At-Risk Students' Experience with Formative Assessment

David Cheney

The Evergreen State College

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AT-RISK STUDENTS AND FORMATIVE ASSESSMENT

Sunshine Campbell MEd, Member of the Faculty

Date

Abstract

This action research investigated whether the effects of formative assessment strategies would positively impact the epistemological beliefs and self-efficacy of at-risk students, primarily junior and senior high school students. Two formative assessment practices were used: daily end-of-period assessments and weekly self-assessments. At the end of this nine-week study, data indicated an increased mathematical perception of the students, an increase in the incremental view of intelligence, and an unanticipated shift towards an algorithmic view of mathematics. Formative assessment was believed to play a role in this positive shift in beliefs, but could not be conclusively identified as the sole factor.

Keywords: at-risk students, epistemological beliefs, formative assessment

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Introduction and Literature Review

With the implementation of the Improving America's Schools Act of 1994, and then the No Child Left Behind Act of 2001, states are now required to give large-scale, high-stakes summative tests in grades 3-8 and at least once during high school. States and school districts have come under increasing pressure to determine which students will be sufficiently prepared to pass these high-stakes exams prior to their examination at the end of the school year (Black & Wiliam, 2005; Marianne, Marion, & Gong, 2000). As Stiggins (1999) questions, "How do we help our students want to learn and feel capable of learning?" One group that has garnered particular attention under these circumstances is "at-risk" students. This action research project aims to determine what is the relationship between formative assessment practices and positive changes in the self-efficacy and epistemological beliefs of this population of at-risk students.

Definition of At-Risk Students

An "at-risk" student is not a universally defined term. Factors traditionally associated with at-risk students are repetition of earlier grades, a history of poor grades in English or mathematics, little completion of homework, students from single-parent households, students who frequently change schools, students who come unprepared to class, students who are frequently tardy or absent, and enrollment in schools with a large minority population (Kaufman & Bradby, 1992). A characteristic of at-risk students is underachievement: a discrepancy between ability and expected performance (Preckel, Holling, & Vock, 2006). This characteristic is exemplified through those students who permanently drop out of school before graduating from high school, or those who do graduate, but with poor academic skills leaving them unprepared for life after high school

(Kaufman & Bradby, 1992). However, researchers have found that while both achievers and underachievers had comparable levels of cognitive ability, underachievers showed lower levels of cognitive and achievement motivation (Preckel, Holling, & Vock, 2006). A teaching practice successfully implemented to increase levels of cognitive achievement motivation would diminish the distinction between achievers and underachievers. For this action research project, the teaching practice to be investigated was formative assessments. The particular population of underachieving students who participated in this research is students who are still enrolled in high school, but have not met the state assessment requirements in order to graduate. For this action research project, at-risk students are defined as students who have not demonstrated proficiency on the appropriate district- or state-wide standardized mathematics assessment for their grade level.

Personal beliefs such as cognitive and achievement motivation are not isolate, independent aspects of self-identity. Rather, they are comprised of a larger network of interrelated beliefs called self-efficacy. In the next section, I will describe these different beliefs, and how particular beliefs in one aspect of self-efficacy serve as predictors for other self-efficacy beliefs.

Self-Efficacy of At-Risk Students

Self-efficacy can be described as one's personal beliefs about their ability to perform successfully in a specific situation. In regards to this action research project, that specific situation is learning mathematics. Since at-risk students have similar cognitive abilities as their achieving peers, the mechanisms which influence and are influenced by cognitive and academic motivation are sources of discrepancies between these two

populations of students. The aspects of self-efficacy of at-risk students that will be studied regarding mathematics are epistemological beliefs, learner empowerment, self-perception, mathematical interest, and views on assessment.

Epistemological beliefs. The conception of the source and limitations of knowledge is epistemological beliefs. For the sake of this action research project, these beliefs are comprised of three specific beliefs: (1) innate ability: "Is intelligence something one is born with or something that can be developed through effort?", (2) quick learning: "Should ideas be expected to be learned upon initial exposure or developed over repeated exposure and time?", and (3) goal orientation: "Is the preference to engage in skills that one already performs well at or towards challenging activities that provide opportunity for new learning?"

Innate ability: incremental and entity theories of intelligence. The "theory of intelligence" refers to an individual's conception about the nature of ability (definition of all Epistemological Beliefs Terminology is included in Table 1). Those individuals that believe intelligence is malleable and can be developed through effort ascribe to the incremental theory of intelligence. The entity theory of intelligence conceives of intelligence as a fixed, uncontrollable trait (Dweck, 2007; Dweck & Leggett, 1988). This belief can be detrimental to student achievement because individuals who do not believe they are capable of learning stop trying, and those that fail to try, fail to learn (Stiggins, 1999).

Quick learning: deep and surface approaches to learning. In addition to differences in beliefs of intelligence, differences exist in beliefs regarding the amount and necessity of effort that should be employed during the learning process. Besides the

Table 1

Definition of Epistemological Beliefs Terminology

Term	Definition
Innate Ability	Intelligence is either developed or natural
Incremental Theory	Intelligence is malleable and can be developed
Entity Theory	Intelligence is a fixed uncontrollable trait
Quick Learning	Learning occurs after repeated or initial exposure
Deep Approach	Critical thinking, synthesis, own reasoning, etc.
Surface Approach	Certainty of knowledge from authority, algorithms, etc.
Goal Orientation	Preference for learning or experienced activities
Mastery	Pursue opportunities to improve ability
Performance	Pursue goals which demonstrate ability

instruments of instruction, the teacher, and the mathematics itself, the student's approach to learning can present the greatest obstacle to achievement (Ginsburg, 2009). A deep approach to learning involves sustained effort, integration of knowledge, critical thinking, analyzing, synthesizing, making inferences, and trust in one's own reasoning (Gijbels & Dochy, 2006; Preckel, Holling, & Vock, 2006). Surface approaches to learning are defined by a belief in the certainty of knowledge from authority and a focus on memorization, algorithms, rote learning, and reproducing factual content (Gijbels & Dochy, 2006; Kizilgunes, Tekkaya, & Sungur, 2009; Preckel, Holling, & Vock, 2006). Surface approaches to learning can prevent students from engaging in higher-order thinking (Gijbels & Dochy, 2006).

Goal orientation: mastery and performance orientation. Students can also differ in their approach to academic tasks, or goal orientation. The goal of mastery orientation (also referred to as learning orientation) is to increase competence, whereas the goal of performance orientation is to seek positive judgments about competence, while avoiding negative judgments about competence. Students who possess the mastery orientation view tasks as an opportunity to improve ability, are challenge seeking, and persist in the face of difficulty. Performance orientated students pursue the goal of proving their ability, and difficulty is perceived as evidence of low ability, which triggers a defensive withdrawal of effort (Dweck, 2007; Dweck & Leggett, 1988). Student beliefs about innate ability serve as predictors of goal orientation: belief in the incremental theory of intelligence positively correlates with mastery orientation, while belief in the entity theory of intelligence is predictive of goal orientation (Dweck & Leggett, 1988).

While innate ability, quick learning, and goal orientation all represent different aspect of epistemological beliefs, each of these categories are closely associated with one another. Students who adopt deep approaches to learning have high levels of mastery orientation, believe in the aspects of the incremental theory of intelligence that knowledge develops from careful thought, analysis, and effort, as well as having greater achievement overall (Dweck & Leggett, 1988; Kizilgunes, Tekkaya, & Sungur, 2009).

Learner empowerment. One aspect of self-efficacy is the amount of empowerment perceived by the learner. Learner empowerment consists of the perception of how meaningful learning is to the student, their competence as a learner, the impact students can have over their learning, and choices available to students. Learner empowerment was shown to have a direct effect on student learning (Houser & Frymier

2009). Student preference to engage in learning new, challenging, and interesting things in mathematics (mastery orientation) is positively correlated with the perception of academic tasks as important, interesting, and useful. Perceived task value also correlated positively with the deep learning approaches of critical thinking, elaboration, and organization (Lau, Liem, & Nie, 2008). In addition to theories of intelligence, a student's sense of their own competence has implications for goal orientation. Additionally, it should be noted that students can have different domain-specific orientations; for instance a student could approach a mathematics task with a performance orientation, while inclined towards a mastery orientation of writing activities. Students with high perceived competence worked to demonstrate their capabilities to others in the class. However, students with low perceived competence focused on avoiding being perceived by teachers or peers as less competent than others (Lau, Liem, & Nie, 2008). This low perceived competence can lead to a decrease in mastery orientation for new skills and an increase in performance orientation for known skills.

Self-perception. How students views themselves, both scholastically and in general, is another aspect of self-efficacy. Mathematical confidence, mathematical ability, and self-esteem are all elements of self-perception. Students' self-perception of domain-specific ability is positively correlated with domain achievement (Dennisen, Zarrett, & Eccles, 2007). Students succeed in mathematics if they feel capable, but with a lack of desire or confidence, students will not be successful (Stiggins, 1999). While related to mathematical confidence, self-esteem represents a different aspect of self-perception which is unrelated to any specific academic domain. Rather self-esteem refers to how students feel about themselves as a whole. Student self-esteem is an important

factor related to the effort students devote to the learning process. In a study involving the use of computer-assisted instructional software, student's math achievement was positively correlated with help-seeking behavior from the software. Self-concept (an element of self-esteem) was not associated with help-seeking behavior, but low self-concept was associated with a significant tendency to employ inappropriate guessing (Beal, Qu, & Lee, 2008).

Mathematical interest. The usefulness, relevance, personal value, and attitude towards mathematics define a student's mathematical interest. Usefulness measures how important mathematics is to the students' future and outside of the classroom. Relevance measures the importance of mathematics within other subjects. Personal value is indicative of how important mathematics is to society in general. Finally, attitude measures to what degree students consider mathematics a problem solving strategy, or simply a series of steps to be remembered as part of an algorithm. Since mathematics is the particular activity that I am measuring my students' self-efficacy about, it is important to know how the students feel about the subject. Students' interest in mathematics is a predictor of belief and ability. Students' self-reported interest in mathematics is positively correlated with achievement in mathematics (Dennisen, Zarrett, & Eccles, 2007). However, lack of interest and fear of mathematics are major impediments of student success (Ginsburg, 2009).

Views on assessment. Assessment takes many forms and is used in a multitude of ways. Students can perceive assessment as a means of accountability, a vehicle to improve learning, as negative, or as useful. Students' opinions regarding assessment is important for understanding their self-efficacy in mathematics, as assessment is the main

method for determining proficiency at the classroom, district, and state level. Prior research (Gavin & Hirschfeld, 2008) found that the best predictor was when students held the conception that assessment makes students accountable. The belief that assessment was for school accountability was a negative predictor of student success. Students who thought of assessment in terms of self-regulation and formative assessment tended to achieve more (Gavin & Hirschfeld, 2008). Additionally, the use of assessment can be a powerful force in shaping students' opinion of themselves as capable learners of mathematics. Evaluative high-stakes assessment results can be counterproductive while students are still in the midst of the learning process because judgment offered prematurely can lead to student disengagement (Stiggins & Chappius, 2005). Standardized district, state, national, or international assessments results are typically too infrequent and broad to be of help to students (Stiggins & Chappius, 2005).

This action research project is looking at the effects of formative assessment on students' self-efficacy in mathematics. In the next section, I will review the research literature on assessment practices to introduce the various types of assessment, establish what is formative assessment, how it is different from other types of assessment, and what the purpose of formative assessment is.

Definition of Various Forms of Assessment

Types of Assessment. Contrary to the informal, everyday use of the word, assessment does not merely consist of standardized tests with uniform rubrics and a universally definition of success or failure. Rather assessments exist in three main forms: observation, talk/task, and clinical interviews (Ginsburg, 2009). Regardless of the form it takes, the purpose of the assessment is what separates the different types of assessment.

Summative Assessment. The most descriptive definition of summative assessment is *assessment of learning*. These assessments are typically given once at the end of the semester or school year, evaluate students' performance against learning standards, and are given district-wide, state-wide, or nation-wide (Marianne, Marion, & Gong, 2000). Black & Wiliam (2005) argue that the unprecedented reliance on summative assessment is the biggest impediment to improving the education system. Stiggins & Chappuis (2005) state that high-stakes summative assessments cause chronic low achievers to disengage from the educational process because of their perception that the of achievement standards are unattainable. Additionally, summative assessments at any level are counterproductive to students who are in the process of learning the material (Stiggins & Chappius, 2005). Despite the limitations of summative assessment, the reliance on end of course assessments as a graduation requirement makes this form of assessment a necessary aspect of the current education system.

Formative Assessment. The most descriptive definition of formative assessment is *assessment for learning*. Formative assessment is the main type of assessment that is used in this action research project. These assessments are given frequently, formally or informally, are brief in nature, determine student learning of curriculum topics, are used to provide feedback of student progress and inform teacher practices on an almost minute-by-minute basis, and are given at the classroom level (Marianne, Marion, & Gong, 2000). However, utilizing only the basic definition of formative assessment does not reveal its true purpose. Formative assessment is not a type of assessment but rather a process: results of a formative assessment must be used to provide feedback to the students and inform teaching practices (Black & Wiliam, 1998; Stiggins & Chappius,

2005). Formative assessment necessitates a teacher's clear understanding of the expected learning goals and the selection of appropriate assessment methods, which match the intended achievement goals (Stiggins, 1999; Stiggins & Chappius, 2005). Feedback should consist of the particular qualities of student work as well as specific advice for improvement; students do not benefit from feedback comprised of only marks or grades (Black & Wiliam, 1998). Additionally, students should be presented with clear explanations of the learning targets and be involved in self-assessment as part of the formative assessment process (Black & Wiliam, 1998; Stiggins, 1999; Stiggins & Chappius, 2005).

Interim Assessment. In recent years, a third type of assessment has begun to gain prominence. In favor of a "comprehensive assessment system," Marianne, Marion, & Gong (2000) advocate the use of interim assessments. Interim assessments are designed to evaluate student abilities within a particular time frame, are used within the classroom and at the school or district level, and can be instructional, evaluative, or predictive (Marianne, Marion, & Gong, 2000). Interim assessment is not used like formative assessments to provide teachers or students with day-to-day feedback, nor is it used in a summative final evaluative grade. Rather interim assessments are typically used as predictors of future results (Marianne, Marion, & Gong, 2000). While not specifically referring to interim assessment by name, Black & Wiliam (2005) state that the pressures of No Child Left Behind Act have increased the need for these types of formal predictive assessments.

Classroom Implementation of Formative Assessment

Benefits of formative assessment. Formative assessment has been shown to consolidate prerequisite skills, focus student attention on learning targets, provide knowledge of desired outcomes, and help students to monitor their own progress (Crooks, 1988). However, the frequency of these assessments is also important in determining their successful implementation. The use of daily quizzes given at the last ten minutes of each class period, followed by 5-10 minutes of whole class review of the quiz results, was shown to be more effective at increasing both homework assignments scores and mathematical achievement as measured on a comprehensive final, than did weekly quizzes over the same material (Shirvani, 2009).

Formative assessment can be effective specifically for underachieving students. This effectiveness is achieved by reducing the range of achievement between individuals while raising the overall achievement of a class (Black & Wiliam, 1998). An Australian study of at-risk students demonstrated that the use of continual formative assessment practices within a support mathematics class resulted in an increase of 15% in the mean class scores when compared to the previous year; a reduction in the number of students not meeting a satisfactory standard; and nearly one quarter of the at-risk student were able to transition to the core mathematics program before the end of the school year (Byers, 2009). These results are attributed to use of frequent assessment feedback (Black & Wiliam, 1998). In a literature review, Black & Wiliam (1998) found that the typical effect size of formative assessment was between 0.4 and 0.7. To illustrate the impact of this effect size:

> An effect size of 0.4 would mean that the average pupil involved in an innovation would record the same achievement as a pupil in the 35% of those not involved.

> An effect size gain of 0.7 in the recent international comparative studies in mathematics would have raised the score of a nation in the middle of the pack of 41 countries (e.g., the U.S.) to one of the top five. (Black & William, 1998, p. 141)

This finding illustrates the potential power of formative assessment and the great gains in learning when properly implemented.

Limitations of formative assessment. As with any aspect of education, there is no universal panacea, and formative assessment should not be misconstrued as such; if formative assessment practices are not implemented appropriately, the promised benefits of formative assessment are not to be expected. The following research demonstrates the consequences of partial implementation and limited experience with formative assessment.

In a study of first-year university students, exposure to high-order thinking question on formative assessments, without feedback to students or changes in teaching practices, showed that students' preference for higher-order thinking assessments was significantly less than before the formative assessment. Despite numerous studies promoting the positive effects of formative assessments, this particular study found that only partial implementation of the formative assessment process can actually be detrimental to students' approach to learning. Additionally, regarding the belief in quick learning, a significant increase in the adoption of a more surface approach to learning was indicated after the inappropriate use of the higher-order thinking formative assessment (Gijbels & Dochy, 2006). While the demonstrated benefits of well-implemented formative assessment might lead to the adoption of this practice in all classrooms,

intention and execution are two separate things. In a study involving teachers with practically equivalent knowledge of mathematics teaching, teachers were able to determine the key principles of each assessment and were able to accurately determine the level of student understanding. However, teachers were not always able to determine the next instructional steps to take based on student results (Heritage, Jinok, Vendlinski, & Herman, 2009). Using the results of formative assessment to provide frequent feedback to students and influence future lessons is a vital component of formative assessment strategies. Being unable to determine next steps means that the teacher is not able to complete the formative assessment process and use the assessment results to influence student lessons. Similar results occurred in a study of 19 science and mathematics teachers who were asked to incorporate formative assessment along with their regular practices. Teachers were given a series of seven full-day and one half-day professional development sessions in which they were educated in the principles of formative assessment, as well as classroom observations by project staff to discuss, plan, and practice implementing formative assessment. At the end of the research period, no significant effect size resulted when compared to the science classes that did not receive the treatment, and a negative effect size was found for the mathematics classes (William, Lee, Harrison, & Black, 2004). Formative assessment was shown to have no significant impact on student motivation, achievement, or conceptual change in a study of twelve middle-school science teachers who implemented formative assessment practices for the first time. However, these teachers only received training at the beginning of the session and had no input into the development of the formative assessments used (Yin, Shavelson, Ayala, Ruiz-Primo, Brandon, & Furtak, 2008). Again, a fundamental

component of using formative assessment effectively is that teachers need to adjust the learning goals of the class to the needs of the class. Using pre-made assessments undermines this important aspect.

In addition to proper professional development and ongoing training, formative assessment is not always a quick practice to implement successfully. A study of sixteen teachers in Scotland who implemented formative assessment practices in their classroom resulted in student gains in self-perception. However, only those students who had experience with formative assessment in previous classes had statistically significant gains in self-perception (Miller & Lavin, 2007). These results could represent that formative assessment practices take multiple exposures or additional time before they are successful for the student, or perhaps there was something different about the original exposure to formative assessment strategies that was beneficial for the students. Considering all of these studies, it should be clear that without proper training and careful implementation of formative assessment strategies, unintended outcomes can occur.

In addition to the research demonstrating the benefits of formative assessment on student achievement, separate disciplines also indicate the positive influence of formative assessment on student beliefs. Since this action research project aims to determine how formative assessment strategies can be used to change student beliefs, this next section will discuss existing findings from current literature.

Effects of Formative Assessment on the Self-Efficacy of At-Risk Students

Epistemological beliefs. Formative assessment aligns with the major psychological approaches of performance, thinking/knowledge, learning potential, and affect and motivation (Ginsburg, 2009). Evidence of increased plasticity of the brain

over time from neuroscience and psychology demonstrates that learning can enhance the fundamental aspects of intelligence (Dweck, 2007). The attribution theory of achievement motivation states that students come to perceive that success and failure in school result primarily from effort, ability, and external factors such as luck and task difficulty. Lower achievement and lower self-assessment of ability can be influenced by low teacher expectations or placement in low track classes, such as is often experienced by at-risk students. However, student beliefs about learning can be positively affected by careful intervention (Bempechat, 2004). When that intervention takes the form of formative assessment, it has been shown to positively impact motivation, self-esteem, and student engagement (Black & Wiliam, 1998). The incremental theory of intelligence (that knowledge can be gained through effort and practice) is associated with mastery orientation (a preference towards activities which are unfamiliar but provide opportunity for growth), persistence in the pursuit of mastery, high cognitive processing, and empathy (Dweck & Leggett, 1988). Conversely, formative assessment practices should lead students away from the entity theory of intelligence (that knowledge is something you are born with), which is associated with performance orientation (a preference toward familiar activities with a high probability of success, but low opportunity for growth, low initiation, rigid over-simplified thinking, and contempt (Dweck & Leggett, 1988). The close association of these attributes shows that when formative assessment positively impacts one of these aspects, then a fundamental change will take place in the beliefs of the student.

Learner empowerment. Learner empowerment can be transferred to students by the empowering behaviors and choices of the classroom teacher. Teacher communication

through informative and accurate feedback and the presentation of meaningful content enhance feelings of competence in the student (Houser & Frymier, 2009). Communication between teacher and student is a key aspect of effective formative assessment. Formative assessment helps students to feel they are competent learners and provides a sense of accomplishment (Crooks, 1988). This is primarily accomplished with self-assessment through the studetns' involvement in the assessment, communication, and self-monitoring process which helps students to understand the meaning of academic success (Stiggins & Chappius, 2005). The incorporation of formative assessment strategies into the daily routines of teachers has been show to increase the self-esteem, self-worth, and self-competence of students (Miller & Lavin, 2007).

Action Research Question

Underachieving at-risk students have the same cognitive ability as their achieving peers, but have lower levels of cognitive and achievement motivation. Low cognitive motivation is a component of the entity theory of intelligence which is associated with low initiation, rigid oversimplified thinking, and performance orientation. A performance orientation predisposes individuals to gravitate towards things they already known how to do, where the challenge is low, the opportunity to learn is minimal, and the chance of success is high. Armed with this set of beliefs, the prospects and possibilities for learning are greatly diminished for these students.

Formative assessment has been shown to positively impact motivation, self-esteem, and student engagement. These traits are closely associated with other aspects of the incremental theory of intelligence: mastery orientation, persistence, and high cognitive processing. By adopting the incremental view of intelligence, at-risk students

have the potential to gain cognitive and achievement motivation, closing the gap between achieving and underachieving students.

The aim of my action research project is to use formative assessment techniques to change the way my at-risk students perceive themselves as learners of mathematics. Positive changes in epistemological beliefs and self-efficacy could overcome the barriers of low cognitive and achievement motivation and allow these students to perform at their true cognitive ability.

Method and Analysis

Setting

This action research study was conducted in a public high school located in the Puget Sound region of Washington State. County, city, and school characteristics are provided in Table 2 below (U. S. Census website; OSPI website). As of October 2008, the high school had an enrollment of 1,478 students, with an on-time graduation rate of 80.1% and an annual dropout rate of 4.9% for the 2007-2008 school year. As of May 2009, 27.8% of the students qualified for free or reduced-price meals, 9.8% of the students are classified as special education, and 5.4% of the students were classified as transitional bilingual (OSPI website).

Table 2

County, City, and School Characteristics

	County	City	School
Median household income	$60, 174	$55,740	-
Below poverty level	7.1%	7.8%	-
Foreign-born	6.7%	9.2%	-
White	84.1%	77%	61.8%
Asian/Pacific Islander	5.6%	8.6%	15.5%
Black	3%	5.6%	5.8%
American Indian/Alaska Native	1.4%	1.3%	3.5%
Other	2%	3%	-
Hispanic/Latino	5.9%	6.6%	11%

Note. Hispanic/Latino data for County and City included other races

Participants

Originally, a total of 157 students, all of whom were students in my classes, intended to participate in this action research study. At first, these students were comprised from five separate sections: two sections of "Algebra Readiness," and three sections of "Segmented Mathematics." In addition to being students enrolled in my classes, the commonality between these two groups of students and the main reason for these students' inclusion in this study is that they had all not met standard on the district or state assessment for their particular grade level. Based on that measurement, that data indicates that these students were underperforming at the appropriate mathematical level for their grade. As such, these underachieving students fit the profile of at-risk students as defined in Chapter 1 of this study: students who had not met the proficiency standard on the appropriate district- or state-wide standardized assessment for their grade level.

Algebra Readiness. The Algebra Readiness course consisted of ninth grade students who did not demonstrate a sufficient level of mathematical proficiency on the school's Diagnostic Online Mathematics Assessment (DOMA) during the previous school year. Students who did not meet standard on the DOMA were recommended to enroll in Algebra Readiness for the current school year, but had the option to attend an abbreviated course based on the Algebra Readiness curriculum provided free of charge by the district during the summer before their ninth grade year. The goal of this summer course was to improve students' mathematical abilities so that they would possess the prerequisite skills necessary to enroll in Algebra 1. These students also had the option to choose to enroll in Algebra 1 despite the results of the DOMA and prior teacher recommendation. As such, the Algebra Readiness course (with the exception of the

transfer of one 10th grade student from another district) consisted of students who did not meet standard on the DOMA, did not enroll in the summer school program, and elected to follow the recommendation of the previous year's mathematics teacher. Algebra Readiness was a new course for the 2010-2011 school year at the high school where this study was conducted. The Algebra Readiness course focused on successfully preparing and transitioning students into Algebra 1 for the subsequent school year, through utilizing the Keys to Algebraic Success (KEAS) curriculum.

Attrition midway through the treatment period. During the third week of the action research project, the Algebra Readiness students, as well as all freshmen in Algebra 1, were given the EasyCBM test. This test was designed to determine a baseline for the mathematical ability of these students, who would subsequently be tested once per quarter in order to monitor their progress. During the fourth week of the treatment period, the results of the EasyCBM data as well as the score on the 8th grade Measurement of Student Progress, a statewide standardized assessment, were received for all freshmen. While the Algebra Readiness class was designed for students who did not yet possess the skills to be successful in Algebra 1, the results from these two exams indicated that a significant amount of the Algebra Readiness students were more than prepared for Algebra 1, and several Algebra 1 students would have been more appropriately placed in Algebra Readiness.

Because of this, students' schedules were changed to ensure that they were enrolled in the appropriate mathematics class. At this point in the treatment period, I made the decision that there was not enough time remaining to include these new students in the data for the action research project. Additionally, with the influx of new

students, the make-up of the class, as well as the goals of this class, changed significantly. Essentially, I was starting the course over from the beginning of the curriculum and reintroducing the formative assessment practices to the students who had been enrolled since the start of the school year. Since this change disrupted the progress that had been gained thus far in the course and with the time constraints of nine weeks to gather data, I decided that even the students who remained in the class from the beginning of the treatment period would not be representative of the effects of appropriately applied formative assessment practices. While these practice continued within the course, I determine that only the Segmented Mathematics students would be included as participates for the findings of the action research project. I intended to look at the results from all of my Algebra Readiness students at the end of the 2011 school year for my own information and professional growth.

Segmented Mathematics. The Segmented Mathematics course consists primarily of eleventh or twelfth grade students. Similar to the Algebra Readiness course, students enrolled in Segmented Mathematics had not met standards on the Washington Assessment of Student Learning (WASL) or High School Proficiency Exam (HSPE) in previous attempts during high school. Students who did not meet standard had the option of enrolling in another mathematics course if they chose, but it was recommended that they enroll in Segmented Mathematics.

While the Segmented Mathematics course had been offered at my high school in previous school years, its original intent was to serve as an alternative course for students who did not meet standard on the mathematics section of the WASL (OSPI website). However, with the adoption of the revised 9-12 Mathematics Standards of Washington

State by OSPI in July 2008, the course as originally designed no longer aligned with the stated objectives of the state. As such, the OSPI website advises that "these modules could be adapted to the new high school standards to provide the same resource." Since this course emphasized the Algebra and Geometry state standards, following the recommendation of OSPI, this course primarily consisted of activities from the Segmented Instructional Support Modules. Also included were those activities that were able to be adapted to fit the new standards, as well as supplemental materials from the College Preparatory Mathematics (CPM) curriculum (which is used as the core curriculum for the Algebra 1, Geometry, and Algebra 2 courses).

Formative Assessment Practices

The purpose of this action research is to determine how at-risk students' epistemological beliefs and self-efficacy is affected by the use of formative assessment practices. Based on the literature review, two separate formative assessment strategies were selected as a means to investigate the effects of these practices on the beliefs on at-risks students: daily, skill-based end-of-period exit slips and weekly student self-assessments.

Daily exit slips. The first type of formative assessment practices were implemented on a daily basis starting in the first full week of the school year and continued throughout the entire first quarter (a total of 40 school days). Rather than using a pre-designed formal worksheet for the daily exit slips, students added these problems to the end of their class work or take out a piece of scratch paper to work out the problems. The problems for the exit slips were always skill-based questions that related directly to the topic studied in class that day. These problems were displayed on the board during

the last five or ten minutes of class and typically consisted of three problems. These formative assessments were evaluated by me on a nightly basis in order to provide feedback to the students the next day. However, the assessments were not included as part of the students' grades. These formative assessments were handed back to the students at the beginning of the following class period and common themes which I noticed in the student work were discussed for approximately five to ten minutes before beginning that day's lesson. During this discussion period, students were also given the opportunity to ask questions and have problems worked out on the board either by myself or other students who volunteered.

Weekly self-assessments. Additionally, students engaged in a second form of formative assessment practices through the use of formal and informal self-assessments at the end of each full school week. These self-assessments were conducted a total of six times during the data collection phase of the research. An example of informal self-assessments was a letter students were to write to their parent or guardian on the back of a progress report, detailing what they were proud of, what they needed to work on, and what their plan was to make the necessary corrections. An example of a formal self-assessment is the "First Quarter Reflection" (Chappuis, 2009). Examples of the formal self-assessments are located in Appendix C.

Data Collection

In order to accurately determine how at-risk students' epistemological beliefs and self-efficacy were affected by the use of formative assessment practices, multiple sources of data needed to be gathered. These sources of data consisted of surveys, student

interviews, student work and self-assessments, and a personal journal of teaching practices.

Surveys. In order to determine students' personally held beliefs and perceptions, surveys were used to collect foundational data on students. As such, pre- and post-surveys were administered to the participants before the formative assessment treatment and again at the end of the study. Students were given the pre-surveys during the first full week of the school year, once per day for five days, during their regular class time. Participants were given a separate paper copy of each survey to respond to anonymously, but students were asked to assign a four-digit code to each survey (comprised of the first initial of their middle name, their two-digit birth date, and their class period), so that pre- and post-survey responses can be compared. Following the treatment period, students were given the same survey questions as post-surveys, conducted in the same manner as before, during the first three weeks of the second quarter. I had originally planned to give the surveys during the first week of the new quarter, but the amount of surveys returned during this period was significantly lower than the pre-survey numbers, so the window for collection was extended.

Five separate questionnaires were developed: Epistemological Beliefs, Learner Empowerment, Self-Perception, Math Interest, and Views on Assessment (see Appendix A for survey questionnaires). The statements on these questionnaires were derived from several different surveys: Epistemological Beliefs Instrument (Jehng, Johnson, & Anderson, 1993), Learner Empowerment Instrument (Frymier, Shulman, & Houser, 1996), Fennema-Sherman Attitude Scales (Fennema & Sherman, 1976), the Rosenberg Self-Esteem Scale (Rosenberg, 1965), Personal Achievement Motivation Questionnaire

(Midgley, 2000), Mathematics-Related Beliefs Questionnaire (Op't Eynde & De Corte, 2003), and Assessment Survey (Brown & Hirschfield, 2007). All original questions that pertained to the beliefs being studied were retained in their original form. The only modifications were that the questions were arranged according to topic to increase the ease for the respondent, adapted to a 5-point Likert scale, and modified for age-appropriate vocabulary (Mertens, 2010). In order to ensure that not all questions were asked in the affirmative, some responses were also reversed scored so that all data analysis results would treat increases in response score as a positive result.

While the surveys provided an opportunity for the true feelings of the participant to be gathered, surveys could only be used to measure a change in opinion over time and are unable to illustrate the mechanism behind that change. Specifically in regards to this research, surveys were used to inform whether changes had taken place in the beliefs of my students, but could not determine if it was the use of formative assessment practices that were responsible for that change. Additional measurements needed to be conducted in order to dig beneath the surface results of the survey data.

Interviews. In order to help determine the possible mechanisms behind the changes in the pre- and post-survey results, interviews were conducted with a particular subset of students. As all of these students were my own, a convenience sampling was utilized (Mertens, 2010). I had originally intended to interview a minimum representative sample of two students from each group whose survey data indicated a positive change, who experienced no or minimal change, and who demonstrated a negative change in their self-efficacy from all the treatment participants. Students whose survey results fit these categories had their four-digit codes from the survey data posted

on the board at the front of the class and were asked to come see me if they were willing to be interviewed. I had intended for the interviews to take place in a strictly voluntary manner in order to minimize the potential for biased responses. However the method for selecting individuals willing to be interviewed needed to be adjusted. Due to time constraints and an inability or unwillingness to take part in the interview process on the part of those students whose survey data indicated interesting results, I opened the opportunity to participate in the interview process to all willing students. This interview data was extremely important to allow the students to give their firsthand account of what they attributed their changes in beliefs.

A total of five students were interviewed. Of those interviewed, four were female, one was male, two were juniors, and three were seniors. All interviews were conducted after school, except for one which occurred during the student's lunch period based on the preference of that student. These interviews took place in a semi-structured manner (Mertens, 2010). A list of general questions were prepared ahead of time to be used as conversation starters with the participant (see Appendix B for interview protocol). All questions were read aloud to the student and the conversation was allowed to flow naturally with some follow-up questions not listed as part of the general questions was asked if necessary. Depending on the responses already elicited by the participant some but not all of the questions were asked. The goal of the interview process was to determine what aspects the students were able to identify as being responsible for the change, or lack thereof, in their epistemological beliefs and self-efficacy.

Student work and self-assessments. While the pre- and post-survey results allowed for a comparison between the amount of change in beliefs from the beginning of

the treatment period to the end, and the interviews allowed for students to share their reflections about how formative assessment practices have or have not influenced their beliefs, both of these measures were unable to account for the ongoing transformations in beliefs of the students during the course of the treatment. To collect data on beliefs during the treatment period, samples of student work were collected in which students were asked to complete self-assessments.

Having students engage in self-assessment has been a regular practice in my classroom throughout my teaching career. These self-assessments took a variety of forms. Typically they consisted of an informal response to a conceptual question from the current unit included in their notes, a summarizing sentence at the end of a homework assignment telling me their level of confidence, or an exit slip explaining one thing they learned and one thing they have a question about from that period's activity. As part of this study, the exit slips that were used on a daily basis were considered a formative assessment relating to the skills practiced that day in class, and not a self-assessment of the students. However, in order to keep track of the ongoing shifts in beliefs of the participants during the treatment, students were asked to complete a formal self-assessment at the end of each school week. A total of six student self-assessments were completed during the treatment period. These self-assessments consisted of two "Progress Report Reflections" (letters written to a parent or guardian reflecting on the students current grade, what was the reason for the current grade, and what they could do to maintain or improve on that grade), two "Assessment Dialogues" (Chappuis, 2009) for general daily assignments, one "Reviewing and Analyzing Results, Secondary Version" (Chappuis, 2009) for summative assessments such as a unit test, and one "First Quarter

Reflection" (Chappuis, 2009) on the first nine weeks of the school year (see Appendix C for examples of all formal self-assessment activities). All of the self-assessments except for the "Assessment Dialogues," consisted only of the student's own words and reflections without input or influence from the teacher. The "Assessment Dialogues" were the exception to this format and allowed for the student to assess themselves, an opportunity for the teacher to provide their feedback, and then the student could utilize the teacher's feedback before conducting one final self-assessment. Since the nature of formative assessment is to provide students the opportunity to reflect on their progress, provide feedback to the students to guide their own learning, and to use their comments to guide my own teaching practices, students were asked to include their names as well as the work they are assessing on their self-assessments. These self-assessments were expected of the students, but were not given a score or factored into their overall grade, so students were not penalized for failing to complete them. Copies of the formal self-assessments and student work were made and kept for further research and data analysis, while the originals were returned to the student. For the action research project, the copied self-assessments and student work were used to determine trends in students' perception, and whether those changes in perception occur gradually, quickly, or sporadically, and what aspects of the class the students were attributing the changes to.

Personal journal of teaching practices. Throughout the course of the action research project, I kept a journal of all teaching practices employed, my rationale for using those teaching practices, and any observations I made regarding their perceived effectiveness. Additionally, any factors external to the planned treatment methods that might have been disrupted or conducive to the action research project were noted. The

information collected through the journaling process was not used for any explicit data analysis, but rather was referenced when interesting trends present themselves in student work and self-assessment, or from interview responses to provide additional data when needed.

Data Analysis

Surveys. In order to look for total change in the students' epistemological beliefs and self-efficacy during the course of the action research project, responses to each of the five questionnaires were tallied and the mean score and standard deviation was calculated for each category and subcategory. Comparisons between the mean score for each of the categories (i.e. "Mathematical Interest") and subcategories (i.e. "Useful," "Relevant," "Personal Value," and "Attitude") of the pre-survey were compared to the mean score for each of the categories and subcategories of the post-survey. Due to the large amount of students enrolling in the class after the beginning of the treatment period and attrition of students who transferred to different schools or classes, I decided only to compare results for each survey between participants who were present for the entire treatment period and had completed both the pre- and post-surveys for that particular survey. Since the surveys were administered on separate days, not all students who were enrolled in the course during the entire treatment period were present when each survey was conducted. As such, some surveys had a higher number of participants than others. The mean and standard deviation for each category and subcategory are located in Appendix D. Data from the survey responses allowed me to conclude whether or not changes had occurred in any aspect of the students' beliefs, to what magnitude, and whether or not those

changes were significant or not. Additionally, the survey data indicated areas of discussion to be emphasized during the interview process.

Interviews. The interviews were conducted during the weeks immediately after the treatment period concluded. I had originally intended to specifically ask students who were representative of having a positive, neutral, or negative overall change on their survey results. However, time constraints, unforeseen occurrences (such as cancelled or delay school days due to weather), and student willingness to participate in the interview process caused me to open this process to anyone who was willing to be interviewed. The interview responses were essential for understanding what student's were personally attributing their change in perception. As such, the students interviewed were told of the results of the class as a whole, rather than their personal changes as was originally planned.

The majority of these interviewed took place immediately after the school day, with one occurring during the student's lunch period as he requested. A total of five students were interviewed: 4 female and 1 male, 2 juniors and 3 seniors. The interviews were recorded using a digital recorded and took place in approximately thirty minutes. The student response were then transcribed and organized by type of response (i.e. "positive," "helpful," "stressful") and subject discussed (i.e. "teacher," "working in groups," "quizzes") to aid in data analysis.

Student work and self-assessments. Student responses to the weekly self-assessment question or worksheet were photocopied before teacher comments were added and the originals were returned to the students. The copies were examined to look for specific instances of students referring to any type of formative assessment being used

in class, as well as how the students felt about it, whether positively or negatively. While the self-assessments were less detailed than the interview responses, they allowed for a wider range of students to respond over a greater time period.

Personal journal of teaching practice. A personal journal was kept during the treatment period. I recorded what types of formative assessment strategies (exit slips or student self-assessments) were used on each particular day and how I was incorporating the results of both into my teaching practices. Additionally, any observations I made regarding the class was recorded as well. However, during the data analysis phase of the action research project, I tried to rely on this personal journal so that the evidence from the students (surveys, interviews, and self-assessments) would form the bulk of the evidence for my findings. Since my research question dealt with the beliefs of the students, I felt it was more important to let their work and words represent their beliefs as opposed to my own second-hand interpretation of what they were thinking or feeling.

Triangulation of data. In order to look for consistence across the different data collection and analysis methods, triangulation of data was employed (Mertens, 2010). The three main sources of data used in the triangulation process were the pre- and post-survey responses, student interviews, and student self-assessments. The survey data was used to determine what specifically changed for the students during the treatment period. The interviews were used to provide a firsthand account of how and why those changes that were evident in the survey responses took place. The self-assessments responses were used to see what aspects of, and how students were incorporating the use of formative assessments into their daily routines. Additionally, my own personal journal entries were used to corroborate findings brought forth from the students' data and to fill

in additional information when needed. This allowed me to describe a more accurate picture of the effects of formative assessment practices as it applies to changes in the self-efficacy of at-risk students.

Threats to Validity, Credibility, and Transferability

By acting as both the researcher for this action research study and the classroom teacher for the participants, I myself represented a threat to the validity of the study. Student responses may have been swayed by the fact that they were trying to demonstrate that they possessed a greater knowledge than they know more than they actually do in an attempt to influence what grades were to be assigned to their learning. While I did not perceive this to be a case of intentional deception, often student self-assessments expressed a greater level of mastery of the topic than was exemplified by their work. Being that this Segmented Mathematics classes consisted of eleventh and twelfth grade students, some of the participants had been students of mine in previous classes, which might have affected how they responded to the survey questions regarding statements about the instructor or mathematics class. I hoped that most students would understand that I wanted them to be honest in their response to the interview questions and on the self-assessments. This was made explicitly verbally clear to them, this aspect of the data collection process would be most drastically influenced by the status I hold of assessing their work and the power of assigning grades to the students (and in the case of some twelfth grade students, whether or not they would be able to graduate).

Formative assessment is designed to both provide feedback to students regarding their strengths and areas in need of improvement and to inform the teaching practices of the instructor. However, the information I received from my students may not have been

the only source which influenced how I altered my teaching practices throughout the year. The results of a four year study, involving 40 schools, and approximately 20,000 students and 1500 teachers were affected because the researchers noted that the schools were enacting more than one initiative during the course of the research (James, Black, McCormick, Pedder, & Wiliam, 2006). Ongoing professional development, professional learning communities, Kagan cooperative learning strategies training, book studies, and continued enrollment in The Evergreen State College Masters of Education program are all aspects of ongoing education which I participated in during the data collection and analysis phase of the action research project. These sources, along with communicating with colleagues within my high school and from around the district directly or indirectly impacted how I teach my classes. Therefore, the implementation of formative assessment strategies was not the only change that my students were exposed to during the treatment period.

As discussed in the preceding paragraph, being able to isolate only one new practice in my teaching strategy, while keeping all other aspects of my approach to the classroom the same as previous years, would be the best way to measure the effect it has on my students. Unfortunately, all of the participants in my action research projects are members of new classes for the current school year. In the case of Algebra Readiness, this class has never been offered before, and is being developed in tandem with other high school teachers in the district and the district mathematics instruction specialist as the school year progresses. While the Segmented Mathematics class has been offered before, this year it is subject to the revised 9-12 Mathematics Standards of Washington State focusing on Algebra and Geometry, and is comprised of an almost entirely new

curriculum. Since these classes are new, there were no true prior teaching practices to hold constant as I implemented the formative assessment practices. This untested nature of the course could also impact the learning experience of my students.

As referenced previously, a study by Miller & Lavin (2007) indicated that for formative assessment strategies to be effective, students may need to experience them for more than one school year. Taking the results of this study into consideration, the length of the treatment period for this action research project may have been detrimentally short to the effectiveness of the desired results. My total interaction with the students for the entire first quarter consisted of 40 school days (three of which were early release days, with a multitude of assemblies and class meetings). Additionally, student absences and teacher absences shortened the amount of time students were exposed to this treatment.

During the sixth week of the treatment period, one particular event unfortunately contributed greatly to student absences. A student at our high school was killed in a traffic accident, along with two other students who were hospitalized for the incident. In addition to the noticeable effects of student absenteeism, there is no telling what type of other hidden effects this even may have also caused for the students. The student was a well-known senior athlete, and the incident dramatically affected the students in the Segmented Mathematics class, particularly the seniors as he was a member of their graduating class. Additionally, the accident had an overall effect on the entire school, students, teachers, parents, and the extended community, even for those who did not intimately know him.

Findings

History of Intervention Mathematics Classes at Action Research High School

Since first coming to the district in December of 2004, my teaching assignment has kept me involved in at least one of the many mathematics intervention courses we had offered each year. The intervention mathematics classes served a variety of student needs, but were typically designed to support students who were not prepared for Algebra level coursework upon entering high school, or students that had not met the proficiency standard on the state mathematics assessment during their sophomore year. A defining characteristic of the intervention mathematics courses during this time was the extreme amount of change which took place in the choice of curriculum for these intervention classes, a lack of student resources, and which students were allowed to enroll in these intervention classes. The reasons for these changes were typically in reaction to state education policy decisions, but often were the result of district or mathematics department decisions as well.

While the philosophy and model behind how these students' needs were addressed has changed significantly, there has always existed some form of support for these at-risk students during my time at the high school where this action research project took place. These intervention classes had been developed separately for each grade level; they almost entirely were motivated by helping the students prepare for, provide extra practice on, or re-teach content and standards on the WASL (and most recently the HSPE). Throughout my time at this high school, these classes have taken the form of a replacement curriculum, support classes in addition to the students' current mathematics class (with and without a particular curriculum), double periods with the same content

and curriculum to provide the students with additional time, individualized computer-developed worksheets, varying combinations of pencil and paper group work integrated with individualized computer-guided practice problems, and OSPI-developed courses tailored directly to the state standards such as Mathematics Modules, Segmented Mathematics, and Collection of Evidence. Of all the intervention classes, the most successful model was the Collection of Evidence course. Between another teacher who also instructed the Collection of Evidence course and myself, every single student who submitted a completed collection of evidence for evaluation by the state met standard. Unfortunately, despite our success with this program, with the introduction of the new state standards, the Collection of Evidence option was eliminated until the end of the 2011-2012 school year.

Rationale for Action Research Project

Since the format, curriculum, and standards of these intervention classes changed so often and so significantly, I knew that trying to rely on one particular teaching strategy to come along, or putting faith in the fact that a successful intervention class, such as Collection of Evidence, would still exist as a viable option for students year after year was not the best way to help at-risk students. As such, I needed to find some instructional strategy that could be integrated into any type of course or curriculum. This need is what first led me to investigate formative assessment strategies in my intervention classes. After completing the literature review for this action research project, I decided on utilizing two different types of formative assessments: short, daily end-of-period exit slips, and longer, reflective student self-assessment activities at the end of every week.

Review of Study & Preview of Findings

The students from three separate sections of "Segmented Mathematics" classes participated in the action research project. A total of 106 students (57 male, 49 female) were present in those three courses at some point during the treatment period. Of those 106 students, 2 are sophomores, 30 are juniors, and 74 are seniors (including 7 students who were retained from the previous school year), 13 have Individualized Education Plans, 3 have 504 plans, and 9 are English Language Learners. These students all fit the definition of at-risk students for this action research paper given that they had not met the proficiency standard on the appropriate state mathematics assessment for their grade level.

At the beginning of the semester, students were given five separate surveys regarding their opinions about Epistemological Beliefs, Learner Empowerment, Mathematics Interest, Self-Perception, and Views on Assessment. At the end of the treatment period, those same five surveys were again completed by the students, and student interviews were conducted. Data Analysis of changes in pre- and post-survey results, interview responses, student self-assessments, and personal journal entries resulted in the following findings: increased mathematical perception of the students, increase in the incremental view of intelligence, an unanticipated simplification in the students' view of mathematics as well as a decrease in overall self-esteem, and no specific change regarding students' view of assessment. In the following section, I will discuss each of the findings and support the findings with specific examples from my data collection.

Student Attribution of Successful Changes in Beliefs

Awareness of changes. During the interview process, I shared with the interview participants the results of the survey data regarding mathematical perception, views on intelligence, definition of mathematics, self-esteem, and views on assessment for the students as a whole. This was done in order to determine whether or not students agreed or disagreed with the changes that took place during the course, and whether or not they were aware of them. While students indicated that the changes "seemed right," most were not able to say they were aware of them. Only Gwen[1] immediately indicated that she was aware of the changes. Brittney and Yoshi answered in the affirmative after some hesitancy, and Paula stated, "Uh, . . . yeah, I guess so." Ophelia answered that she was not aware of these changes, but did not disagree with them.

Since the students were not necessarily aware of the changes that had taken place, it was not easy for them to verbalize what they thought was specifically responsible for the changes. Most of their comments came in generalities about the course, "I like this class," or "Segmented is the best math class I took," or about my role as their instructor, "'cause you help me a lot," or "you actually taught us something." All four of the students indicated that the teacher, or something unspecified that the teacher was doing, was helpful to their learning. Paula stated, "You actually helped us." Ophelia said, "You actually taught us something."

Crediting the teacher with helping the students learn also occurred on some of the self-assessments, but infrequently. One student indicated that "Mr. Cheney helps a lot." Other students wrote that they were able to learn best when "the teacher helps me," they "see each step by the teacher," and having "a conversation with a teacher and having the teacher helping me." While the latter comments indicate that help from the teacher was

[1] All names in this paper are pseudonyms to protect the identity of my participants

useful, this is more of a learning strategy rather than acknowledging the teacher as the lone source of knowledge or a factor that influenced student belief.

Formative Assessment Strategies. Given that the students were unable to list specific aspects of the course, I specifically asked them their opinions regarding the formative assessment treatments. All but one student indicated that this was the first time they could recall doing any sort of formative assessment. While it is all but a certainty that these students had indeed previously participated in some form of formative assessment, this is indicative of the fact that the particular type of formative assessments I chose to use were new to the students. Paula had noted that she had taken part in formative assessments in "my other math class – Geometry, English, History," but they took the form of reflective writing "only at the beginning and end of the semester."

Daily end-of-period exit slips. While the students responded favorably regarding both types of formative assessments, their responses indicated that the end of period assessments were universally appreciated, "they were good," as Gwen mention, and considered more beneficial to the learning of most students. Student comments also indicated that the end of period assessments were part of their learning process. Brittney stated the assessments "got my brain thinking," and Paula felt they were "refreshing. Keeps my mind going, I guess, eye-opening." Yoshi used them as a way to "review stuff we learned all year, a good thing." Ophelia indicated that the formative assessments were "pretty easy," but "helpful, [the concepts] were actually being explained." These comments show that the end of period assessments were more than just a means for the teacher to understand how my students were learning the material, but also a tool used by the students themselves in order to see if they were understanding the concepts.

Student self-assessments. The formal self-assessments did not appear to be as useful to the students in terms of their own learning. Some students either did not realize what the purpose of the self-assessments were, or did not think they had any effect on their learning. Ophelia specifically stated, "I don't remember it." Gwen stated that "I like it," but "I thought it was a quiz. I didn't really use it though." While Paula, the only student to have recalled previously experiencing formative assessments, stated, "they were OK. Not helpful, but decent. Like, 'Oh yeah, I could use this [math] for the future.' You can reflect on what you do [in class], but it is not helpful for changing [habits] in the future." However, some students indicated that the self-assessment activities were very instrumental in determining how comfortable they were with the material and what their next actions should be to facilitate their learning. Brittney said, "I like it, it gives you good feedback [about what] to work on next." In agreement, Yoshi stated that the self-assessments were "helpful. It's like knowing my opinions about what I hate, what I like, and what I need to do."

Positive Increase in Student Perception of Mathematical Interest, Ability, and Competence

Mathematical Interest.

At the end of the treatment period, the most significant change indicated by survey data, interview responses, student self-assessments, and personal observation was an increase in the perceived usefulness of mathematics for the students. Of the five surveys given, the Mathematical Interest survey, which gauged the students' perception of mathematics as a beneficial means to solve problems and how pertinent it is to their lives, had the greatest overall change in the mean ($\Delta M = 0.11$, $\Delta SD = 0.02$). Despite the increase in mean value and the positive mean score of the post-

survey ($M = 3.47$), student responses during their interviews clearly indicated that mathematics, as a subject, was still not a topic that these students enjoyed. Ophelia said, "It sucks, with three S's. They keep teaching you the same things over and over again. It pushes out the old things to push in the new things, and when you don't remember the old, you can't do the new." However, later in the interview, students indicated that the Segmented Mathematics course, in which they were enrolled in during the treatment period, was not something they necessarily considered to be the same as the mathematics they were referring to early. "You actually taught us something that can be used later," Ophelia continued, "but don't quote me on that because I always tell myself I won't use it." The entirety of Brittney's statement was "I don't really like it, but this course I do. I understand more, I like to figure it out." Gwen echoed the same sentiment stating, "I don't like math, but I like this course. It's easier to understand, more understandable." Yoshi's comments again demonstrate a belief that this mathematics course and the learning he engaged in during class rests somewhere outside of the realm of traditional mathematics, "Last year, I really hate math, I decided I don't do any work. Segmented is much better than [any] math class I ever took." Of all of the students interviewed, only one discussed mathematics in a strictly positive light. Despite having experienced difficulty with the subject in the past, Paula still considered mathematics "challenging, extremely helpful. I think it's the most important actually, not just in school, but in life. It's everywhere, literally everywhere, I mean even in swimming: If I jump into six feet of water, will I hit my head?"

With the exception of Paula, the students' initial comments demonstrated that they still considered themselves to hold a low opinion towards what they defined as

mathematics. Yet later comments indicated that they had a change in opinion regarding mathematics during their time in the treatment period of the Segmented Mathematics course. The students' responses share a common theme of enjoyment, success, and understanding that have not been experienced by the students in some time. These sentiments exemplify the positive results within three of the four subcategories of the Mathematical Interest survey. The subcategories of Personal Value, how important mathematics is to society in general, Relevance, the importance of mathematics within other subjects, and Usefulness, how important mathematics is to the students' future and outside of the classroom all showed an increase in the mean indicating that overall scores increased and were more similar to each other at the end of the treatment period as indicated by a decrease in the standard deviation. The survey results indicate that these changes discussed during the interview responses were not unique to those students, but rather were representative of the students as a whole.

The student self-assessments typically asked questions that pertained to particular assignments, student effort, or study habits. As such, students were much more likely to discuss how they felt about certain aspects of mathematics, like concepts they understood or skills they were struggling with, rather than reporting about their interest in mathematics in general. Despite the fact that students were not prompted to discuss their opinion regarding mathematical interest, specific comments would occasionally show up on their self-assessments. One student wrote that "math is cool" and another stated that "I like math . . . we are learning new things every day." Student responses during the interview process ranged between positive and negative comments. However, although infrequent, any response pertaining to interest in mathematics on the self-assessments

was strictly positive, with a complete absence of negative comments. Additionally, the mean score on the post survey increased, reaching a score almost a half-point above the neutral score (M=3.47). While interview responses may have been mixed, the information from all three sources indicated a greater mathematical interest than before the treatment period.

Mathematical Ability and Competence. The changes expressed in the students' Mathematics Interest were compounded with positive changes in the students' perception of their mathematical ability and competence as learners. The primary indication of this was an increase in the mean score of Mathematics Ability, a subcategory of the Self-Perception survey, and an increase in the mean score of Competence, a subcategory of the Learner Empowerment survey.

The Self-Perception survey measured the students' belief in their ability to do mathematics, their confidence regarding mathematics, and their self-esteem and confidence in general. While the mean score of the Self-Perception survey increased only slightly ($\Delta M = 0.04$, $\Delta SD = -0.02$), the mean of Mathematics Ability increased the most of any subcategory among all of the surveys given ($\Delta M = 0.27$, $\Delta SD = 0.04$). This is particularly significant given that the Mathematics Ability subcategory also had the lowest pre-survey mean ($M = 2.67$) of any subcategory. Interview responses from the students corroborated the increase in mathematical ability illustrated by the survey. Gwen said that she felt "very confident [about class], I understand all of it." Others indicated that for the majority of the course, they have positive feelings regarding their ability. "75% positive, 25% negative," said Ophelia, "sometimes I get it, other times I

blank out." In agreement with her, Paula stated "on a scale of 1 to 10, I'd say I'm a 7. I slack, if I already know it, I don't do [the assignment]."

Additionally, students frequently reported a new found pride in their mathematical ability through their self-assessments. One student stated that "I am proud of understanding math more and being able to do the work." Another wrote, "I am proud of my ability to learn math so fast . . . that I am actually successful doing it." Students also indicated that they were beginning to experience a success in mathematics that they had not experienced in a long time, if ever: "My current grade is an A, it's been a few years . . . my first A in math of my whole high school years," "I am proud of my grade in math because that's about the best grade I have ever gotten," "this is the first A I've goten[2] in math in a year," and "I'm proud of doing well in math for the first time."

The Learner Empowerment survey gathered information regarding what impact and choice students felt they have in their mathematics class, how meaningful the class is, and to what degree they feel competent enough to perform what is required of them in class. As with the Self-Perception survey, the mean score of the Learner Empowerment survey ($\Delta M = 0.06$, $\Delta SD = 0.05$) also increased slightly, but to a greater degree. While the mean score of this category was unremarkable, the Competence subcategory of the Learner Empowerment survey did increase significantly, the greatest increase in mean ($\Delta M = 0.15$, $\Delta SD = 0.02$) of all the Learner Empowerment subcategories. While these survey results indicated that students were feeling more competent in their mathematics class, students expanded upon this change during the interview process. Commenting on this change in competence during the interview process, in response to a question regarding how they feel regarding their work in class, Brittney stated, "I feel very

[2] All student comments were transcribed directly as written

confident, I get the work done in all my classes." Additionally, Yoshi stated that his work is "awesome, I like all my classes [this year]." One student also reported this success with all classes on the self-assessment. Regarding what the plan was for the next quarter, the student wrote, "to do exactly what I did because I was completely satisfied with my report card." The comments by these three students indicate that the change in competence reported on their Learner Empowerment survey has increased regarding all of the classes that they are enrolled in and not just in Segmented Mathematics. Responses from several students on their self-assessments also indicated a sense of competence in mathematics: "I'm actually coming to class and doing all my assignments," "I'm proud of my attention span this year," and "lately, I have been doing my work . . . and I'm going to maintain it."

Increase in the Incremental View of Intelligence

The Epistemological Belief survey asked questions regarding students' beliefs about the nature of intelligence and what types of learning activities they were more likely to participate in. Results from the Epistemological Beliefs survey show that there was a slight increase in the overall mean score ($\Delta M = 0.06$, $\Delta SD = 0.00$). However, the mean scores from the subcategories reveal a mixed result as to the students' perception of learning after the treatment period. Research has shown that there is a positive correlation between a person's belief regarding the nature of intelligence and their goal orientation (Dweck & Leggett, 1988). As such, it would be expected to see all of the subcategories either experience an increase in the mean, or a decrease, but not a simultaneous increase in some subcategories and a decrease in others during the same treatment period (this is expanded upon later on in the Unintended Consequences section

of this chapter). The two subcategories associated with a student's belief about learning and intelligence, Quick Learning ($\Delta M = 0.09$, $\Delta SD = -0.04$) and Innate Ability ($\Delta M = 0.08$, $\Delta SD = 0.02$), both experienced an increase in their mean score. These results indicate that students are now more likely to believe that learning something often takes time and continued effort, and intelligence is something that can be gained as opposed to being a fixed value at birth. While the Epistemological Beliefs survey did indicate mixed results, during the interview process, all of the students indicated that they felt intelligence was something that could be changed, provided the person put in effort. Although Yoshi was not completely sure of the mechanism behind it, he indicated that it had something to do with effort. He stated that intelligence was "something that could change, 'cause, I don't know, do more work, focus on school." Ophelia believed that intelligence could be "changed, because at one time you don't know anything, let's say you're two years old and still don't know how to read, you will eventually. It changes over time if you try." Paula said, "It could be changed. It's a matter of learning: if somebody is determined to learn, then they are going to do it." Brittney indicated that intelligence "can be changed. If you set your mind to it, you can learn it." Gwen also indicated that intelligence "can be changed. Anyone can be better if they try hard enough."

As with the Mathematical Interest category, I would not have expected my students to discuss their beliefs regarding the nature of intelligence on their self-assessments. However, it is the information that was not reported on the self-assessments that provided the best insight into the students' opinion. Of all the formative self-assessments during the entire treatment period, not a single student reported anything

indicating that they were not capable of learning mathematics, that they cannot do mathematics, or that they were not a math person. While the typical responses to questions such as how they could do better or what their goal was for the next quarter consisted of brief answers such as "focus," "study," "pay attention," or "work harder," all of the responses portrayed a student with a plan to do better in the future because they felt this was something that was within their ability to learn. Several students also provided longer answers that expanded upon the sense of being able to acquire knowledge provided they put forth effort: "make sure to complete all my work, check my planner every night," "put my attention to complete and understand upcoming units," and "get better at realy consitrating on my work." While these optimistic comments do not represent an unequivocal belief in the incremental theory of intelligence, the absence of any pessimistic or derogatory comments about their ability to perform what is asked of them lends weight to this conclusion.

Interpretation of Student Attributions. My interpretation of their responses was that I was able to successfully respond to the needs of my students through the use of formative assessment strategies, specifically through the use of daily exit slips. As noted previously, students were not able to readily indicate any specific aspects of the course that they felt might have been responsible for their changes in perception prior to my prompting during the interview process. Additionally, I had to specifically ask each student for their opinion of the treatment methods in order for them to address the formative assessment practices. In order to ensure that I was giving students an opportunity to express their feelings about all parts of the course, students were allowed to present anything about the course that they felt helped or hindered their learning at the

end of the interview. Four of the five students choose to answer the question, with Yoshi deciding that he had nothing more to add to the interview.

All four of the students indicated that the teacher, or something unspecified that the teacher was doing, was helpful to their learning. Paula stated, "You actually helped us." Ophelia said, "You actually taught us something." Gwen mentioned how she "liked that you would come around and help . . . you made sure that we got our work done." Additionally, Brittney also indicated that "if nobody got it, then you would come over and help us out." My hunch is that while the students are not using the term formative assessment practices, the credit given to me as the teacher for having "actually taught [them] something," was because of the alterations I made to the following day's lesson plan based on the information I received from the preceding day's exit slips. Using student feedback is one of the essential aspects of formative assessment, and since I was able to tailor the lesson to compensate for misunderstanding or similar mathematical errors exactly when they needed it, students were crediting me with this help as opposed to the formative assessment practices. However, additional aspects of the course could also have been responsible for the positive opinions of the students.

Other aspects of the course which students credited with helping their learning process was working at their own pace (individualized instruction), a binder with all of the past, present, and future assignments available to the students, that the course focused on a combination of Algebra and Geometry topics, and working in groups. On the student self-assessments, the use of groups was one of the most frequently acknowledged aspects that students credited with helping them learn that was not part of the treatment being used for this action research project. Students stated they were able to learn best

when they "worked with my group members," "sit next to my friends, makes me feel comfortable," and "talk to people around me." While this was brought up frequently, group work was one of the core pedagogical beliefs of the CPM curriculum used in the Algebra and Geometry classes. As a previous teacher of the course I can state that all teachers, including myself, at the treatment high school engaged in group work. Since the majority of the students in the Segmented Mathematics courses had already attempted, but not passed one or both of these courses, while they might have found it helpful to their learning in Segmented Mathematics, it was not a novel approach that can be credited as the sole reason for the students' success.

Only one student listed aspects of the course that could have been better. Again, since I was the one conducting the interview, other students may have had suggestions, but might have been intimidated by my presence and decided not to answer the question. Paula said that it would have been helpful if I had "gone over stuff more clearly, longer, and more often." While not specific, Paula's comments indicated that spending more time going over the results of the end-of-period formative assessments would have been beneficial for her.

Unintended and Unanticipated Outcomes

The questions and topics that comprised the subcategories of each survey were selected and grouped together because they all related to the same subjects. As such, their similar concepts as well as information from the literature review for this action research project suggested that all the related subcategories would all result in the same positive or negative changes. Although these changes might have been of differing

magnitudes, it would not have been expected that some categories would have opposite results within the same survey.

However, that is exactly what occurred with the Self-Perception and Epistemological Belief surveys. While the Mathematics Ability mean increased, the mean of the other two Self-Perception subcategories, Mathematical Confidence ($\Delta M = -0.02$, $\Delta SD = -0.02$) and Self-Esteem ($\Delta M = -0.04$, $\Delta SD = -0.01$), decreased slightly. Akin to the manner in which the students were able to view the Segmented Mathematics course as something separate from their perception of mathematics, the mean scores of the Self-Perception subcategories indicate that the students' Mathematical Confidence and Self-Esteem are not associated with their Mathematical Ability. This indicates that the students were able to compartmentalize away their belief in the ability to do mathematics, while still not considering themselves mathematicians.

One of the subcategories of the Mathematics Interest survey also indicated a negative change contrary to the other three subcategories. The Attitude subcategory measures students' beliefs regarding whether mathematics is a collection of algorithms to be memorized or a method to be used in problem solving. There was a negative mean change at the end of the treatment period for the Attitude subcategory ($\Delta M = -0.17$, $\Delta SD = -0.01$). This indicates that students were more likely to think of mathematics as simply a series of steps to be memorized, or at least more so than when they began the treatment. This could be due to the fact that the end-of-period formative assessments were comprised mainly of low cognitive demand tasks, consisting of questions asking the students to solve a particular set of equations rather than asking the students conceptual questions about the task they were engaged in during class. Questions typically consisted

of skill-based tasks such as "Given $f(x) = 4x + 6$, find $f(8)$" or "Find the 9th term in the sequence: $2, 5, 8, 11, \ldots$" Being that the students experienced the skill emphasizing end of period formative assessments daily, they may have come to think of these simplistic tasks as what I was emphasizing as the main point of the lesson, and therefore the important learning they were supposed to take away from that day's lesson. Since this was an unintended consequence of the action research project, I did not think to specifically address how the students' belief in the nature of mathematics was specifically influenced by the exit slips, and this remains a subject of investigation for the future.

Results from the Epistemological Beliefs survey show that there was a slight increase in the overall mean score ($\Delta M = 0.06$, $\Delta SD = 0.00$). However, the mean scores from the subcategories reveal a mixed result as to the students' perception of learning after the treatment period. The two subcategories associated with a student's motivation, Mastery Orientation ($\Delta M = -0.02$, $\Delta SD = 0.07$) and Performance Orientation ($\Delta M = -0.06$, $\Delta SD = -0.05$), both experienced a decrease in their mean score. These results indicate a slight increase in the preference towards continuing to work at tasks or concepts that the students excel at, and away from activities or ideas that are challenging.

Unaffected Outcomes

When looking at the results of the Views on Assessment survey, there was practically no alteration in students' perception of the role of assessment as indicated by the mean score ($\Delta M = 0.01$, $\Delta SD = -0.16$). However, further analysis of the subcategories indicates that there was some change for particular beliefs. There was an increase in the mean score in the subcategories of Learning ($\Delta M = 0.14$, $\Delta SD = -0.09$) and Useful ($\Delta M = 0.12$, $\Delta SD = -0.11$). These changes indicate that students had a

beneficial change in the perception that assessment helps in the learning process and is a positive aspect of the learning process. There was also a slight increase in the mean score for the Accountable subcategory ($\Delta M = 0.06$, $\Delta SD = -0.34$). This increase indicates that assessments are used to keep students, teachers, and schools honest about the results of the learning taking place within them. Two of the students interviewed gave responses that agreed with these findings. Gwen stated that assessment is used "to see what you know and how you are doing in class." Brittney indicated that "it helps you know if you're understanding most things. If you do bad, then you know what you need to work on." However, this positive perception of assessment was not shared by all students interviewed.

While three of the four subcategories of the Views of Assessments survey increased, the gains of these four subcategories were diminished by one subcategory that decreased significantly. The Negative subcategory ($\Delta M = -0.23$, $\Delta SD = -0.14$) had a negative mean change and a decrease in standard deviation. This indicated that students as a whole were more likely to view assessment as a hindrance to their learning, rather than a benefit, or at least had a less positive perception of assessment than they did prior to the treatment period. Yoshi indicated that assessment causes "stress. Don't like it. Don't like it when the answer is wrong, but I think it's right." More forcefully, Paula responded to the question of her opinion of assessment by stating, "It's bullcrap! Because I took the WASL and the HSPE and I failed the math [section] each time. And not just me personally, it's not fair, it sucks. I don't think it's fair that there is one test that determines whether or not people graduate. It's a waste of time and money. [Class] time should be spend on practicing, not testing. What's the point of testing if you're not ready

to take it?" It is not surprising to me that student from this class would have a negative opinion of assessment, given that all of the students who are enrolled in Segmented mathematics are in the class because they have not managed to pass the mathematics portion of the state assessment or alternative means of assessment. However, it was surprising to see that this negative opinion increased over the course of the treatment period. At this point, I can only speculate that the amount of assessment the students experienced was responsible for the increase in the negative attitude because it took away from time in class that could be spent on teaching and learning. While specific aspects of the students' view of assessments increased, the additional increase in the negative view of assessment as well as the students' comments of the unfair and stressful feelings associated with assessment leads me to believe that the use of formative assessment strategies, at least in the short term, may not beneficially change opinions regarding assessment.

Conclusion

Connections between Research Question, Literature Review, and Study Findings

The motivation for this action research project began with my own teaching experience with at-risk students and was reinforced through the research of Preckel, Holling, & Vock (2006) which found that both achieving and underachieving students had comparable cognitive abilities, but that underachievers possessed lower levels of cognitive and achievement motivation. As a teaching strategy, formative assessment has been shown to be specifically effective for these underachieving at-risk students through positively benefiting their overall achievement (Black & William, 1998). Additionally, Black & William (1998) demonstrated that formative assessment has also been found to positively impact motivation and self-esteem. The combination of the findings from these studies led me to question whether formative assessment strategies could be effective in changing the beliefs of at-risk students. While this action research project did find positive changes in student beliefs, it could not be conclusively determined that formative assessment was the sole factor for that change. Additionally, while formative assessment may have been beneficial for at-risk students, not all formative assessment strategies were equally effective. Of the students interviewed, all participants had a positive opinion of the exit slips and considered beneficial to their learning. This result agree with the findings of Shirvani (2009), who found that the use of daily quizzes given during the last ten minutes of each class period were effective at increasing mathematical achievement. While this study was conducted with students in general, my action research project demonstrated that the use of end-of-period formative assessments are

beneficial to the mathematical self-perception and an increased view of the incremental theory of intelligence for at-risk students as well.

A key component for the effective use of formative assessment strategies is that students should be involved in the assessment process and engage in self-assessments (Black & William, 1998; Stiggins, 1999; Stiggins & Chappius). While my students did complete weekly self-assessments during the treatment period, this was a new experience for many of the students involved, and students did not necessarily understand the purpose of reflection or how to engage meaningfully in the process. As such, students reported that self-assessment was not a significant factor which led to the changes in their beliefs. Additionally, students' self-reported interest in mathematics has been shown to positively correlate with mathematics achievement (Dennisen, Zarrett, & Sungur, 2009). During my action research project, Mathematical Interest had the greatest overall change in mean of all the categories of the survey data. While this action research project did not focus specifically on achievement, every single participant (with the exception of students who were un-enrolled from the class due to excessive absenteeism, long-term suspension, or expulsion) finished the semester by earning a C or higher in Segmented Mathematics.

Some discrepancies between the literature review and my action research project also resulted. Formative assessment has been found to positively impact self-esteem of students (Black & William, 1998). While my students did report an increase in their perceived mathematical ability, they also indicated a decrease in perceived mathematical confidence and self-esteem in general. Additionally, findings from this action research data showed an increase in the incremental view of intelligence, and aspects of deep

learning such as the belief that ability can be developed through effort and that complex topics take significant time and persistence to be understood. Research from the literature review indicated that beliefs in innate ability served as a predicator of goal orientation and that the incremental view of intelligence positively correlated with mastery orientation (Dweck & Leggett, 1988; Kizilgones, Tekkaya, & Sungur, 2009). However the increase in those beliefs for my students also came with a shift away from mastery orientation and towards performance orientation, contrary to those previous findings.

Implications for My Own Teaching Practice

This action research project has demonstrated to me that significant positive changes in student beliefs can occur in a fairly short period of time. From the beginning of my teaching career, I have been searching continually for a way to get my students to believe in themselves, to continue to push forward, and to have faith in their own ability to learn, even when that learning becomes difficult. Working closely with at-risk students, this need to keep students positive about their ability to do mathematics and to be important, contributing members of a collaborative learning community, was all the more important. While I cannot conclusively credit the formative assessment strategy of daily exit slips as the sole factor in the positive shifts in student beliefs, comments reported during the interview process, and the students' appreciation for my teaching practices during the treatment period cause me to infer that formative assessment practices were a beneficial influence on student epistemological beliefs and self-efficacy. While faithfully using formative assessment practices by initiating a routine of daily end-of-period exit slips and weekly student self-assessments, during the treatment period, my

students' interest in mathematics, their perception of their mathematical ability and competence, and their belief that learning can take place through effort and practice increased.

The most beneficial aspect of these formative assessment strategies is that with little effort and great frequency, I was able to gain insight into the thought process of my students, what aspects of their learning was successful, and what needed additional attention, as well as what students had been particularly successful or needed individualized help. Equipped with this knowledge, I was able to go over any misconceptions or common errors from the previous day's assessment and into the next lesson confident that I was starting just where the students needed me. Additionally, the end-of-period assessments gave me a window into the thinking of individual students that needed one-on-one attention so I could help them work through the material they were struggling with. The benefit of the end-of-period assessments was in their ease and frequency: the information gathered daily from the students allowed me to make minor course corrections as we proceed through the mathematics, as opposed to having to stop completely to review previous material if assessment is too infrequently used or relying only on summative assessments. By understanding my students' learning needs and attending to them quickly, I am able to ensure that no one in the class would get too far off-track or become so far behind the rest of the class that they would lose faith in themselves and give up trying.

However, if the formative assessment techniques were solely responsible for the changes in student belief, the techniques I implemented might have been more influential on the students' thinking than I had intended or anticipated. I had focused on two

particular types of formative assessments during the action research project: brief, daily end-of-period exit slips focused on skill-based knowledge (the mechanics behind the mathematics), and longer, weekly student self-assessments (the concepts, learning, and thinking behind the mathematics). Unfortunately, the students were not well-versed or experienced with the self-assessments and did not tend to take them seriously. Often questions that I would have expected several sentences from the students to answer completely were summed up in single words. As such, I think students put too much importance into the daily end-of-period assessment. Since these were a daily occurrence, students may have misinterpreted the frequency with which we completed this activity as an indication of its importance in the classroom. This overemphasis on skill-based questioning on the exit slips may have contributed to the shift in student thinking away from mathematics as a problem solving strategy and towards a belief that mathematics is simply a series of steps in an algorithm to be memorized, as indicated by the Attitude subcategory of the Mathematics Interest survey. Additionally, students began to show a preference towards performance-orientation: a tendency to gravitate towards completing tasks with familiarity, which provide for high levels of success but low levels of new learning.

The benefits that have occurred in the beliefs and mathematical interest of my students during this treatment period have convinced me to continue with formative assessment strategies in the future. However, I feel I need to incorporate more conceptual, open-ended, metacognitive, and higher-order questions into the end-of-period assessments. While the skill-based assessments were successful for the students in the action research project, students need to experience and see the importance of all aspects

of mathematics as well as practice using all aspects of their own thinking process. This change will hopefully develop a more robust definition of mathematics within the students, and allow them more practice with self-assessments between the weekly formal self-assessments.

Limitations and Unresolved Questions

While changes in beliefs definitely occurred with my students during the treatment period, I cannot be completely confident in crediting formative assessment entirely as the source of that change. While interview responses and student comments regarding my teaching style informed my decision that formative assessment was a benefit to students, the minimal mention of formative assessments on the self-assessments as well as the limited completion of self-assessment caused me to be unable to triangulate results as much as I would have liked. Additionally, with the manner in which they were designed, the self-assessments did not prompt the students to indicate what they might find is responsible for changes in opinion, only what their opinions were.

While the study originally included students from primarily from the freshman, junior, and senior class, unforeseen circumstances during the middle of the treatment period caused me to limit the study only to students enrolled in Segmented Mathematics, primarily junior and senior students. I am interested to know if the same changes in belief would have occurred if all grade levels would have been included.

Additionally, this action research was limited only to at-risk students. I am curious to know if these formative assessment strategies would cause similar results in students who did not qualify as at-risk students, but had low epistemological beliefs and self-efficacy.

Finally, the action research project was only a nine-week study (consisted of 40 total full school days). I am curious to know if these positive changes were simply the result of novelty from a unique teaching strategy, or if the positive benefits were simply the beginning of changes that would increase as exposure to these formative assessment strategies continued

References

Beal, C. R., Qu, L., & Lee, H. (2008). Mathematics motivation and achievement as predictors of high school students' guessing and help-seeking with instructional software. *Journal of Computer Assisted Learning, 24,* 507-514.

Bempechat, J. (2004). The motivational benefits of homework: A social-cognitive perspective. *Theory Into Practice, 43*(3), 189-19.

Black, P., Swann, J., & Wiliam, D. (2006). School pupils' beliefs about learning. *Research Papers in Education, 21*(2), 151-170.

Black, P. & Wiliam, D. (1998). Inside the black box: Raising standards through classroom assessment. *Phi Delta Kappan, 80*(2), 139-148.

Black, P., & Wiliam, D. (2005). Lessons from around the world: How policies, politics and cultures constrain and afford assessment practices. *The Curriculum Journal, 16*(2), 249-261.

Byers, T. (2009). The BASICS intervention mathematics program for at-risk students. *Australian Mathematics Teacher, 65*(1), 6-11.

Chappuis, J. (2009). *Seven strategies of assessment for learning.* Oregon: Educational Testing Service.

Crooks, T. (1988). The impact of classroom evaluation practices on students. *Review of Educational Research, 58*(4), 438-481.

Denissen, J., Zarrett, N., & Eccles, J. (2007). I like to do it, I'm able, and I know I am: Logitudinal couplings between domain-specific achievement, self-concept, and interest. *Child Development, 78*(2), 430-447.

Dweck, C. (2007). The perils and promises of praise. *Educational Leadership, 65*(2), 34-38.

Dweck, C., & Leggett, E. (1988). A social-cognitive approach to motivation and personality. *Psychological Review, 95*(2), 256-273.

Gavin, B., & Hirschfeld, G. (2008). Students' conceptions of assessment: Links to outcomes. *Assessment in Education: Principles, Policy & Practice, 15*(1), 3-17.

Gijbels, D., & Dochy, F. (2006). Students' assessment preferences and approaches to learning: Can formative assessments make a difference? *Educational Studies, 32*(4), 399-409.

Ginsburg, H. (2009). The challenge of formative assessment in mathematics education: Children's minds, teachers' minds. *Human Development, 52*, 109-128.

Henning, J., Stone, J., & Kelly, J. (2009). *Using action research to improve instruction: An interactive guide for teachers.* New York: Routledge.

Heritage, M., Jinok, K., Vendlinski, T., & Herman, J. (2009). From evidence to action: A seamless process in formative assessment? *Educational Measurement: Issues and Practice, 28*(3), 24-31.

Houser, M., & Frymier, A. (2009). The role of student characteristics and teacher behaviors in students' learner empowerment. *Communication Education, 58*(1), 35-53.

James, M., Black, P., McCormick, R., Pedder, D., & Wiliam, D. (2006). Learning how to learn, in classrooms, schools, and networks: Aims, design, and analysis. *Research Papers in Education, 21*(2), 101-118.

Kaufman, P., & Bradby, D. (1992). *Characteristics of at-risk students in NELS:88* (NCES 92-042). California: National Center for Educational Statistics.

Kizilgunes, B., Tekkaya, C., & Sungur, S. (2009). Modeling the relations among students' epistemological beliefs, motivation, learning approach, and achievement. *The Journal of Educational Research, 102*(4), 243-255.

Lau, S., Liem, A., & Nie, Y. (2008). Task- and self-related pathways to deep learning: The mediating role of achievement goals, classroom attentiveness, and group participation. *British Journal of Educational Psychology, 78*, 639-662.

Marianne, P., Marion, S., & Gong, B. (2000). Moving toward a comprehensive assessment system: A framework for considering interim assessments. *Educational Measurement: Issues and Practices, 28*(3), 5-13.

Mertens, D. (2010). *Research and evaluation in education and psychology.* Los Angeles: Sage.

Miller, D., & Lavin, F. (2007). 'But now I feel I want to give it a try': Formative assessment, self-esteem and a sense of competence. *The Curriculum Journal, 18*(1), 3-25.

Office of Superintendent of Public Instruction. (2009). *Washington State Report Card*. Retrieved from http://reportcard.ospi.k12.wa.us/summary.aspx?year=2008-09

Preckel, F., Holling, H., & Vock, M. (2006). Academic underachievement: Relationship with cognitive motivation, achievement motivation, and conscientiousness. *Psychology in the Schools, 43*(3), 401-411.

Shirvani, H. (2009). Examining an assessment strategy on high school mathematics achievement. *American Secondary Education, 38*(1), 34-45.

Stiggins, R. (1999). Assessment, student confidence, and school success. *Phi Delta Kappan, 81*(3), 191-198.

Stiggins, R. & Chappuis, J. (2005). Using student-involved classroom assessment to close achievement gaps. *Theory Into Practice, 44*(1), 11-18.

U. S. Census. (2008). *U. S. Census - Fact Sheet – American FactFinder.* Retrived from http://factfinder.census.gov

Wiliam, D., Lee, C., Harrison, C., & Black, P. (2004). Teachers developing assessment for learning: Impact on student achievement. *Assessment in Education, 11*(1), 49-65.

Yin, Y., Shavelson, R., Ayala, C., Ruiz-Primo, M., Brandon, P., & Furtak, E. (2008). On the impact of formative assessment on student motivation, achievement, and conceptual change. *Applied Measurement in Education, 21*, 335-229.

Appendix A: Survey Questionnaires

EPISTEMOLOGICAL BELIEFS RESPONSE FORM

#	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	Students have lots of control over how much they can get out of their education					
2	The statement "Genius is 10% ability and 90% hard work" is *not* true					
3	Even for a smart student, getting ahead takes a lot of work					
4	Some people are born good learners; others are just stuck with limited ability					
5	Students who are mediocre in high school will remain mediocre in college					
6	An expert is someone who has a special gift for a particular field					
7	The really smart students do not have to work hard to do well in school					
8	If I work hard enough, I can usually get what I want					
9	Sometimes I feel that I lack the talent to do well in school					
10	Everyone is born with the ability to learn					
11	Hard work is more important than talent for learning					
12	If you are *not* smart enough, working hard usually does *not* help you learn					
13	It usually takes a lot of time to learn important things					
14	For almost all information that I can learn from a textbook, I can understand most of it on the first reading					
15	Going over and over a difficult textbook chapter many times does not help me understand it any better					
16	Learning is a process of building up knowledge gradually					
17	If I find time to re-read a textbook chapter, I get a lot more out of it the second time					
18	If a person cannot understand something within a short amount of time, he/she should keep trying					
19	If I am ever going to be able to understand a topic, it will make sense to me the first time I read or hear about it					
20	If I cannot understand something quickly,					

	usually it means I am never going to be able to learn it at all					
21	For good students, understanding a concept is easy					
22	Usually the first time I try a new subject, I can tell how well I am going to do at it					
23	Successful students learn things quickly					
24	It is important to me that other students in my class think I am good at my class work					
25	One of my goals is to show others that I'm good at my class work					
26	One of my goals is to show others that class work is easy for me					
27	It is important to me that I look intelligent compared to others in my class					
28	It is important to me that I improve my skills this year in mathematics					
29	I am very motivated to study mathematics					
30	It is important to me that I thoroughly understand my class work					
31	It is important to me that I learn a lot of new mathematical concepts this year					
32	One of my goals is to master a lot of new skills this year					
33	One of my goals in class is to learn as much as I can					

LEARNER EMPOWERMENT RESPONSE FORM

#	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	My math class is consistent with my values					
2	I work hard for math class because I want to not, because I have to					
3	The tasks required in my math class are personally meaningful					
4	I like to talk about what I'm doing in my math class with friends or family					
5	I agree with the standards I must meet in my math class					
6	I find my math class interesting					
7	The tasks required in my math class are valuable to me					
8	I agree with the meaning my math instructor(s) has for what good performance on class work is					
9	I feel confident that I can adequately perform my math duties					
10	My math instructor(s) makes me feel inadequate					
11	I am overwhelmed by all the work my math class requires					
12	I feel intimidated by what is required from me in my math class					
13	I possess the necessary skills to perform successfully in math class					
14	I find my math class to be exciting and energizing					
15	I am able to perform the necessary activities to succeed in my math class					
16	I have the power to make a difference in how things are done in my math class					
17	My participation is important to the success of the math class					
18	I actively participate in all the tasks required in my math class					
19	I can have an impact on the way things are run in my math class					
20	I look forward to going to my math class					
21	My success in this math class is under my control					
22	Potential employers value the tasks required in my math class					
23	I typically do more work than is required by the math syllabus					
24	I have a choice in the methods I can use to perform my math work					
25	My math instructor(s) allow flexibility in the					

	way I perform my tasks					
26	My math instructor(s) believe that he/she must control how I do my work					
27	Expressing my own attitudes and ideas is rewarded in my math class					
28	My math instructor(s) think he/she is always right					
29	I have a high level of autonomy in accomplishing my math work					
30	I can be creative in the way I perform tasks required in my math class					

MATHEMATICS INTEREST RESPONSE FORM

#	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	Knowing mathematics will help me earn a living					
2	Math will not be important to me in my life's work					
3	I'll need mathematics for my future work					
4	I don't expect to use much math when I get out of school					
5	Math is a worthwhile, necessary subject					
6	Taking math is a waste of time					
7	I will use mathematics in many ways as an adult					
8	I see mathematics as something I won't use very often when I get out of high school					
9	I'll need a good understanding of math for my future work					
10	Doing well in math is not important for my future					
11	Math is not important for my life					
12	I study math because I know how useful it is					
13	Some knowledge of mathematics helps me to understand other subjects					
14	Knowing mathematics will help me earn a living					
15	I think mathematics is an important subject					
16	Studying mathematics is a waste of time					
17	I can use what I learn in mathematics in other subjects					
18	I study mathematics because I know how useful it is					
19	Mathematics enables us to better understand the world we live in					
20	I can apply my knowledge of mathematics in everyday life					
21	Knowledge of mathematics is important; it helps us to understand the world					
22	Mathematics is useful for our society					
23	After graduating, I have many opportunities to apply my mathematical knowledge					
24	Mathematics is a collection of facts and processes to be remembered					
25	Mathematics is about coming up with new					

	ideas					
26	I learn mathematics through route learning (memorization, learning by repetition, etc.)					
27	I usually understand a mathematical idea quickly					
28	I cannot connect mathematical ideas that I have learned					

SELF-PERCEPTION RESPONSE FORM

#	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	I am sure that I can learn math					
2	I don't think I could do advanced math					
3	Math is hard for me					
4	I am sure of myself when I do math					
5	I'm not the type to do well in math					
6	Math has been my worst subject					
7	I think I could handle more difficult math					
8	Most subjects I can handle OK, but I can't do a good job with math					
9	I can get good grades in math					
10	I know I can do well in math					
11	I am sure I could do advanced work in math					
12	I'm no good in math					
13	Mathematics is my worst subject in school					
14	Mathematics is a hard subject for me					
15	I am good at mathematics					
16	I think what I am learning in mathematics is interesting					
17	Compared with others in my class, I think I am good at mathematics					
18	I understand everything we have done in mathematics this year					
19	On the whole, I am satisfied with myself					
20	At times, I think I am no good at all					
21	I feel that I have a number of good qualities					
22	I am able to do things as well as most other people					
23	I feel I do not have much to be proud of					
24	I certainly feel useless at times					
25	I feel that I'm a person of worth, at least on an equal plane with others					
26	I wish I could have more respect for myself					
27	All in all, I am inclined to feel that I am a failure					
28	I take a positive attitude toward myself					

VIEWS ON ASSESSMENT RESPONSE FORM

#	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	Assessment is assigning a grade or level to my work					
2	Assessment is checking off my progress against achievement objectives					
3	Assessment is comparing my work against set criteria					
4	Assessment measure the worth or quality of schools					
5	Assessment keeps schools honest					
6	Assessment provides information on how well schools are doing					
7	Assessment changes the way teachers teach me					
8	Assessment information changes the way my teacher teaches me					
9	Assessment helps me improve my learning					
10	Assessment makes me do my best					
11	Assessment provides feedback to me about my performance					
12	Assessment is appropriate and beneficial for me					
13	Assessment is integrated with my learning practice					
14	Assessment is a positive source for improving social climate in my class					
15	Assessment is an engaging and enjoyable experience for me					
16	Assessment interferes with my learning					
17	Assessment is unfair to students					
18	Assessment is valueless					
19	Assessment forces me to learn in a way against my beliefs about learning					
20	Assessment is an imprecise process					
21	Assessment has little impact on my learning					
22	I ignore or throw away my assessment results					
23	I do assessments but make little use of the results					
24	I ignore assessment information					
25	Assessment results should be treated cautiously because of measurement error					
26	Students should take into account the error and imprecision in all assessment					
27	Assessment is a way to determine how much I have learned					
28	Assessment identifies my strengths and weaknesses					

29	Assessment measures my higher order thinking skills					
30	Assessment is objective					
31	Assessment identifies how I think					
32	Answers to assessment show what goes on in my mind					
33	Assessment results predict my future performance					
34	Assessment results are trustworthy					
35	Assessment results can be depended on to show what I really know or can do					

Appendix B: Interview Protocol

INTERVIEW PROTOCOL

1. Results from your survey indicate that you experienced (positive/no/negative) change over the course of the treatment, where you aware of this change?

2. What do you attribute to this change?

3. What is your opinion of the end of period assessments?

4. What is your opinion of self-assessment?

5. Have you ever had these types of assessments in other classes?

6. Do you think that intelligence is something that can be changed, or something that we are born with?

7. How confident do you feel about your work in class?

8. What is your opinion of mathematics?

9. What do you feel the purpose of assessment is?

10. Is there anything you would like to share about the way this class has helped or hindered your learning?

Appendix C: Formal Self-Assessments

Assessment Dialogue (Form A)

Name: _____ Date: _____

Assignment: _____ Feedback Focus: _____

MY OPINION

My strengths are _____

What I think I need to work on is _____

FEEDBACK

Strengths: _____

Work on: _____

MY PLAN

What I will do now: _____

ETS Assessment Training Institute, 2009.

Reviewing and Analyzing Results, Secondary Version

Name: _____ Assignment: _____ Date: _____

As you answer each question, decide whether you feel confident in your answer or are unsure about it and mark the corresponding box.

Problem #	Learning Target #	Confident	Unsure		Right	Wrong	Simple Mistake	Don't Get It

Analyzing My Results

1. After your test has been corrected, identify which problems you got right and which you got wrong by putting Xs in the "Right" and "Wrong" columns.
2. Of the problems you got wrong, decide which ones were due to simple mistakes and mark the "Simple Mistake" column. (If it was a simple mistake, you can correct it without help.)
3. For all of the remaining wrong answers, mark the "Don't Get It" column.

ETS Assessment Training Institute, 2009.

Reviewing and Analyzing Results, Secondary Version *(continued)*

Name: _____ Assignment: _____ Date: _____

My Strengths

To identify your areas of strength, write down the learning targets for problems you felt confident about **and** got right.

Learning Target #	Learning Target or Problem Description

My Highest Priority for Studying

To determine what you need to study most, write down the learning targets for problems you marked "Don't Get It" (problems you got wrong, NOT because of a simple mistake).

Learning Target #	Learning Target or Problem Description

What I Need to Review

To determine what you need to review, write down the learning targets for problems you were unsure of and for problems on which you made simple mistakes.

Learning Target #	Learning Target or Problem Description

ETS Assessment Training Institute, 2009.

Reflecting on the First Nine Weeks (page 1)

NAME: _____ DATE: _____

Overall

This grade/class is _____. (harder, easier or about what I expected)

Socialization

The first nine weeks, I socialized:	Too much	Enough	Not enough
The first nine weeks, my parents think I socialized:	Too much	Enough	Not enough

Homework

I complete homework on time in ALL classes.	Yes	No
I check my agenda book AT HOME EVERY night.	Yes	No
I have a comfortable, well-lit place for doing homework.	Yes	No
I have a regular homework time.	Yes	No
I complete my homework before picking up the phone or turning on the TV etc...	Yes	No

Study Habits

The first nine weeks, I studied:	Too much	Enough	Not enough
The first nine weeks, my parents think I studied:	Too much	Enough	Not enough
I typically wait until the night before a test to study.	Yes	No	

Class

I ask questions in class.	Too much	Enough	Not enough
I feel comfortable asking teachers for help.	Yes	No	
I participate in classroom discussions.	Yes	No	

- The teacher was to ask me to stay with
- when I'm absent...

Reflecting on the First Nine Weeks (page 2)

Report Card Reflection

I think I did my best work during the first grading period.	Yes	No
My parents will think I did my best during the first nine weeks.	Yes	No
My teachers think I did my best during the first nine weeks.	Yes	No
My grades represent what I have learned in class.	Yes	No

I learned best when I was able to _____

_____

_____

If I had the quarter to do over again, I would _____

_____

_____

For the second nine weeks, I have decided to _____

_____ so that I'll be more satisfied with my report card.

After reviewing my first nine weeks reflection I have decided that...

My challenge is:

My goal is:

Adapted with permission from Jessica Cynkar, unpublished classroom materials, Olentangy Local School District, Lewis Center, OH, 2008.

Appendix D: Tables of Survey Results

Table 3

Differences in Pre- and Post-Survey Results: Epistemological Beliefs

	Pre-Survey		Post-Survey		Change	
Characteristic	*M*	*SD*	*M*	*SD*	*M*	*SD*
Innate Ability	3.36	0.92	3.44	0.94	0.08	0.02
Quick Learning	3.23	0.93	3.32	0.89	0.09	0.04
Performance Orientation	3.28	0.93	3.22	0.88	0.06	0.05
Mastery Orientation	3.66	0.91	3.64	0.98	0.02	0.07

Table 4

Differences in Pre- and Post-Survey Results: Learner Empowerment

	Pre-Survey		Post-Survey		Change	
Characteristic	*M*	*SD*	*M*	*SD*	*M*	*SD*
Meaningfulness	3.15	0.87	3.18	0.96	0.03	0.09
Competence	3.29	1.03	3.44	1.05	0.15	0.02
Impact	3.35	0.86	3.31	0.87	0.04	0.01
Choice	3.23	0.80	3.32	0.87	0.09	0.71

Table 5

Differences in Pre- and Post-Survey Results: Mathematics Interest

	Pre-Survey		Post-Survey		Change	
Characteristic	*M*	*SD*	*M*	*SD*	*M*	*SD*
Usefulness	3.52	0.99	3.66	0.96	0.14	0.03
Relevance	3.41	0.93	3.62	0.91	0.21	0.02
Personal Value	3.39	0.91	3.61	0.88	0.22	0.03
Attitude	2.86	1.01	2.69	1.00	0.17	0.01

Table 6

Differences in Pre- and Post-Survey Results: Self-Perception

	Pre-Survey		Post-Survey		Change	
Characteristic	*M*	*SD*	*M*	*SD*	*M*	*SD*
Mathematical Confidence	2.89	1.10	2.87	1.08	0.02	0.02
Mathematical Ability	2.67	1.02	2.94	1.06	0.27	0.04
Self-Esteem	3.73	0.89	3.69	0.88	0.04	0.01

Table 7

Differences in Pre- and Post-Survey Results: Views of Assessment

	Pre-Survey		Post-Survey		Change	
Characteristic	*M*	*SD*	*M*	*SD*	*M*	*SD*
Accountable	3.18	1.13	3.24	0.79	0.06	0.34
Learning	2.93	1.09	3.07	1.00	0.14	0.09
Negative	3.32	1.04	3.09	0.90	0.23	0.14
Useful	3.01	1.08	3.13	0.97	0.12	0.11