence guidelines for documenting success. Students graph their results from the pre-assessment and use the graph to monitor and record all assessment results. The following three days the teacher provides a variety of lessons that target students' specific needs. The teacher and students reflect daily on their learning and discuss with each other the progress toward their learning. During the latter portion of the week, students are required to post a blog response posted on the classroom's blog. Blog questions check student understanding and comprehension of tasks. Blog questions can also address ideas about metacognition and learning. A blog question geared at checking for understanding is an online word problem presented for the students to solve. The students must solve the problem and explain the reasoning and thinking behind their answer. Blog questions or comprehension checks not only assist the teacher in planning, but also serve as a learning tool for the entire class. The whole class reviews the blog responses and the teacher helps students understand and clarify each student's entry.

On the fifth day of Unit One, students take their first formative assessment. During the same class period, the teacher and students review the assessment results. As part of the assessment review, the teacher and students look at each item on the assessment and the teacher helps students understand errors and clarify misconceptions. Students participate in reviewing the assessment by asking the teacher questions in order to understand their errors. Students graph the assessment results next to their pre-test results. The graph serves as ongoing visual evidence of student progress.

Week two begins with a re-evaluation of goals. Students modify their goal forms and make the necessary adjustments based on the formative assessments. Students reaching mastery continue the week doing enrichment activities. Enrichment activities include creating podcasts and teaching videos, peer tutoring, and computer based activities that provided a more in-depth knowledge of the skills through graphing, analysis, and synthesis of real-world word problems.

During the second week, the teacher begins to use video as a means to assess comprehension. Students solve problems for the class and the session is videotaped. The teacher and class then analyze the video together and the teacher and peers offer the student positive feedback and insights to help overall understanding. Such an analysis helps other students who choose to create a teaching video later on the unit.

Students take the last formative assessment at the end of the second week and chart their progress. The teacher decides at this point how to proceed. If the majority of the students have not reached mastery, then they continue the unit an additional week. The teacher may also begin a new unit with the students, and continue to work with the few students not yet at mastery on the previous skills. Figure 2 shows a general flow chart of the project sequence.

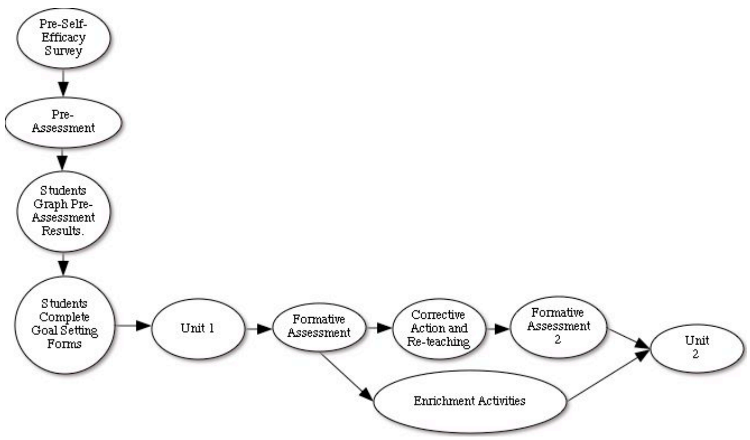


Figure 2: Flow chart of mastery learning sequence.

A critical component of the ML & SEI curriculum is teaching students how to think critically about learning. Students need to be taught about metacognition and how metacognitive strategies can help them reach their desired goals. Metacognition training is a key link that bridges the gap between students who give up when the curriculum becomes difficult to students who persevere and select strategies that help them succeed. Several lessons take place during the unit to teach students about metacognition. Metacognition lessons teach students how to reflect on their own learning and the strategies needed to help them learn. Metacognitive awareness assists students in becoming self-monitoring, independent learners.

Conclusion

The Mastery Learning and Self-Efficacy Intervention curriculum originated as a strategy to meet the increasing demands of rising performance goals. The ML & SEI curriculum focuses on three main goals, increasing students' perceived self-efficacy, enhancing academic performance in math, and improving students' metacognitive awareness. All activities and constructs directly correlate with at least one of the three goals. The curriculum incorporates a variety of technology resources including computer-based learning programs, interactive math games, video recordings of students peer teaching, and podcasts. Chapter VI provides a detailed account of the ML & SEI implementation.

VI. Implementation and Revision of ML & SEI

I developed and implemented the Mastery Learning & Self-Efficacy Intervention Curriculum (ML & SEI) in a sixth grade *intervention* mathematics classroom. Students in the *intervention* math class also attended regular sixth grade math. Therefore, the intervention students received two 52-minute class periods of math each day instead of having the ability to choose an elective class. The second math intervention class replaced an elective course. The ML & SEI curriculum was implemented for eight weeks during the school's second trimester and covered three distinct units. Unit One of the project covered California math standard, Number Sense (NS) 2.3. NS 2.3 covers solving problems with positive and negative integers using addition, subtraction, multiplication, and division. Unit Two topics included California NS standards 1.2 and 1.3. California content standards NS 1.2 and NS 1.3 include interpreting ratios and rates in various contexts, and using proportions to solve unknown quantities. Unit Three dealt with California content standard NS 1.4. NS 1.4 includes converting fractions to decimals to percents and covers calculating percents of quantities and solving problems incorporating discounts, tax, tips, and interest earned. Rates and ratios in Unit Two, and fractions, decimals and percents in Unit Three often challenge students. Therefore, extra time and ongoing practice was key to student success. Table 1 shows the California math standards covered for each unit.

Table 1: California math standards covered in each unit.

Unit One	Unit Two	Unit Three
Number Sense 2.3 Solve addition, subtraction, multiplication, and division problems, using positive and negative integers and combinations of these operations.	Number Sense 1.2 Interpret and use ratios in different contexts (e.g., batting averages, miles per hour) to show the relative sizes of two quantities, using appropriate notations (a/b, a to b, a:b).	Number Sense1.4 Calculate given percentages of quantities and solve problems involving discounts at sales, interest earned, and tips.
	Number Sense 1.3 Use proportions to solve problems and to find the length of a side of a polygon similar to a known polygon. Use cross-multiplication as a method for solving such problems, understanding it as the multiplication of both sides of an equation by a multiplicative inverse.	

The Setting of the ML & SEI Curriculum

Pseudonyms are used for school sites and students names throughout the document. East Valley Middle School (EVMS) is a Title I school with approximately 98% of the students receiving free and reduced lunch. In the 2006-2007 school year, 856 students were enrolled in grades six through eight, and 276 were sixth graders (California Department of Education [CDE], 2007). The enrollment breakdown by ethnicity is as follows: 55% Hispanic, 23% White, 18.2% African American, 1.2% American Indian or Alaska Native, .8% Filipino, .7% Pacific Islander, .6% Asian, and

.5 % Multiple or No Response (CDE, 2006-2007). EVMS school is a targeted year-five improvement school. Schools labeled as a year-five improvement school are targeted for restructuring. Restructuring includes increased professional development, new curriculum, and implementation of an alternative governance plan which the governance team members use to monitor and track progress. Restructuring requirements strive to improve the academic performance of the students. EVMS' restructuring plan included intervention courses in both Mathematics and Language Arts. The math intervention courses served students who scored basic and below basic on the California Standards Test (CST) test. The ML & SEI curriculum served *a class of* ten students, five girls, and five boys. The entire class of ten students participated in the project. Three of the students scored basic on the CST, and seven scored below basic. Each 12-week trimester a new group of 10 to 12 students are handpicked to participate in the intervention class. Students selected for the intervention class received a C or below in their regular math class the previous trimester, and scored below basic on the CST.

The Teacher

I have been teaching for ten years, and I began teaching middle school about five years ago. Prior to my middle school experience, I taught at the elementary school level in grades three and five. My third grade class was a transitional bilingual classroom and all students in my class were transitioning out of the bilingual program. The students in my class received instruct*ion* in English for the very first time, and many students struggled to learn content in a new language. The desire to motivate my students plunged me into technology. I knew my students needed constant visual reinforcement to enhance their understanding and comprehensible input. Technology was key in keeping students engaged and excited about learning. I flourished with technology and quickly launched into using PowerPoint, HyperStudio, Inspiration, iMovie, online games, and WebQuests to engage and motivate my students. My desire to be on the cutting edge of technology has stayed with me ever since.

When I came to middle school, colleagues already knew me for my innovative use of technology in the classroom. Teachers counted on me to assist them in incorporating technology into their own curricula. Technology was a natural part of my teaching, and I designed my lessons around the most innovative and cutting edge approach to learning. My daily instructional practice included the use of podcasts, blogs, video conferencing, iChat, and wikis. I seek out online forums, or tools such as simulations and interactive games that support the goals of my lesson. The use of video, podcasts, blogs, and computer-based learning was a natural component to include in the ML & SEI curriculum. My students are "digital natives" and my lessons need to reflect their natural mode of learning.

Pre-Implementation of the ML & SEI

A+LS Software

I spent many lessons teaching students the needed *computer* skills to succeed in the ML & SEI curriculum. Incorporating the A+LS computer-based software into the curriculum took several weeks. Students had their own login names and passwords and the software allowed me to track each student's progress. I created a fictitious student name for myself, so I could engage and progress through the A+LS software as a student. At the onset of each new lesson, I logged in as a fictitious student in order to demonstrate to the students how the program would appear to them. A fictitious student name allowed me to preview the various lessons and make teaching notes based on the difficulties I anticipated for students. I taught students how to monitor their progress, and I created a sequence guide for students to progress through the A+LS software. Students learned how to sequence their learning and systematically progress from the guided practice lessons through the final assessments. Students gained knowledge on their own learning trends by tracking their progress through the A+ LS program. Initially I used the A+LS software at the beginning of each unit. However, I found that the software best suited the students once they mastered a particular skill. The A+LS software focused on self-guided learning, and since my students had difficulty guiding their own learning the A+LS software was less effective as an initial learning tool. Therefore, students used the A+LS software to review and practice newly mastered skills. Figure 1 shows a screen shot of the A+LS software during the independent practice section. The screen shot was from a student's practice session. The student worked out the problem generated on the screen and typed in their answer. In this case, the students typed in -62 as the answer. When the student hits the enter key, the program *displays* a message to the students telling them if their answer is correct, or not. If the answer is incorrect, the student must try again, and re-enter a response. Figure 3 displays a screen shot of a problem and the student's response.

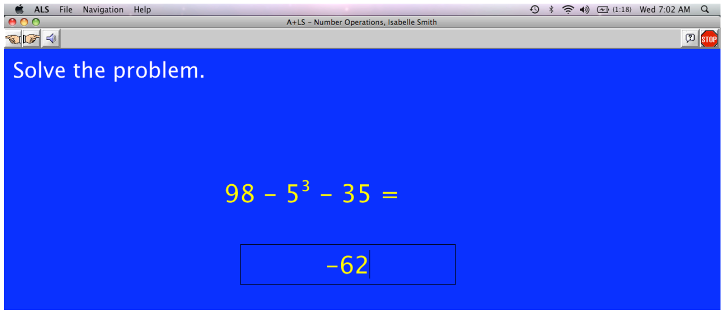


Figure 3: Screen shot of student work during independent practice in A+LS software.

In order to monitor student progress I ran a software summary report of student grades. I noticed that students were not scoring very well on the tests in the A+LS software, so I brought this to their attention. I used remote desktop to show students that I could view them working on their problems. I printed a report from A+LS to illustrate the types of reports and information I had about their progress, navigation trends, and overall performance. The reports provided information on a student's mastery rate, the number of tests attempted, and the final assessment results. I printed out a report of a randomly selected student, blocked out the student's name, and showed the report to the class. I asked the class to look at the report and tell me as much as they *could* about the data presented. Students immediately noticed the score column and commented on the failing scores. Then the students realized that the report told them how many attempts a student made on an assignment. Several students began to wonder why a student continued to have a low test scores after three attempts. One student admitted that even though she went through the lessons, she still was not confident in her abilities. Another student bluntly said, "I go through the lessons, and I still don't get it." Students began to slowly admit that they were not feeling confident about their knowledge after finishing the guided lessons. I found that sharing this information with students made them look critically at their learning practices. I needed to scaffold the A+LS software for students, but I was not sure how to do that yet. I decided to meet with students individually and discuss their progress. Figure 4 shows one student's sample report.

Date	Assignment	Score	Tries
11/28/2007	Number Sense 1	73.333	1
11/28/2007	Number Sense 2	86.667	1
12/12/2007	Problem Solving 1	40.0	3
02/13/2008	Review Test 1 - Place Value	64.286	3
02/27/2008	Number Operations	0.0	1
02/27/2008	Ratio & Proportion	40.0	1
	Total	304.28	10
	Average	50.71	1.66

Figure 4: Sample student report from A+LS software.

I met with *Nadine* and shared her progress on ratio and proportions. *Nadine* mentioned that she is struggling with reducing when it comes to both ratios and proportions. *Nadine* was also concerned about meeting her academic goal of reducing ratios by the target date. *Nadine* and I discussed strategies to help her succeed with reducing fractions. The initial idea was to sit with *Nadine* as she went through the guided lesson to assist her understanding. As I sat with *Nadine*, I noticed that when it was time to reduce fraction she struggle*d* with finding factors of a number. I noticed her uneasiness as she tried to think of factors of a number. I suggested using a factor sheet. I gave *Nadine* the factor sheet, and showed her how to determine common factors for two numbers. Once *Nadine* was able to find common factors, she had greater amounts of success with reducing fractions. I made *Nadine* the factor expert, and she taught others how to use the factor sheet to find common factors, and reduce fractions. I continued to meet with students to discuss their A+LS progress report. My goal was to offer each student at least one strategy *for increasing* their progress. I made each student an expert in their specific strategy, so the expert student could help others. Students began to make greater efforts in their work by asking for help from the experts, and using the various strategies available to them.

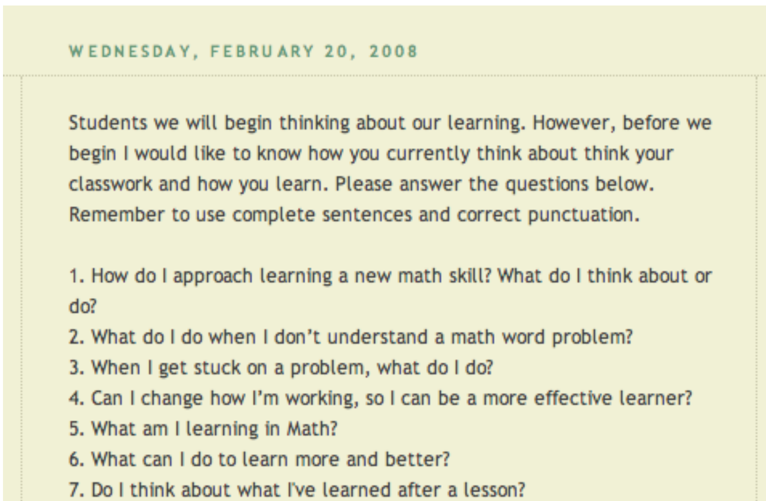
Videotaping

I also spent several lessons preparing students for videotaping. I wanted students to have a low stress level when being videotaped, so I began by videotaping the expert students explaining their math scaffolding strategy to the class because expert students were already comfortable sharing their strategy with others. *Nadine* explained how to use the factor sheet to find common factors and *Martin* explained how to use a number line to order positive and negative integers. I then rewound the tape and played the video back for students. On occasion, students wan*t*ed to re-tape their video to correct errors. I allowed students to re-tape and correct errors because their biggest fear was solving problems incorrectly on tape. I wanted students to know that they could re-tape and correct errors as part of the process toward mastery.

The next step was to tape students solving problems after they had worked out the problem on their own and verified their answers. Students were very eager to be taped because they knew their problems were correct before they started and this alleviated their fears. As I noticed students gaining mastery, I gradually began having students solve problems randomly up on the docuCam, and while being video taped. *A docuCam is projector that can project any object placed under the camera*. Once students became comfortable solving problems in front of the class, I began taking chances and asked students solve problems even if they were struggling. The last approach offered the greatest amount of insight into student understanding because students saw how their peers worked through problems when they were struggling. One example *a student struggling to solve a problem* came when *Joanna* demonstrated her understanding of solving proportions while being video taped. *Joanna*'s confusion began after she cross-multiplied. *Joanna*'s confusion quickly prompted the observing students to raise their hands and offer assistance. Several students commented that *Joanna*'s confusion was identical to their confusion. The class opened up and fear diminished because students saw that even though *Joanna* was being videotaped, everyone was willing to help her out when she struggled. No one judged, or ridiculed her for struggling on camera, and after that, all students were very eager to videotape themselves solving problems.

Blogs

Blog posting was an additional area of practice. I started out by having students write a draft of their blog *post* on a piece of paper and then just copy it into the classroom blog page (see Appendix). I found this approach very helpful for students who needed extra time to think and write out their response before posting. I found that most students had blog responses that were more thought out when they drafted a response out on paper first. Not all students were successful in writing a blog response and posting it before the end of class, so slower students were given additional time the following day to complete their posts. Figure 5 shows some initial questions used to introduce blog posting and lead students into thinking about learning and metacognition. Figure 6 exhibits one student's response.



WEDNESDAY, FEBRUARY 20, 2008

Students we will begin thinking about our learning. However, before we begin I would like to know how you currently think about think your classwork and how you learn. Please answer the questions below. Remember to use complete sentences and correct punctuation.

1. How do I approach learning a new math skill? What do I think about or do?
2. What do I do when I don't understand a math word problem?
3. When I get stuck on a problem, what do I do?
4. Can I change how I'm working, so I can be a more effective learner?
5. What am I learning in Math?
6. What can I do to learn more and better?
7. Do I think about what I've learned after a lesson?

Figure 5: Blog questions on learning and metacognition.

1.when I learn a new skill I just try my hardest to do the best I can.
2.when I don't understand something I ask a neighbor if they know it.
3.when I get stuck on a problem I look at my math note book.
4.I can change the way i work on anything.
5.what I learn in math class is proportions and cross multiply and other things.
6.what i can do to learn more is to pay attention better.
7.I think about what i learn after a lesson is i take notes on what I need to learn.

11:38 AM

Figure 6: Student's blog post.

Garage Band

Students learned the program GarageBand before using *it* as part of the ML & SEI curriculum. Creating podcast*s* is part of the ML&SEI curriculum and students needed to know the program GarageBand in order to demonstrate mastery through podcasts. GarageBand lessons included teaching students how to import pictures and movies, record and edit their voice, add music, and share files. Figure 7 shows a completed student project in GarageBand. The first podcast track is a series of embedded photos. The second track is for voice recordings. The third piano track is for music and audio enhancements. The student's project is called a video enhanced podcast, or vodcast. Vodcasts are different from podcasts because vodcasts contain images and videos attached to voice or music recordings. Vodcasts are content delivered with images, voice, and music.

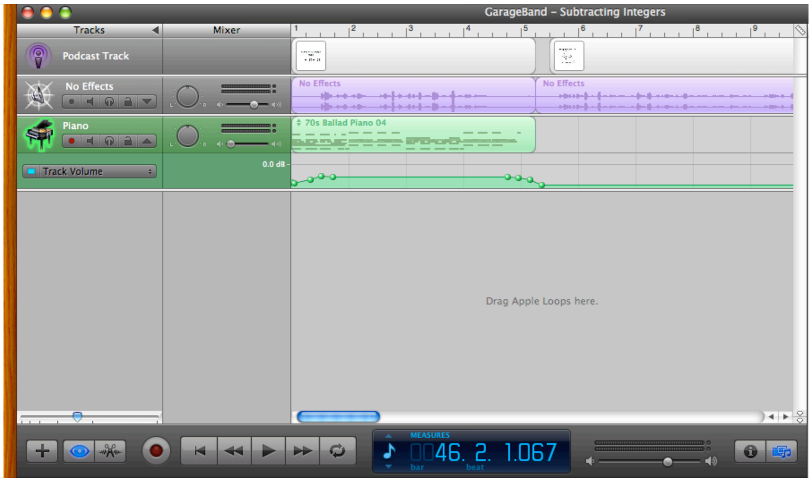


Figure 7: Student project created in GarageBand.

iChat

Students used the program iChat to quickly share files *with* each other. I spent two lessons teaching students about iChat's many features. Students learned how to videoconference and share files and photos via iChat. iChat has many collaborative benefits, and my students used it in every content area. In iChat, students can transfer files by dragging the file over the recipient's name and hitting send. In iChat, students can also talk with each other through text, or through video. Figure 8 shows a screen shot of the iChat software. The Bonjour List includes all students logged on within the school's closed server system. iChat was limited to students logged into the school's server. No access outside the school server was permitted.

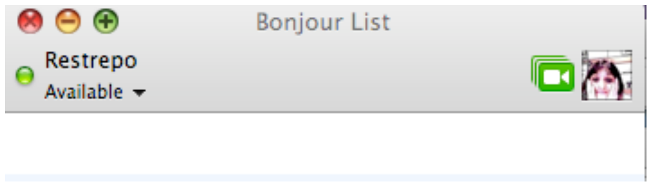


Figure 8: Screen shot of iChat software.

Excel

Teaching students how to create Excel spreadsheets was one of the last *lessons* before beginning the units. Students struggled with Excel because they were unfamiliar with how to navigate and insert data within cells, rows, and columns. Students gradually became more successful with practice. Students used Excel to create spreadsheets and graphs that quantitatively documented their progress. The graphs were very motivating for students to create and see. Students used the graphs along with their goal forms to monitor their progress. Figure 9 shows a single student's Excel spreadsheet.

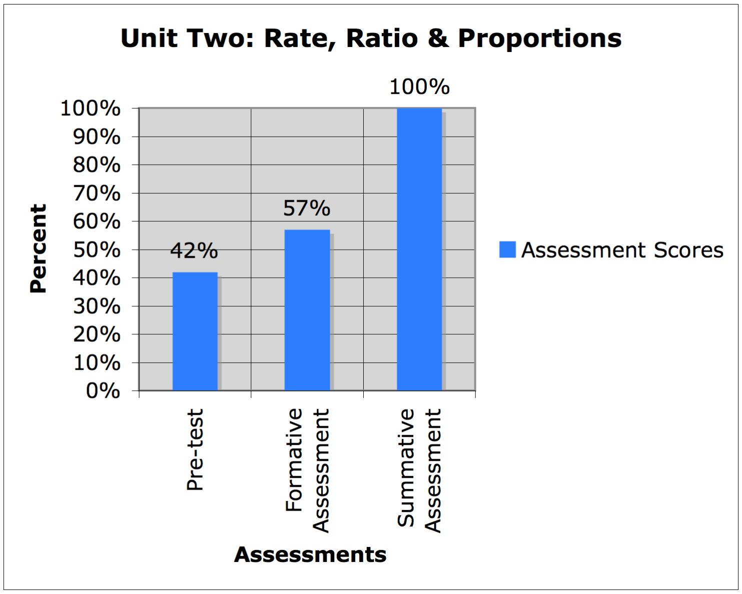


Figure 9: One student's progress monitoring chart for Unit Two.

Implementation of the ML & SEI

I designed the ML & SEI curriculum to last eight weeks. I chose three units to cover during the eight-week period. Unit One lasted two weeks, and Unit Two and Unit Three lasted three weeks each.

The day before I began Unit One, I gave the pre-assessment and the initial self-efficacy survey on integers. Day one began with my explanation to students on how the ML & SEI was going to look in the classroom. I discussed my goals and explained the rationale for the surveys, reflections, and ongoing progress monitoring.

I talked to students about the A+LS software and how it would serve as a tool to reinforce previously learned skills. I discussed the purpose of videotaping, and creating podcasts. I shared videotapes of the previous students, so students could visualize the process. I talked with students about the learning benefits of watching peers work through problems. I discussed the key benefits of peer comparisons. Peer comparison allowed students to identify the strategies available to assist in problem solving. I spoke about the value of the reflection piece and how reflections played a key role in thinking about learning and metacognition.

Unit One: Number Sense 2.3, Positive and Negative Integers

Unit One covers Number Sense (NS) 2.3, which requires students to solve addition, subtraction, multiplication, and division problems, including those arising in concrete situations that use positive and negative integers and combinations of these operations. Day one of Unit One included reviewing pre-assessment results with students and having them graph the results manually. Students then completed the goal setting form based on their assessment results. As a group, we set a target date for reaching our learning goals.

Lessons began on day two. From the pretest results I noticed that several students did not know how to construct a number line in order to plot numbers, so as part of the first lesson students created a their own number line on a long strip of tag board. The number line assisted students in visualizing positive and negative integers as relate to a number line. The concrete number line served as a scaffold for several students who had trouble visualizing positive and negative integers and how they appear on a number line.

Days two, three and four of week one continued with a variety of lessons that focused on adding and subtracting positive and negative integers. One lesson included using colored red and white poker chips to represent positive and negative integers. White poker chips represented positive integers and red poker chips represented negative integers. A positive and negative chip together represented a zero sum. Students used the chip model to help them gain a greater understanding into adding and subtracting positive and negative integers. The lesson focused on creating the perfect temperature for a cooking pot by adding and subtracting (hot) positive or (cold) negative chips. Students started by drawing a large image of a cauldron. I then instructed students to add ten positive chips, and ten negative chips to their cooking pot. The purpose of having ten positive integers and ten negative integers is for students to see that the cooking pot can have an unlimited amount of zero sums in which to add or subtract. Figure 10 shows a sample of cooking pot with using positive and negative chips to show a zero sum.

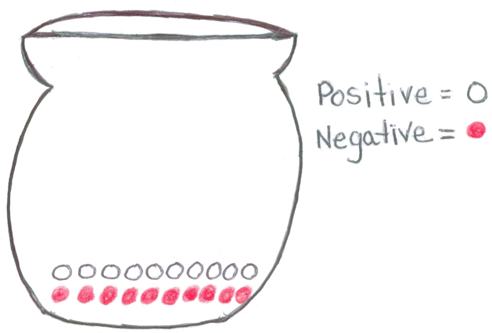


Figure 10: Positive and Negative Integer Lesson

The original story called *The Chef's Hot and Cold Cubes* can be found in the book *Interactive Mathematics Program: Integrated High School Mathematics: Year 1* (2003). I used the general introduction to the story and then created my own math problems using addition and subtraction of positive and negative integers. The introduction to *The Chef's Hot and Cold Cubes* begins like this:

> In a far-off place, there was once a team of amazing chefs who cooked up the most marvelous food ever imagined. They prepared meals over a huge cauldron, and their work was very delicate and complex. During the cooking process, they frequently had to change the temperature of the cauldron in order to bring out the flavors and cook the food to perfection. They adjusted the temperature of the cooking by either adding special hot cubes or cold cubes to the cauldron or by removing some of the hot or cold cubes that were already in the cauldron. The cold cubes were similar to ice cubes except they did not melt, and the hot cubes were similar to charcoal briquettes, except they did not lose their heat. If the number of cold cubes in the cauldron was the same as the number of hot cubes, the temperature of the cauldron was 0º on their temperature scale. For each hot cube that was put into

> the cauldron, the temperature went up one degree, and each cold cube removed the temperature went down one degree (Fendel, Resek, Apler, & Fraser, 2003).

I told students to pretend that they *were* the chefs in the story as they manipulate*d* the temperature of the cauldron by adding, or subtracting positive (hot) chips, and negative (cold) chips. The biggest struggle arose when students had to subtract larger numbers. For example, I said, "Show with your chips the temperature of the cauldron when the chef adds 8 positive cubes, and removes 12 negative chips." The confusion of removing 12 negative chips surfaced because students had a hard time visualizing the unlimited *number* of zero*s* in the cooking pot, which they could use as needed. A zero sum is the combination of one positive chip and one negative chip, and originally they only had ten sets of zero. To remedy the confusion, I had students remove all the chips from their cauldron and begin again. This time I told students to add 15 zero sums to their cauldron. The main criteria for adding more positive and negative chips were that *the* pot's balance had to equal zero before beginning, yet students had enough zero totals to extract negative numbers. I began again and repeated the problem. "Show with your chips the temperature of the cauldron when the chef adds 8 positive cubes, and then removes 12 negative chips." Students were successful with the problem and I asked them, "Why were you able to do the problem this time, but were confused when I initially stated the problem?" *Irwin* said, "We had more zeroes this time, so it was easy to remover 12 negative chips." I responded by saying, "What would you need to do if the next problem said that the chefs needed to subtract 20 positive cubes?" *Joanna* commented and said, "We can just add more groups of zeroes, and then we'll have enough to take out." I then had the students work in pairs and they each took turns solving an integer problem using the chips and the cauldron. Student had to verbalize their thinking process and they went through the problem. The next day I gave students a worksheet on adding and subtracting integers, and they had to draw the solution by illustrating the cauldron and the colored chips. Students had the option to work with a partner or on their own. Everyone chose to work with a partner. Figure 11 shows one student's work using illustrations to show subtracting integers. The student's work demonstrates some confusion about using the chip model to confirm results from subtracting integers. In the fifth problem, the student drew three white positive chips and six white positive chips to solve the problem 3 – 6. When the student realized that she needed to subtract six negative chips, she drew six pairs of zero, so she could remove the six negative chips. The student wrote the algorithm on the side, 3 + (-6) = -3, which tells me that the student understands how to solve the problem using the algorithm, but struggled to create an illustration to match the algorithm. The correct illustration should have been to draw three white positive chips, and six red negative chips because the original problem 3 – 6 converts to an addition problem, 3 + (-6). When all the chips were drawn, the student should have crossed out three pairs of zero, three white chips and three red chips. The remaining chips in the pot would have been three red negative chips and illustration would match the algorithm, 3 - 6 = -3.

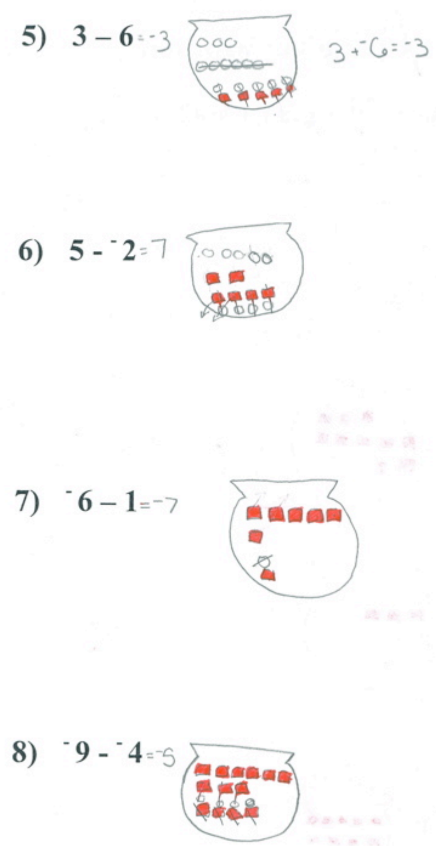


Figure 11: Student's work illustrating subtracting integers.

The numbers within the integer unit became increasingly larger and using the colored chip model was not always the most efficient for students. I found that students had a hard time understanding that the answer to an integer problem will have the same sign as the number with the largest absolute value. For example, students could not initially grasp that the answer to 38 + (-49) would be a negative number. In the problem 38 + (-49) the largest absolute value of both numbers is 49 and since 49 is negative the answer is negative. I used a balance scale with colored chips to help students “see” the relationship of the final answer when positive and negative integers are combined. I put in 38 positive white chips on one side of the balance scale, and 49 negative red chips on the other side of the scale. The side of the balance scale with the larger number of chips fell downward while the other side went up. I asked students what conclusion could they make about the answer to the problem based on the results from the scale. Ryan said, “The part that went down, has the most amount of chips.” *Karen* came up to the balance scale and looked at the colored chips. *Karen* then added, “That means the answer is negative because the red chips have more than the white chips.” Ryan then said, “That makes sense because 49 is more than 38.” I reminded them of the absolute value rule when subtracting integers, and told them they could always visualize the numbers on a balance scale and think about which side will go down.

Students needed a variety of scaffolding tools to help them grasp adding and subtracting multiple positive and negative integers. Students struggled when solving a problem containing multiple integers such as (-135) + 78 + (-42) + 31. *An additional* scaffolding tool many of the students chose to use included highlighting all the positive numbers in one color, and highlighting all the negative colors in another color. Students then added the total numbers for each color and calculated the final answer when they simplified the problem down to only two numbers, one positive, and one negative. I noticed that students began checking answers with their peers to confirm the accuracy of their calculations.

Throughout the week, I made informal assessments based on student work. Each day I looked at student work and made a list of skills and student misconceptions that I needed to target in my instruction. My list included items such as: confusion when subtracting integers, confusion when adding multiple positive and negative numbers, confusion with addition and subtraction rules versus multiplication and division rules. On the last day of Week 1, students took a formative assessment and both the students and I immediately reviewed the results. Students graphed the results of the formative assessment next to their pre-assessment graph. Three boys got very excited about their score*s*. One of the three boys shouted out, "I got one of the highest scores in the class, 96%!" The other two boys noticed that they were also in the top ranking. I congratulated the boys, but then I said to the class, "Let's see who made the greatest growth between the pretest and posttest?" I explained to the class what I meant by greatest amount of growth and we discussed how to use the pre and post test scores to determine individual growth. One student noticed that one of the boys with the highest percentage of 96% had a pre-test with a score of 80%. He said, " Hey look, *Devon* got 80% on the pre-test, and only 96% on the post-test. He was already smart, no fair." I said, "Let's look at the kids who scored low at the beginning, and see where they are now?" I took this opportunity to create an Excel spreadsheet for the entire class and individual student*s* called out their scores as I typed them in for all to see. While I was entering pre and post test scores students began figuring out their individual percent of growth. The class discovered that *Martin* made the greatest growth with a pre-test score of 28% and a final score of 93%. The class spontaneous*ly* began to clap for *Martin*.

On the first day of Week 2 students reviewed their learning goals and made modifications based on the results of the formative assessment. The integer unit continued and the focus shifted to multiplying and dividing positive and negative integers. *The greatest confusion for students within the NS 2.3 standard (working with positive and negative integers) was remembering that the rules for multiplying and dividing integers were different from the rules for adding and subtracting.* In order to minimize confusion the students created a Venn diagram that highlighted the similarities and differences between addition and subtraction of integers and multiplying and dividing them. The Venn diagram was a key tool that helped them succeed. I continually made informal assessments throughout the week and kept a list of skills students still needed to learn in order to reach mastery. On Friday, at the end of Week 2, a final summative assessment was given and the students immediately graphed their results. All students reached mastery of NS 2.3 at 80% or higher, and so the unit on integers ended. However, before beginning Unit Two, I wanted to get some feedback from students about their experience, so I sat with them and we had informal class discussion. I asked them what they liked about the unit, what they disliked, and what they can say about their learning. Students said that they enjoyed graphing their test results, and getting daily feedback and guidance on how to improve. Students enjoyed working with positive and negative colored chips, but they did not like having so many different rules because it was hard to remember. Several students commented that they thought a unit on positive and negative integers would be easy, but it turned out more complicated then they thought. Students also commented that they liked working with partners, taking videos of their work, and using computers. The students said that they felt challenged, but they liked it because it was fun learning math in so many different ways.

Unit Two: Number Sense 1.2 and 1.3, Ratios, Rates and Proportions,

Unit Two *covered* standards Number Sense (NS) 1.2 and NS 1.3. NS 1.2 includes interpreting and using ratios in different contexts (e.g., batting averages, miles per hour) to show the relative sizes of two quantities. NS 1.3 involves using proportions to solve problems and finding the length of a side of a polygon similar to a known polygon and utilizing cross-multiplication as a method for solving such problems.

Unit Two began the following Monday and students took another pre-self-efficacy survey that covered the new topics and standards of the unit. The teaching standards in Unit Two were NS 1.2 and NS 1.3. NS standard 1.2 deals with ratios and rates, and NS standard 1.3 covers solving problems with proportions using cross multiplication. Students completed a pre-assessment the first day of Unit Two. The pre-assessment includes a variety of problems that represent all the standards within the unit. The second day of Unit Two students completed a new goal form and all students agreed on a new target date to reach mastery.

During Unit Two, I began teaching lessons on metacognition. I explained to students that metacognition involved thinking about *how they think* and how they learn. I mentioned to the students that I wanted them to understand how they can use their thinking to monitor their thoughts and enhance their learning. The first metacognitive lesson was an adapted version from Marten (2007) in which I asked students, "How do you decide what clothes to wear when going to a party?" I gave students large index cards to write down their answers. Similar to Marten (2007), I divided my whiteboard into two sections. On the left side of the whiteboard I wrote "metacognition" and on the right side I wrote, "no metacognition." I asked students to read their answers and as each student read their answers, the class and I decided if their decision involved metacognition, or not. Answers varied. Students placed their responses under the appropriate word. I asked students what they noticed about the type of answers under "metacognition" and those under "no metacognition." *Alexa* said, "The students who put their answers under "no metacognition" didn't think about what they wanted to wear. They just took what was available and didn't care." *Irwin* said, "Look at everything under the "metacognition" section. In that section students thought about the last time they went to a party, they thought about the weather, they thought about the kind of party and should they dress up fancy, or not. The girls even thought about matching colors, and bringing a sweater for later in the day. Wow, I never realized how much thinking is involved in the things we do." Students became more aware of their thinking because of this lesson.

I wanted to increase *students' thinking* about learning, so I posed more reflective type questions on the classroom blog (see Appendix). I told students that the blog questions would now focus on questions about their learning and thinking processes. I also asked reflection questions about how they approached difficult problems. Figure 12 shows a sample of daily math reflections from the classroom blog page, and Figure 13 reveals one student's response.

MONDAY, FEBRUARY 25, 2008

Math Reflection

1. What did you learn in Math today?
2. Did you pay attention the best that you could?
3. What was difficult for you in Math today?
4. What was easy in Math today?
5. Is there anything you still find confusing?
6. What could you do to help you understand better?

posted by C.Restrepo @ 9:13 AM 7 comments

Figure 12: Metacognition reflection questions from classroom blog page.

1. I learned about cross multiplying with is,of and percentages. 2. Did you pay attention in class,yes I did,but I didn't know how to do the assignment.3 .My difficulty was cross multiplying.4.what was easy in math was changing a problem to a percent.5. Changing a decimal to a percent is still confusing to me.6. What could I do to understand better is to ask for one-on-one help.

11:58 AM

Figure 13: Student's reflection response.

Through several blog responses and student observation, I noticed that students often asked for teacher assistance when they were struggling, but rarely sought out strategies that they could use independently. I also noticed that several students just sat there and waited until I was available without attempting to seek out strategies they could use on their own. I wanted students to feel confident in using scaffolding strategies on their own, and perhaps they needed direct instruction on the types of strategies available to them. Based on my observations of student behavior, I decided to do another metacognitive lesson. I told students that one part of metacognitive awareness is being able to regulate your learning and not always wait for the teacher to help you. The class and I decided to brainstorm a list of metacognitive strategies that the students could use on their own.

The list includes ideas such as:

- Look in your math notebook for an example.
- Look in the textbook for an example.
- Ask a neighbor, or ask your group members.
- Review *textbook's* video lesson*s*.
- Ask the teacher.
- Use the online textbook for review videos and lessons.
- Go to A+LS software and review the lesson.
- Review podcasts for step-by-step instructions.
- Ask a strategy expert
- Goggle the instructions for a math procedure. Example: "How to create percents from decimals."

Students used the above list to guide them to access additional support whenever they struggled. The list is a non-sequential list, and students chose any scaffolding method that seemed the most appropriate in the moment. Students were given a printed list to put in their math notebook, and I made a large poster of the list for quick reference.

In Unit Two, I introduced ratios to the students by putting piles of classroom objects along the back counter of the classroom. Classroom objects included 15 boxes of colored pencils, 12 erasers, 25 protractors, 16 notebooks, 21 stopwatches, and 14 graduated cylinders. I labeled each pile with the total amounts. Students used whiteboard to record their answers to my ratio questions. The class and I gathered around the objects and I gave them an introductory lesson on ratios. I then had the students practice writing out ratios of the objects on the counter, as I called out a ratio problem. I said, " What is the ratio of colored pencils to erasers?" Students were required to write 15:12 and then reduce it down to 5:4. I continued this process of calling out ratio problems until all students began mastering the concept. As I noticed student success, one by one I dismissed students to the computer to practice *online* ratio games I posted on the classroom webpage.

Formative assessments showed that students quickly mastered the concepts of ratios. Several advance*d* students created podcasts showing how ratios are comparisons between objects. One student used the digital camera and took pictures of a group of students wearing hooded jackets, and another group of student dressed in pink. The podcast showed how students wearing hooded jackets are compared to students wearing pink, or how students wearing pink are compared to the group as a whole. The podcast was extremely motivating for students to create because they felt confident in explaining the concept, and all their friends were in the photos.

The following week I introduced rates and proportions. My informal assessments indicated that students were struggling with rate problems and proportions. My informal assessments included notes and observations I made about student learning during each class lesson. I noticed that students were able to set up rate problems as proportion with scaffolding, but they struggled when it came to cross-multiplication. I had students use different colored highlighters on the problems to help them know which numbers to cross-multiply. Highlighting helped students identify the numbers they needed to multiply.

Students continued writing reflections on their learning during the second week. Based on students' responses, students made progress on their awareness of their learning. Figure 14 shows a blog reflection questions and Figure 15 reveals a single student's response. At the end of week two, I gave a summative assessment on rates and proportions to the students and the results made it apparent that students were not ready to move on to a new unit. Mastery level on rates and proportions only reached about 71%, so I added an additional week to Unit Two.

Math Reflection

1. What did you learn in Math today?
2. What was difficult, or confusing for you today?
3. Did you use any resources when you needed help, ask the teacher, a friend, look in your math notebook? Why, or why not?
4. What could you do that would help you do better tomorrow in Math?
5. Did you pay attention in class today and do your best to learn?

Figure 14: Blog reflection question.

anonymous said...

1. I learned about rates.

2. The division part is hard, and sometimes i don't really get how to set up the problems, but sometimes I do.

3. I used my math notebook with the examples, and my neighbor helped me.

4.Working with a partner works good for me. it helps me think about what I need to do.

5. yes, i paid attention. i tried really hard to understand how to do rates.

Figure15: Student's blog reflection.

During the third week of Unit Two, the students and I went back to their original goal sheet and made some modifications. Students selected two goals to focus on during the week: setting up rate problems accurately as proportions, and using cross-multiplication successfully to find the value of a missing term. I looked at the overall progress and mastery levels of the students and I noticed that some students mastered certain skills while others did not. I made an expert chart and listed the names of the students who had mastered the first goal, setting up proportions, and a list of students who mastered the second goals, successful use of cross-multiplication. I told the class that this list serves as peer tutoring guide. Students who struggled with one of the goals could look at the expert list, find a student who has mastered that goal, and ask them for one-on-one help.

As students continued to work with rates and proportions, I videotaped students solving rate and proportions problems. *Karen* volunteered to set up and solve a proportion problem as we videotaped her attempt. She successfully set up the proportion, and then stood there quietly and appeared stumped. Ryan raised his hand and asked *Karen* if she wanted help? Ryan said, "You have to cross-multiply next, use yellow and orange highlighters and create an "x" across the proportion. Start with the yellow highlighter and make a line so the top number on the left connects with the bottom number on the right. Use the other color highlighter and do the same thing on the other side. Multiply both yellow numbers, and then multiply both orange numbers." *Karen* successfully crossed multiplied the solved for the missing value. After *Karen*'s taped session, the class and I reviewed the video to clarify understanding, and help students make comparisons on how peers solved problems when they are struggling. The use of videos rapidly increased the learning for students by allowing them to see how other students overcame their struggles. The video of *Karen* and Ryan was an excellent scaffolding demonstration on cross-multiplication. I put the video on the classroom computers, so students could reference it as need. Students continued to work with peers on rates and proportions and by the end of the third week the summative assessment revealed that all students reached mastery of 85% or higher. I ended Unit Two after three weeks *because all students reached mastery.*

Unit Three – Number Sense 1.4, Fractions, Percents and Decimals

Unit Three began the following Monday. Unit Three topics covered California Number Sense (NS) standard 1.4. NS 1.4 includes converting fractions to decimals and percents. Number Sense 1.4 also includes calculating percentages of discounts at sales, interest earned, and tips. Students took a new pre self-efficacy survey and a pre-test on the Unit Three standards. The students and I reviewed the results of the pre-test and all students completed an individual Excel graph and goal setting form based on pre-assessment results and the goals of the unit. Mastery target date was set for March 14.

As the time progressed, I noticed *that* students lost interest in the A+ LS software. I observed a lack of enthusiasm and sincere efforts for success. *Specifically* I used remote desktop to secretly watch the students' screens as they worked and I noticed that during the practice session students randomly typed in nonsense answers. I watched *Martin* type in the numbers "3489898" to answer rate questions. I saw two other students go through the guided lessons at record speeds. I set a minimum five minutes that students need to stay in the lesson portion. *I*f a student spend*s* less than five minutes the A+LS software will not let them progress to the next section. A*s* I watched the students, I noticed that neither of the two students took the time to read the lesson and review the material. Students tried to access the test portion as quickly as possible without regard for the review and practice lessons. I determined this through my observational field notes, and the A+LS software data printouts. I decided to talk with the students individually, and so I called them up to my desk one by one. I showed students their screens shots, the type of answers they were inputting, and the speed in which they progressed through the lessons. Students indicated the program was boring, and it was hard to understand the lessons. "Its just work, there is no fun in it," one student said. Students were not responding to the A+LS software as I had hoped, so I ventured out and searched online for new methods that motivated students to learn. I decided to use the online program Quia to solicit competition among students. Quia is a site that provides teachers with templates to create and post games, flashcards, quizzes, and other activities that target key standards. I found a jeopardy game on converting fractions, decimals, and percents. I paired students into teams to compete against each other in a game of math jeopardy. Figure 16 shows an example of the Quia Jeopardy game.

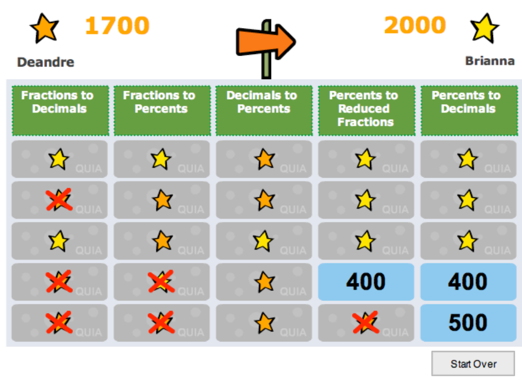


Figure 16: Quia Jeopardy game.

I began watching students, and I still noticed that some students were typing in answers without attempting to solve the problem on paper. Many of the problems were two-step problems and it was rare that any of these students could successfully solve a two-step problem mentally. I needed to create another motivating factor for students to learn. The next day I decided to offer a piece of candy to the winner from each pair. I also qualified that the winner must have over 2500 points to be eligible for the candy prize. Now I began to see the efforts I was looking for. I noticed something interesting with a team of two girls. They were beginning to help each other. I noticed the girls began taking turns, and as one of the girls began to struggle with solving her problem, the next girl jumped in to help. I went over to them and watched for a short period of time. At one point, both girls were stumped and so I decided to jump *in* and help. I ended up telling the girls that I would give them each a piece of candy if they both reached 1500 points. The girls worked together and both were eligible for the candy prize at the end of the period.

The observation I made between the lack of enthusiasm for the A+LS software and the heightened enthusiasm for the jeopardy game prompted me to ask some questions. I asked students which program they preferred, A+LS, or Quia. Students said that they disliked the A+LS software because it was boring and there was no immediate reward to do well. Students thought the A+LS program was hard, and it lacked interaction. *Martin* said, " It's like doing a boring worksheet. You see a problem and have to work it out. When I keep getting a problem wrong, I want to give up because it is too hard. The lesson doesn't help me and its boring working all by myself." On the other hand, students liked the two-player Quia games because *they* could work with a partner and help each other. Students also liked trying to get high scores in order to win the game. Interaction was a critical piece to motivation.

I noticed that students were struggling the last week of the unit *because* of the extensive multiple step procedures in many of the problems. Students had to master finding tax, discounts, and tips, and then step two of each problem involved finding the total price with tax, new sale price with the discount, and total cost of a services plus tips. Students were able to solve multi-step problems with scaffolding, but they were struggling on their own. The semester ended in a week and my students would no longer be with me, so I decided to narrow the learning goals to four key skills:

- Skill one: Changing fractions to percents.
- Skill two: Changing percents to decimals.
- Skill three: Finding discount amounts.
- Skill four: Finding tax and tips.

Student*s seemed to be* more relaxed when I reduced the number of skills because they felt that current curriculum was extremely challenging and they were getting confused and frustrated. I videotaped students solving problems with percents and decimals, so students could see how their peers processed knowledge and worked through problems when they were struggling. A good example occurred when *Joanna* explained how to change a percent into a decimal. *Joanna* said, “ Percents are out of 100, so if you have 2% you have to multiply it by 100.” Students begin to raise their hands. *Martin* said, “ If you multiply 2 by 100 then you get 200, that’s not a decimal.” *Joanna* looked confused, so she said, “ If you have 2% and want to make it into a decimal you write .20.” Another student raised his hand. *Devon* said, “Doesn’t 0.20 mean 20%?” *Joanna* was even more confused than ever. She said, “Oh yeah that’s right, now I really don’t get it.” The process of students watching *Joanna* struggle eased the stress of *others* who were also struggling. I asked the class, "OK, let's help *Joanna*, can anyone explain how to change 2% into a decimal. *Irwin* volunteered to come up. He said, "Since a percent is out of 100% and you have 2% then you can write it as a fraction 2/100. Once you have a fraction, you divide the numerator by the denominator. Two divided by 100 is 0.02, or if you are good with place value you just know that 2/100 equals .02 (two-hundredths). The decimal for 2% is 0.02." Students began raising their hands and everyone wanted to solve a problem converting percents to decimals. Videotaping *Joanna* was highly motivating, and instructional.

The next day, I taught the third metacognition lesson. The lesson involved grouping students in pairs, so they c*ould* think aloud and solve the problems together (Whimbey & Lockhead 1986; Gourney, 1998).

I told them that the purpose of the lesson was to help them monitor their progress, and clarify their thinking. *In each pair, o*ne student served as the "problem solver" and the second student was the "listener." The problem solver was required to read the problem, and think aloud from beginning to end explaining every action along the way. The listener's job was to monitor thinking, ask questions, and make sure every step of the problem was verbalized. The two roles switched when the problem was complete. Throughout the week, students began to master the required skills and I once again I created an "expert" list of students. Students knew the expert list was a resource for them to seek one-on-one help.

Unit Three lasted three weeks, and ended with a final self-efficacy survey a final summative assessment. The Unit Three summative assessment showed 60% of the students reached mastery level. The trimester had ended and the students were moving on to a different class the following Monday. Ideally, Unit Three should have continued another week because several students were not ready to move on.

March 14th was the last day of the unit and of the trimester. The students in my intervention math class were headed off to a new class the following Monday, so I decided to have a discussion with the students to get *their* feedback about the class, their final assessment results, and their feeling about moving on to a new class on Monday. Students said they enjoyed the structure of the class because they were successful in learning. Students commented that they appreciated being able to share their opinions about what was working and what was not working and they liked that I listened to them and made changes based on their feedback. *Karen* and *Alexa* mentioned that for the first time they liked math. Ryan said, "I liked that there were so many different ways to learn. It wasn't boring all the time. We got to play games, we got to draw about math, we made videos, and helped each other whenever we wanted." *Nadine* said, "I liked being an expert. I finally felt good at math."

VII. Evaluation and Assessment of the ML & SEI Curriculum

I designed the Mastery Learning and Self-efficacy Intervention Curriculum to accomplish three goals. Goal One aimed at increasing students' math self-efficacy through a series of self-efficacy intervention strategies. Goal Two focused on increasing students' academic performance in mathematics by using a systematic mastery learning approach for students to reach mastery in a variety of skill areas. Goal Three targeted developing and strengthening students' metacognitive skills through a series of metacognitive lessons. I utilized a variety of evaluation and data collection methods to analyze the effectiveness and success of each goal. I used pre and post self-efficacy surveys to evaluate students' perceived self-efficacy based on Bandura (2006) model for creating self-efficacy surveys. In order to evaluate academic growth in mathematics I used a combination of pre-tests, ongoing formative and summative assessments, video analysis of student work, and progress monitoring graphs. I measured increased metacognitive awareness through blog reflections, student selected scaffolding strategies, and successful application of selected scaffolding strategies. Table 2 summarizes the evaluation methods used for each goal.

Table 2: A summary of evaluation methods.

Evaluation and Data Collection Methods	Goal One	Goal Two	Goal Three
Pre and post self-efficacy surveys.	✔		
Pre-tests, ongoing formative and summative assessments.		✔	
Student work and comprehension analysis via video recordings, blog post, and podcasts.		✔	
Metacognition reflections rubric			✔

Goal One: Increase Students' Mathematical Self-Efficacy

To evaluate if students increased their perceived self-efficacy in mathematics I used a pre and post self-efficacy survey adapted from Bandura's (2006) guide for constructing self-efficacy scales. Bandura's (2006) guidelines gave me the ability to design questions specifically tailored to the math skills the students needed to learn. Self-efficacy surveys were designed for each of the three units: Unit One: Positive and Negative Integers, Unit Two: Ratios, Rates and Percents, and Unit Three: Fractions, Percents, and Decimals.

Finding One: Students Increased Mathematical Self-Efficacy

The results from the pre and post self-efficacy survey revealed that students increased their self-efficacy beliefs in mathematics for all three units. Figure 17 outlines the pre and post surveys results for all math units. The results shown are both a combined average for each individual question resulting in a total average for the entire pre self-efficacy survey and a total average for the post self efficacy survey.

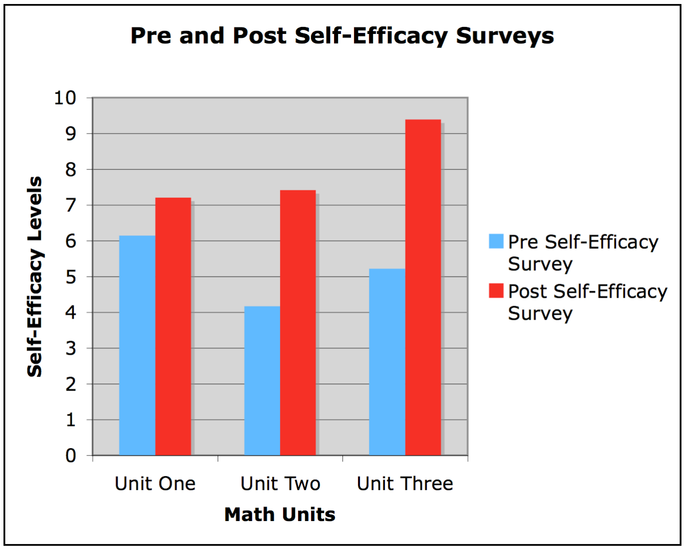


Figure 17: Self-efficacy survey results.

Discussion. Although the average results for the pre and post self-efficacy surveys increased for all three units, there were two instances when students decreased their perceived self-efficacy for specific skills. In Unit One, three of the ten students indicated on the pre self-efficacy survey that they had strong self-efficacy belief for putting positive and negative integers in order from least to greatest. However, on the post survey, the same three students indicated a low self-efficacy for ordering positive and negative integers. Students' post self-efficacy survey results on ordering numbers went down three to six points on a ten-point scale. I showed each of the three students their pre and post self-efficacy results and asked them why they felt that their self-efficacy scores went down. All three students in one manner or another stated that they thought they understood positive and negative integers, but as they began working with multiple negative numbers they became very confused. All three students stated that they did not realize how hard integers would be until they started getting feedback from their scores. One student said, "It's hard for me to remember that a negative nine is smaller than a negative five. I thought I knew that nine was bigger, but than you add the negative and I get confused."

Students' post self-efficacy survey results on Unit One also went down on average by a single point for question nine. Question nine states: How confident are you in using order of operations to solve this problem? 7(-2) + (-8) x 4. I asked students why they felt less confident about order of operations at the end of the unit than at the beginning and the answers were similar to the previous reason. Students did not realize the difficulty in applying order of operations. One student said, " I looked at the numbers and thought it was easy. I did not realize how tricky it could be to get the right answer if you mess up on the order." Another student commented, " It doesn't make sense to me. I get confused with all the parenthesis, and negative numbers. Sometimes I don't even realize I that I went out of order."

Unit One showed a drop in perceived self-efficacy for questions one and nine, ordering positive and negative integers and using order of operations to correctly solve problems. One possible rationale for the decrease in perceived self-efficacy perhaps came from prior success. Students receive integer instruction in the 5^{th} grade, but not at the intensity of 6^{th} grade standards. In the 6^{th} grade students must add, subtract, divide, and multiply positive and negative integers in a single extended problem. If students performed well in 5^{th} grade then their previous success could have influenced they self-efficacy belief. However, with the increased difficulty at the 6^{th} grade level, and the confirmation of errors confirmed by feedback, previous self-efficacy beliefs were not sustainable at the 6th grade level

Goal Two: Increase Academic Achievement in Mathematics

Goal Two aimed to increase students' academic performance in mathematics by using a systematic mastery learning approach. I evaluated students' academic achievement using pre-tests, formative and summative assessments, video recordings of student solving problems, blog responses, and student generated progress-monitoring graphs.

Finding One: Students Increased Academic Achievement in Mathematics.

The results from the pre-test, formative assessments and post-test verify that students increased their academic performance in all three units. Figure 18 compares the pre-test, formative assessment and final post-test assessments for Unit One. In

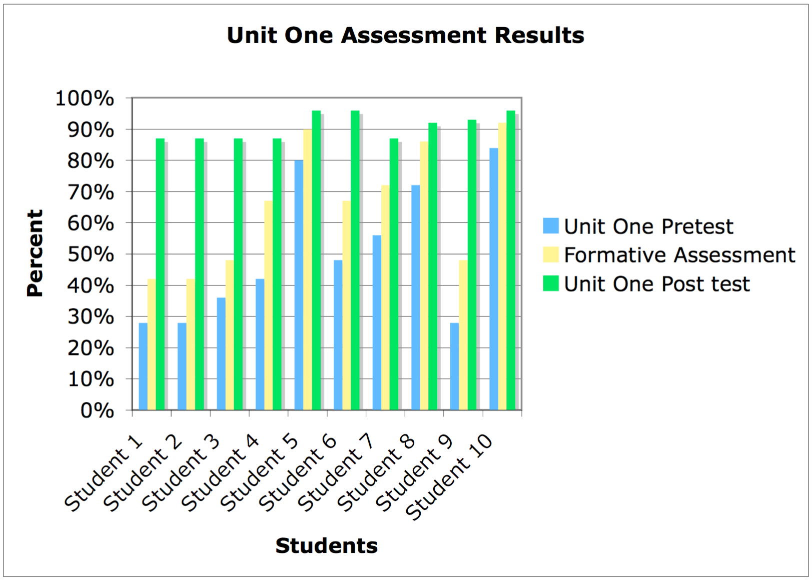


Figure 18: Unit One assessment results

addition to unit assessment results, I assessed comprehension and mastery through video analysis and blog posts. Figure 19 is a sample blog question I used to check for student understanding. Figure 20 is one student's response.

Students,

In this week's post you have two tasks.

1.The first task is to answer the questions below in a complete sentence.
2.The second task is to define the word ratio and give an example.

Question: In a survey of 100 dentists, 75 of the dentists prefer Toothpaste A to Toothpaste B. Find the ratio of the number of dentists who prefer toothpaste A to the total number of dentists surveyed.

Figure 19: Blog question to check for understanding.

k.r said...

1. The answer is 75 to 100.

2. A ratio is a comparison of two numbers or quantities.

There are 8 kids in a class the ratio from girls to boys is 3 to 5.

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Figure 20: Student blog response.

Karen answered the ratio question and definition correctly, but from her personal example, I was not convinced she fully understood ratios. In order to gain insight into *Karen*'s understanding I videotaped *Karen* solving ratio problems, and asked her to read several ratio problems and express several variations of ratios. *Karen* had an

85% accuracy rate in her videotaped responses, and so she demonstrated mastery for understanding simple ratio comparisons.

Podcasting provided another form of mastery assessment. As mentioned in Chapter VI, several students demonstrated mastery through podcasts. One student used the digital camera and took pictures of a group of students wearing hooded jackets, and another group of student*s* dressed in pink. The podcast showed how the ratio of students wearing hooded jackets compared to the ratio of students wearing pink, and how the ratio of students wearing pink compared to the ratio of the entire group. Podcasting served and as additional data source to document mastery.

Unit Two covered standards on ratios, rates, and proportions. Within the ratio, rates, and proportions standards, students had to master an array of concepts such as batting averages, miles per hour, cost per unit, and use the appropriate notations of ratios (a/b, a to b, a: b). Mastery of the ratio and proportion standards included solving proportions and the use of cross multiplication as *a* method for solving such proportions. In addition to cross multiplication, students had master finding the length of an unknown side of a polygon based on a similar polygon.

I noticed that the number of skills that students needed to master increased the difficulty of the unit, which affected the length of time to complete the entire unit. Unit Two had a *higher* number of skills within each of the standards, and therefore students had a slower progress rate than the previous unit on integers. The formative assessment results from Unit Two after the second week of instruction confirmed that only one student reached mastery, so therefore I extended Unit Two an additional week (Figure 21).

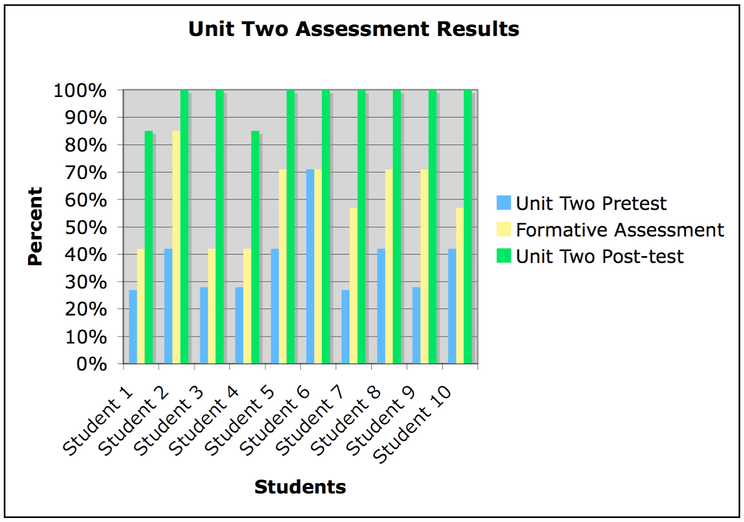

Figure 21: Unit Two *a*ssessment *r*esults.

Video analysis also served to document student mastery. In Chapter VI, I discussed the example of Ryan assisting *Karen* with cross multiplication. From the example Ryan was successful is scaffolding a highlighting technique to aid *Karen* in solving a proportion problem using cross-multiplication. In the example of Ryan and *Karen*, I was able to use a checklist to track Ryan's mastery in cross-multiplication. A simple checklist tracked students as they mastered each standard (*s*ee Appendix).

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Unit Three covered standards dealing with fractions, decimals, and percents. From the results in Figure 22 it is clear that not all students reached mastery at 85% or higher. Similar to Unit Two, the results indicated that students needed additional time to master the concepts.

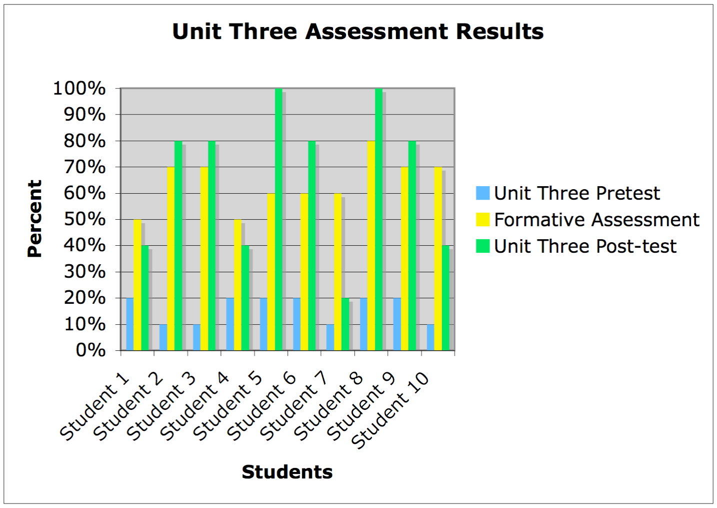

Figure 22: Unit Three assessment results.

Discussion. Unit One had the greatest success in the shortest amount of time. All students were able to reach mastery in two weeks, and the majority of the students had enrichment opportunities.

The concepts in Unit Two, ratios and proportions, were difficult concepts for students to master and the unit required three weeks of instruction. Although the majority of the students reached a mastery level of 85% or greater, students were unable to explain the reasoning behind their method for solving a problem, or justify the reasonableness of their answers.

Unit Three covered standards dealing with fractions, decimals, and percents. From the results in Figure 22 it is clear that not all students reached mastery at 85% or higher by the end of the project, which indicated that students needed additional time to master the concepts. Unit Three ended the last day of the trimester and perhaps students knew that they were no longer required to remain in the intervention course, and so their efforts greatly diminished. Reports cards were also coming out that day, and several students knew the final assessment score would not affect their grade. Since several students made a drastic decline in their performance ability from the formative assessment to the final post assessment, I tend to believe that their final efforts did not reflect their true abilities.

When I think about all the added instructional time students received, and the increased instruction in metacognition, I wonder why students only reached a superficial level of understanding. Students appeared stuck at a procedural level because they often failed to explain their rationale behind the problem solving approach they attempted. If students in this project spent an additional class period each day attempting to master a standard should they have reached a grade level understanding? Perhaps my project brought students to the beginning stages of mastery, and now they can attempt to gain deeper understanding. Was the lack of in-depth understanding *related to the fact that* all the students in the project were at least two years below grade level and their number sense understanding was poor at best? Is it plausible to say that because of their novice understanding about math, students were unable to recognize features, patterns and similarities, and their inability to recognize mathematical features hindered reaching a deeper understanding? Since students were at least two years below grade level, perhaps their previous knowledge of number sense was insufficient for them to reach a level of deep understanding in such a short time period.

Goal Three: Increase Metacognitive Awareness

The third goal focused on increasing students' metacognitive awareness. I created a rubric for analyzing metacognitive growth based a modified version of Jr. Metacognitive Awareness Inventory (Jr. MAI) (Sperling, Howard, Miller, & Murphy, 2002). I applied the rubric to students' blog responses to determine metacognitive growth over time.

Finding One: Increased Metacognitive Awareness

The results from students' metacognitive growth over the eight-week period reveal that students made modest growth in their metacognitive awareness. In order to analyze metacognitive awareness, I used modified questions (see Appendix) from the Jr. MAI to guide my analysis of students' metacognitive awareness (Sperling et al., 2002). Each of the 12 questions on the Jr. MAI (Sperling et al., 2002) were labeled with "conceptual affiliation" as either knowledge of cognition (K), or regulation of cognition (R). As I read through students' blog responses I used each question to decide if the metacognitive awareness item was present, or not. I used a three-point scale to measure the student responses according to each question. A score of one indicated that no mention of awareness was present in the response. A score of two indicated that moderate awareness was present, but lacked elaboration. A score of three indicated that the student's response included metacognitive awareness and elaborations, or examples were mentioned.

The results of the MAI rubric indicated that students had an increase in metacognitive awareness (Figure 23).

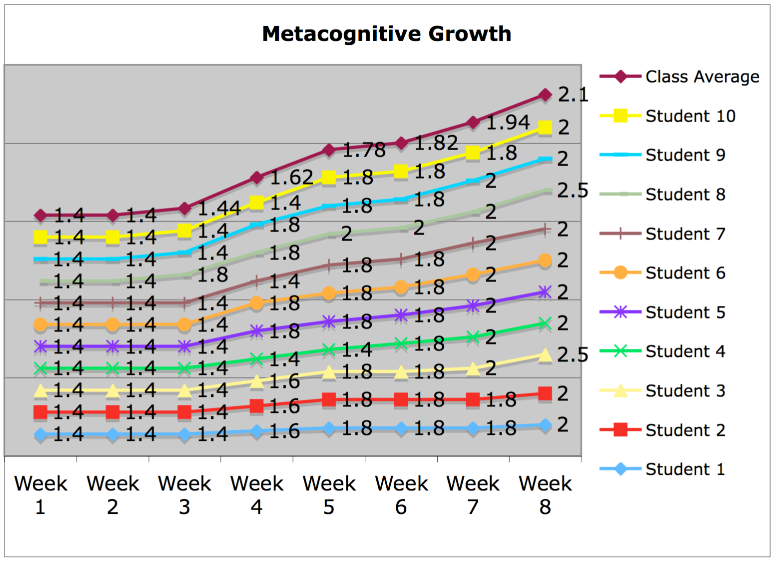

Figure 23: Metacognitive growth

Discussion. The slow progress of metacognitive awareness raised some questions about the needs of students several years below grade level. Students in the project had difficulties in explaining their procedures, projecting the reasonableness of their answers, selecting appropriate strategies to scaffold their own learning, and determining if the strategies they selected led them to their goal. In several blog reflections students described a procedure, yet failed to notice that the strategy was ineffective. Research demonstrates that novice students often select a strategy, execute it, and rarely pause to evaluate to its effectiveness (as cited in Gourney, 1998). Even students who had adequate knowledge to solve problems were unable to use their knowledge constructively. Novice learners are often misled by surface features that lead them to ineffective strategies, and never stop to ask themselves if their chosen strategy is leading them to their desired goal (Gourney, 1998).

Perhaps more work in pattern recognition and number sense would have been helpful for the group. I wonder if teaching them how to decide which strategy to employ would have been beneficial. My concern was that, with the minimal understanding and connections of number sense, *it may not be* realistic to expect students to understand both the reasonableness of their answers and the application of strategies. In the future, I think I would focus on the underlying skills that would develop a higher degree of number sense in addition to metacognitive instruction. Teachers are pressured to only teach the standards, but sometimes it does students a disservice if we do not take into account students' specific needs and gaps of knowledge.

VIII. Conclusion

Review of Mastery Learning and Self-Efficacy Intervention Curriculum

The Mastery Learning and Self-Efficacy Intervention Curriculum strived to meet the current demands of rising performance goals set by the No Child Left Behind Act. The Mastery Learning and Self-Efficacy Intervention Curriculum targeted low performing students in an attempt to improve their academic achievement and meet the increased demands of academic accountability. The ML & SEI curriculum focused on three specific goals, increasing students' perceived self-efficacy, enhancing academic performance in math, and improving students' metacognitive awareness. The ML & SEI curriculum incorporated a variety of technology resources including computer-based learning programs, interactive math games, video recordings of students peer teaching, and podcasts. The ML & SEI curriculum spanned an 8-week period in a 6th grade math classroom. The curriculum covered three distinct units and each unit lasted *two to three* weeks. Daily classroom instruction included goal setting, progress monitoring, computer based learning programs, peer tutoring, small group learning, individual instruction, enrichment activities, and metacognitive lessons.

Evaluation of the ML & SEI curriculum confirmed growth in all goal areas. The methods used for evaluating the project included pre and post self-efficacy surveys, formative and summative assessments, and reflection questions to monitor metacognitive growth. Students' perceived self –efficacy increased an average of 2.83

points on a ten-point scale. Students' academic growth ranged from 20% to 58%. The slowest overall growth was in students' metacognition. Metacognition growth evaluations were made on a three-point based on the Jr. Metacognitive Awareness Inventory (Sperling, 2002). Students' average metacognitive awareness scores jumped from 1.4 during week one to 2.1 for week eight. Students took two to six weeks to increase their metacognitive awareness. The highest score of metacognitive awareness reached 2.5 on a 3-point scale. Results from reflection questioners revealed metacognitive growth varied according students' understanding and mastery of the topic. Slightly higher performing students took less time to progress to higher metacognitive levels than the lower performing students did.

Implications and Questions

All students in the project performed below basic, or far below basic on the 2007 California State Test (CST). The CST test scores identify the students as low achieving students because they are all performing at least two grade levels below their peers. Based on students' performance levels, I would label the students participating in the project as novices in mathematics. According to Bransford et al. (2000), novices differ from experts in several ways. First, experts are able to discern distinctive features and identify meaningful patterns within problems. Experts' ability to arrange knowledge according to applicability demonstrates a deep and extensive understanding of the content. Flexibility in retrieving knowledge also distinguishes experts from novices. Based on the metacognitive growth during the project, I wonder if slower growth levels correlated in any way to the novice status of the students.

Only two out of ten students reached level five on the metacognitive scale. Students reach level five when they can apply selected scaffolding strategies and achieve success. *Successful application of strategies often* demonstrate *the difference between* novices *and* experts because experts categorize knowledge based on applicability I found that the *students in the study* knew of *many* strategies that could help them succeed, *but* they were unable to choose *and apply* the appropriate strategy *correctly.* Students must understand when, where, why, and how to apply their newly learned skills in solving novel problems (Bransford et al., 2000). I question *whether* my metacognitive growth expectation for the students in the project was unrealistic due to the limited amount of time and their beginning metacognitive levels and novice skills.

My second area of interest lies in students' perceived self-efficacy. I found on two separate occasions that students rated themselves as having a higher self-efficacy than *their* actual ability based on test results. However, on the post self-efficacy survey the students' scores went down in certain skill areas. When I pointed the discrepancy out to students and questioned them about my observations they said that they did not realize the difficulty involved in solving certain problems, and before discovering that fact they thought they were perfectly capable of solving certain types of problems. This observation perhaps suggests why the students in the project also had great difficulties deciding if strategies were appropriate. Many of the students could not correctly identify *whether* answers were reasonable and perhaps this is because they do not have enough number sense, or real life application experience to make such a judgment.

I learned that attempting to *help* low-achieving students *reach* grade level performance requires a multitude of strategies, and there is not a one size fits all approach. Students progress at varying rates. Learning new skills takes time, and it is not always linear. Students' attitudes and beliefs about learning and achievement also influence desired results.

As a teacher researcher, I learned that every attempt to improve students' ability to achieve, evaluate learning, and believe in their abilities is worth the effort. My results for all three goals were positive, but I hope to fine-tune several of my strategies and evaluation methods in order yield more declarative results. I plan to improve the strategies and data collection methods I used to increase students' metacognitive awareness. I think the Jr. MAI (Sperling et al., 2002) is a good tool for measuring students' metacognitive awareness. My plan is to use it in my classroom and have students keep track of their own metacognitive growth. The metacognition lessons were both motivating and insightful for students because it gave students greater insight into thinking about how people learn and it provided them with strategies to regulate their own learning. The greatest impact on students from the mastery learning approach came from tracking their individual academic achievement, and watching themselves on video. Videotaping was a valuable learning tool for learning. Videotaping assisted me in documenting mastery, and it helped students see themselves as active, self-regulating learners. Videotaping also served as a teaching tool to show how struggling students overcome obstacles and work through difficult problems. I plan to use videotaping in my classroom next year as part of my general curriculum. Success increases their self-efficacy, and a positive self-efficacy reinforces their desire to persevere. Perseverance breeds success and success breed*s* confidence. Teaching students how to be confident self-efficacious learners is *both rewarding for a teacher and* essential for *a student's* successful academic career.

Appendix

Table of Contents

Teacher Letter

Dear Fellow Educator,

I designed the Mastery Learning and Self-Efficacy Intervention Curriculum (ML&SEI) as an intensive intervention strategy to target low-achieving students in the area of mathematics. The overall curriculum design is applicable to most classroom formats. The strategies outlined in ML&SEI curriculum are ideal as a supplemental program for the regular classroom teacher, a curriculum for specialized intervention courses, or to use for homework clubs and individual tutoring. The mastery learning portion of the curriculum focuses on general strategies to assist students in achieving higher academic success. The mastery learning segment comprises many of the routine practices teacher use daily, ongoing feedback, formative assessments, goal setting, and progress monitoring. Metacognition instruction gave my students greater insight into their own learning because it provided strategies for students to regulate their learning. The technology portion of the curriculum is truly motivating for students, but no all teachers will feel comfortable, or have the equipment necessary to implement the technology component. If I were to suggest one technology tool to use it would be videotaping. Videotaping turned out to be the most valuable learning tool for my students and myself. Videotaping assisted me in documenting mastery and it helped students see themselves as active, self-regulating learners. Videotaping also served as a teaching tool to show how struggling students overc*a*me obstacles and work*ed* through difficult problems.

I have included a generic unit timeline for the ML & SEI curriculum. The curriculum is designed for all academic areas. The forms in the Appendix are *samples that can be modified for other curricula areas. Teachers can use the Comprehension Check questions in other academic areas by creating their own questions that test students on knowledge of standards. Although I used a blog web site to post students responses, all the activities can be done in paper format. The inclusion of technology is an optional component depending on the teacher's comfort level and available resources. I designed the ML & SEI curriculum to be flexible, so teachers can easily select and choose aspects of the curriculum that work best for them.* I hope you find the ML&SEI curriculum as valuable as I did.

Sincerely,

Carmen L. Restrepo

ML& SEI Sample Unit Timeline

	Monday	Tuesday	Wednesday	Thursday	Friday
Week One	Pre-Self-Efficacy Survey. Pre-Assessment. Metacognition Questionnaire.	Students graph pre-assessment results. Students complete goal-setting form. Metacognition Lesson 1.	Begin unit. Begin using checklist for mastery of standards throughout unit. Blog Post: Reflection about learning 1 (see Appendix).	Continue with unit standards. Provide a comprehension check question for students (see Appendix). Teacher analyzes blog post using the Metacognitive Awareness Rubric.	Re-teach concepts based on results form comprehension check question. Formative Assessment
Week Two	Students graph formative assessment results in Excel. Corrective feedback and reteaching based on formative assessment results. Videotape students solving problems.	Metacognition Lesson 2 Blog Post: Reflection about learning 2 (see Appendix). Teacher analyzes blog post using the Metacognitive Awareness Rubric.	Continue with unit standards. Revisit checklist for mastery of standards. Students who have reached mastery move on to enrichment activities.	Continue with unit standards. Provide a comprehension check question for students. Videotape students solving problems.	Re-teach concepts based on results form comprehension check question. Formative Assessment

Week Three	*Students graph formative assessment results in Excel.* *Corrective feedback and reteaching based on formative assessment results.* *Videotape students solving problems.* *Revisit checklist for mastery of standards.*	*Metacognition Lesson 3* *Blog Post: Reflection about learning 3 (see Appendix).* *Teacher analyzes blog post using the Metacognitive Awareness Rubric.*	*Continue with unit standards.* *Revisit checklist for mastery of standards.* *Students who have reached mastery move on to enrichment activities.*	*Continue with unit standards.* *Provide a comprehension check question for students.* *Videotape students solving problems.*	*Summative Assessment* *Post Self-Efficacy Survey* *Students graph summative assessment results in Excel.*

My Goal Setting Form

By ____

My goal is:
____

____

My target date is:
____

Three things I will do to reach my goals:

1. ____

2. ____

3. ____

Evidence to show I have reached my goals include:
1. ____

2.____

3. ____

Student Pre-Self-Efficacy Survey
Unit One

This questionnaire is designed to gain insight into how confident you feel about certain types of math problems. Please rate yourself using the scale below. If you believe you cannot solve a particular type of problem rate yourself with a zero. If you feel you are certain that you can solve a particular type of problem then rate yourself with 100.

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

Rate yourself for each question.

1. How confident do you feel when putting in order positive and negative integers?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

2. How confident are you in adding positive and negative integers?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

3. How confident are you in finding the absolute value in a number?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

4. How confident do you feel you can correctly solve this problem? -120 + (-80) + 40

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

5. How confident do you feel that you can correctly solve this problem? -9 + 4

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

6. How confident do you feel that you can correctly explain the meaning of "Absolute Value?"

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

7. How confident do you feel you can correctly solve this problem? -4 - (-12)

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

8. How confident do you feel that you can correctly solve this problem? 7(-3)(-1)

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

9. How confident are you in using order of operations to solve this problem?
7(-2) + (-8) x 4

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

10. How confident do you feel that you can correctly solve this problem? 42÷(-6)

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

Student Post-Self-Efficacy Survey
Unit One

This questionnaire is designed to gain insight into how confident you feel about certain types of math problems. Please rate yourself using the scale below. If you believe you cannot solve a particular type of problem rate yourself with a zero. If you feel you are certain that you can solve a particular type of problem then rate yourself with 100.

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Cannot do at all					Moderately can do					Highly can do

Rate yourself for each question.

1. How confident do you feel when putting in order positive and negative integers?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

2. How confident are you in adding positive and negative integers?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

3. How confident are you in finding the absolute value in a number?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

4. How confident do you feel you can correctly solve this problem? -120 + (-80) + 40

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

5. How confident do you feel that you can correctly solve this problem? -9 + 4

0	10	20	30	40	50	60	70	80	90	100

Cannot do at all	Moderately can do	Highly can do

6. How confident do you feel that you can correctly explain the meaning of "Absolute Value?"

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Cannot do at all					Moderately can do					Highly can do

7. How confident do you feel you can correctly solve this problem? -4 - (-12)

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Cannot do at all					Moderately can do					Highly can do

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Cannot do at all					Moderately can do					Highly can do

9. How confident are you in using order of operations to solve this problem?
7(-2) + (-8) x 4

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

10. How confident do you feel that you can correctly solve this problem? 42÷(-6)

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

Student Pre-Self-Efficacy Survey
Unit Two

This questionnaire is designed to gain insight into how confident you feel about certain types of math problems. Please rate yourself using the scale below. If you believe you cannot solve a particular type of problem rate yourself with a zero. If you feel you are certain that you can solve a particular type of problem then rate yourself with 100.

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

Rate yourself for each question.

1. How confident do you feel you can explain the definition of a ratio?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

2. How confident are you in writing a ratio from reading a word problem?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

3. How confident are you in explaining the definition of a proportion?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

4. How confident do you feel in deciding if proportions are equal to each other?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

5. How confident do you feel that you can create an equivalent proportion?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

6. How confident do you feel you can reduce ratios?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

7. How confident do you feel you can write ratios in all three forms?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

8. How confident do you feel that you use proportions to find the length of a polygon?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

9. How confident do you feel that you can use ratios to find batting averages, miles per hour, or similarities between two quantities?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

10. How confident do you feel that understand how to solve proportions by cross-multiplying?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

Student Post-Self-Efficacy Survey
Unit Two

This questionnaire is designed to gain insight into how confident you feel about certain types of math problems. Please rate yourself using the scale below. If you believe you cannot solve a particular type of problem rate yourself with a zero. If you feel you are certain that you can solve a particular type of problem then rate yourself with 100.

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

Rate yourself for each question.

1. How confident do you feel you can explain the definition of a ratio?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

2. How confident are you in writing a ratio from reading a word problem?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

3. How confident are you in explaining the definition of a proportion?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

4. How confident do you feel in deciding if proportions are equal to each other?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

5. How confident do you feel that you can create an equivalent proportion?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

6. How confident do you feel you can reduce ratios?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

7. How confident do you feel you can write ratios in all three forms?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

8. How confident do you feel that you use proportions to find the length of a polygon?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

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0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

Student Pre-Self-Efficacy Survey
Unit Three

This questionnaire is designed to gain insight into how confident you feel about certain types of math problems. Please rate yourself using the scale below. If you believe you cannot solve a particular type of problem rate yourself with a zero. If you feel you are certain that you can solve a particular type of problem then rate yourself with 100.

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

Rate yourself for each question.

1. How confident do you feel you can change a fraction to a percent ?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

2. How confident are in changing a decimal to a percent?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

3. How confident are you changing a percent into a decimal?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

4. How confident are you in changing a percent into a fraction?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

5. How confident are you that you can change a fraction to a decimal?
0 10 20 30 40 50 60 70 80 90 100
Cannot do at all — Moderately can do — Highly can do

6. How confident do you feel you can change a decimal into a fraction?

0 10 20 30 40 50 60 70 80 90 100
Cannot do at all — Moderately can do — Highly can do

7. How confidant are you can figure out 8% sales tax on an item that cost $52.00?
0 10 20 30 40 50 60 70 80 90 100
Cannot do at all — Moderately can do — Highly can do

8. How confident do you feel you can solve this problem?

Jeans are on sale for 35% off. The original price of the jeans is $60.00. How much is the sale price?0 10 20 30 40 50 60 70 80 90 100
Cannot do at all — Moderately can do — Highly can do

9. How confident do you feel you can solve this problem?

Your dinner bill is $42.00. You want to leave a 20% tip for the waiter. How much would you leave including the price of the meal?0 10 20 30 40 50 60 70 80 90 100
Cannot do at all — Moderately can do — Highly can do

10. How confident do you feel you can correctly solve this problem?

Miguel deposited $500.00 into an account and earned 5% simple annual interest. What will his account balance be after 2 years?
0 10 20 30 40 50 60 70 80 90 100
Cannot do at all — Moderately can do — Highly can do

Student Post-Self-Efficacy Survey
Unit Three

This questionnaire is designed to gain insight into how confident you feel about certain types of math problems. Please rate yourself using the scale below. If you believe you cannot solve a particular type of problem rate yourself with a zero. If you feel you are certain that you can solve a particular type of problem then rate yourself with 100.

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

Rate yourself for each question.

1. How confident do you feel you can change a fraction to a percent?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

2. How confident are in changing a decimal to a percent?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

3. How confident are you changing a percent into a decimal?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

4. How confident are you in changing a percent into a fraction?

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly can do

5. How confident are you that you can change a fraction to a decimal?
0 10 20 30 40 50 60 70 80 90 100
Cannot do at all | Moderately can do | Highly can do

6. How confident do you feel you can change a decimal into a fraction?

0 10 20 30 40 50 60 70 80 90 100
Cannot do at all | Moderately can do | Highly can do

7. How confidant are you can figure out 8% sales tax on an item that cost $52.00?
0 10 20 30 40 50 60 70 80 90 100
Cannot do at all | Moderately can do | Highly can do

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Cannot do at all | Moderately can do | Highly can do

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Cannot do at all | Moderately can do | Highly can do

10. How confident do you feel you can correctly solve this problem?

Miguel deposited $500.00 into an account and earned 5% simple annual interest. What will his account balance be after 2 years?
0 10 20 30 40 50 60 70 80 90 100
Cannot do at all | Moderately can do | Highly can d

Checklist for Mastery of Standards

Name:______________________

Unit One:

Standard	Week 1	Week 2
Number Sense 2.3		
Comments		
Source: Blog (B) Podcast (P) Video (V)		

Unit Two:

Standard	Week 1	Week 2	Week 3
Number Sense 1.2 & 1.3			
Comments			
Source: Blog (B) Podcast (P) Video (V)			

Unit Three:

Standard	Week 1	Week 2	Week 3
Number Sense 1.4			
Comments			
Source: Blog (B) Podcast (P) Video (V)			

Comprehension Check – Integer Activity

Name: ____________________________________
Date: ______________

For each of the following problems below, use the chip model to illustrate adding and subtracting positive and negative integers.

1. (-9) + 13
2. 12 + -(17)
3. (-5)+11
4. 14 + (-8)
5. (21) + (-6)
6. (-7) – 5
7. 16 – (-7)
8. 3- (14)
9. (-4) – 11
10. 15 – (-8)

Comprehension Check – Ratio Activity 1

Name: ___________________________________ Date: _____________

Students,

In this week's post, you have two tasks.

1. The first task is to answer the questions below in a complete sentence.
2. The second task is to define the word ratio and give an example.

Question: In a survey of 100 dentists, 75 of the dentists prefer Toothpaste A to Toothpaste B. Find the ratio of the number of dentists who prefer toothpaste A to the total number of dentists surveyed.

Answer:

____

____

____

Define ratio, give an example using a word problem, and then state the answer.

____

____

____

____

____

____

Comprehension Check – Ratio Activity 2

Name:___________________________________
Date:____________________________________

Explain how to determine if the ratios 2/10 and 3/15 are equivalent?

$$\frac{2}{10} = \frac{3}{15}$$

____

____

____

____

____

Comprehension Check – Ratio Activity 3

Name:___________________________________
Date:____________________________________

Explain how to determine if the ratios 5/10 and 8/16 are equivalent?

$$\frac{5}{10} = \frac{8}{16}$$

____

____

____

____

____

____

____

Comprehension Check-Percent Activity

Name:______________________________________ Date:_________________

Solve the problem and explain in detail the steps and procedures you used to solve the problem.

You buy a pair of jeans that is 30% off the original price of $29.00. What is the sale price?

Solve problem here.

Explain all the steps you used here.

____

____

____

____

____

____

____

Reflection Problem on Percents

Name:______________________________________ Date:_________________

1.What did you have to think about before solving the problem on discounted jeans?

____

____

____

2.What part was confusing to you, or state and area that you needed help?

____

____

____

3.Did you ask for help from the teacher, or your peers to help you with solving the problem?

____

____

____

4. How confident do you feel that you got the answer correct?

____

____

____

Reflection about learning #1

Name: ____________________________
Date: __________________________

What does learning mean to you?

____

____

____

____

What was your experience about how you learn?

____

____

____

____

What are your study habits? Do you make a plan to study and follow through?

____

____

____

____

What types of study habits work best for you?

- Writing things down?
- Making note cards, or flashcards?
- Reading and re-reading?

____

____

____

____

Reflection about learning #2

Daily Reflection

1. What did you learn in Math today?

____

____

2. What was difficult, or confusing for you in Math today?

____

____

3. Did you use any resources when you needed help, ask the teacher, a friend, look in your math notebook?

____

____

4. What could you do that would help you do better tomorrow in Math?

____

____

5. Did you pay attention in class today and do your best to learn?

____

____

Reflection about learning # 3

Name: ______________________________
Date: _______________________________

Daily Reflection

1. What did you learn in Math today?

____

____

2. Did you pay attention the best that you could?

____

____

3. What was difficult for you in Math today?

____

____

4. What was easy in Math today?

____

____

5. Is there anything you still find confusing?

____

____

6. What could you do to help you understand better?

____

____

Metacognitive Lesson #1

Lesson Goal: Teach students that metacognition is thinking about how your think.

1. Hand out several large index cards to each student.
2. Ask students to write down how they choose what to wear to a party.
3. Divide the whiteboard into two sections. On one side write the word "Metacognition," and on the other side write the word, "No Metacognition."
4. Call on individual students and ask them to read their answers aloud to the class. The teacher decides which side to place the students card. The students then tape the index card to the appropriate side of the board.
5. When all the cards on placed on the board, the class discusses any patterns shown between the card placed on the "Metacognition" side and those placed on the "No-Metacognition" side.
6. Teacher records students' observations on the board, or on a poster.

The goal of the lesson is have students notice that metacognition is thinking about your thinking.

This lesson idea can be applied to any topic.

Alternate topics include:
How did you decide to do how you would study for a test?
How did you decide how to get a better grade in a class you were failing?
How did you decide what to bring on a vacation?

Metacognitive Lesson #2

Lesson Goal: To have students brainstorm strategies that they use scaffold their learning.

1. Pick a subject area.
2. Talk about the strategies that the class has learned as part of the curriculum.
3. Have students general a list of every strategy that they can use to support their learning.
4. Teacher and students record the strategies as they are generated.
5. The teacher can create a strategy poster listing all the various strategies students can use.

Optional: The teacher can provide a printed version of the list that students can keep in their notebook as a reference. Students may also find it helpful to highlight the strategies they know work best for them.

Metacognitive Lesson #3

Lesson Goal: To teach students to monitor thinking.

This lesson is similar to the pair-share method.

1. Group students in pairs. Pairs can be self-selected or teacher selected.
2. Give students a list a printed problem on a piece of paper. Option: Students can be given more than one problem, so they have choice in their selection.
3. Assign one student as the listener, and the other student as the problem solver.
4. The problem solver begins by reading the problem and thinking aloud as he solves the problem from beginning to end. The goal of the problem solver is to verbally emphasize each step along the way until the entire problem is solved.
5. The listener's job is to monitor the thinking of the problem solver and ask questions as needed.
6. When the problem solver had completely finished solving the problem, the roles reverse, and the listener solve the identical problem.

This lesson helps students monitor each others thinking, and helps them ask questions to clarify their own understanding. This lesson is designed to help students see gaps in their understanding and reach agreements on problem solving strategies.

Metacognition Questionnaire

Name: ________________________
Date: _________________________

How do I approach learning a new math skill? What do I think about or do?

What do I do when I do not understand a math problem?

When I am stuck on a problem, what do I do?

Can I change how I am working a little to be a more effective learner?

What am I learning in Math?

What can I do to learn more and better?

Metacognitive Awareness Rubric

The following questions were modified from the Jr. MAI (Sperling, Howard, Miller, and Murphy, 2002). Questions are rated on a three-point scale. A score of one indicates that no mention of the awareness is present in the response. A score of two indicates that moderate awareness is present, but lacks elaboration. A score of three indicates that the student's response includes metacognitive awareness with an explanation or example. The rubric can be used for written responses, or as observational field notes.

1= No awareness mentioned
2= Moderate awareness, no elaboration
3= Awareness and example, or elaboration

1. Student indicates knowledge, or lack of knowledge about material.	1	2	3
2. Students use strategies that were successful in the past.	1	2	3
3. Student is aware of what the teacher requires students to learn.	1	2	3
4. Student draws pictures or diagram to help understand while learning.	1	2	3
5. Student reflects on learning, and asks if actual learning matched goals.	1	2	3
6. Student thinks of various strategies and select the most appropriate one.	1	2	3
7. Student thinks about what they need to learn before beginning.	1	2	3
8. Student thinks about how well they are doing as they are learning.	1	2	3
9. Student pays attention to important information.	1	2	3
10. Student sees different learning strategies depending on the task.	1	2	3

Positive and Negative Integer Assessment

Name ______________________________ Date __________ Class ___________

CHAPTER 2 **Quiz**
Section A

Choose the best answer.

1. Order the integers −2, 5, 0, −1, and 3 from least to greatest.
A −2, 5, 0, −1, 3
B −2, −1, 0, 3, 5
C 0, −1, −2, 3, 5
D 5, 3, −2, −1, 0

2. Find the absolute value |−4|.
A −4 **C** 1
B 0 **D** 4

3. Find the sum 25 + (−21).
A 4 **C** 26
B 22 **D** 46

4. Find the difference 7 − (−8).
A −15 **C** 15
B −1 **D** 56

5. Find the product 8 • (−7).
A −56 **C** 1
B −15 **D** 56

6. Find the quotient −48 ÷ (−6).
A −42 **C** 8
B −8 **D** 54

7. During a game, Fernando earned a loss of 8 points and 3 gains of 5 points each. Fernando started the game with 0 points. How many points did Fernando have at the end of the game?
A −7 **C** 7
B 0 **D** 9

8. Solve the equation $5 + y = 15$.
A −10 **C** 10
B 3 **D** 20

9. Solve the equation $6 \cdot p = -84$.
A $p = -504$ **C** $p = 12$
B $p = -14$ **D** $p = 14$

Ratio, Rates, and Proportions Assessment

Name ______________________________ Date __________ Class ___________

CHAPTER 5 **Quiz**

Section A

Choose the best answer.

1. There are 14 cars, 8 minivans, and 5 trucks in a parking lot. Write the ratio of minivans to trucks in all three forms.

A $\frac{14}{5}$, 14 to 5, 14:5

B $\frac{8}{5}$, 8 to 5, 8:5

C $\frac{5}{8}$, 5 to 8, 5:8

D $\frac{27}{5}$, 27 to 5, 27:5

2. On a recent trip, Josh drove 324 miles and used 12 gallons of gasoline. Find the unit rate.

A 12 mi/gal

B 27 gal/mi

C 27 mi/gal

D 330 mi/gal

3. Marlee drove 60 miles using 2 gallons of gas. Which is the unit rate in fraction form?

A $\frac{\text{1 gallon}}{\text{30 miles}}$ **C** $\frac{\text{30 miles}}{\text{1 gallon}}$

B $\frac{\text{1 gallon}}{\text{60 miles}}$ **D** $\frac{\text{60 miles}}{\text{1gallon}}$

4. Convert 104 ounces to pounds.

A 6.5 pounds **C** 10.4 pounds

B 6.8 pounds **D** 13 pounds

5. Which of the following ratios are proportional?

A $\frac{2}{3}, \frac{3}{4}$ **C** $\frac{6}{9}, \frac{9}{12}$

B $\frac{5}{6}, \frac{11}{12}$ **D** $\frac{3}{5}, \frac{9}{15}$

6. Find the missing numbers in the equivalent ratios: $\frac{3}{5}, \frac{12}{x}, \frac{y}{75}$.

A $x = 20, y = 45$

B $x = 20, y = 48$

C $x = 45, y = 20$

D $x = 45, y = 45$

7. If it costs $2.60 to purchase 4 muffins, how much would it cost to purchase 7 muffins?

A $3.25 **C** $4.55

B $3.90 **D** $5.20

Fractions, Decimals, and Percent Assessment

Name ______________________________ Date __________ Class ___________

CHAPTER 6 **Quiz**
Section A

Choose the best answer.

1. Which shows 32% as both a decimal and a fraction in simplest form?
   A 0.32, $\frac{32}{100}$ C 0.32, $\frac{8}{25}$
   B 0.32, $\frac{16}{50}$ D 32.0, $\frac{8}{25}$

2. Which shows 12.5% as a decimal and a fraction in simplest form?
   A 0.125 and $\frac{1}{8}$
   B 0.125 and $\frac{125}{1000}$
   C 0.125 and $\frac{12.5}{100}$
   D 12.5 and $\frac{1}{8}$

3. What is 0.625 written as a percent?
   A 0.625% C 37.5%
   B 6.25% D 62.5%

4. What is the fraction $\frac{3}{4}$ expressed as a percent?
   A 0.75% C 34%
   B 25% D 75%

5. Estimate 29% of 78.
   A 8 C 24
   B 16 D 29

6. Mr. Ricardo bought a set of luggage that regularly sells for $249.95. It was on sale at a discount of 30%. About how much was the discount?
   A $30 C $90
   B $75 D $175

7. 58% of 90 is what number?
   A 5.22 C 52.2
   B 48.8 D 64.4

8. Find 150% of 42.
   A 21 C 63
   B 42.5 D 84

9. Jennifer left $2.40 as a 15% tip for dinner. How much was the dinner bill?
   A $16 C $32
   B $24 D $36

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