THE EFFECTS OF HIGH STAKES TESTING ON TEACHERS IN NJ

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ABSTRACT

A great number of teachers in the United States have found themselves wrestling with an internal conflict between their teaching beliefs and a need to revert back to traditional modes of teaching in order to have their students demonstrate proficiency on high-stakes tests. While they want to include more non-traditional methods in their repertoire of teaching strategies, they fear that in implementing these methodologies their students will not be prepared for success on standardized testing. This paper examines why teachers experience this conflict, even when they have a commitment to non-traditional teaching strategies. Additionally, the data that is presented will demonstrate that students can and do develop computational skill, a necessity for achievement on standardized tests, in a learning environment that fosters inquiry, discovery and problem- solving.

Keywords: High Stakes Testing, NJ Education, Models and Modeling, Middle School Education.

INTRODUCTION

When the United States participated in the Third International Mathematics and Science Study (TIMSS) in 1995, and again in 1999, 2003 and 2007 (which was later called Trends in Mathematics and Science Studies), the results for the United States were abysmal. In fact, the United States has scored 19th, behind countries such The Slovak Republic, Slovenia, Latvia and Bulgaria.

These poor scores brought about two discrete phenomena that led to distinct results. Firstly, researchers opted to examine the education in successfully-testing countries in an effort to glean information that could productively impact the education system in the United States. In the forefront of this research were James Stigler and James Hiebert, who wrote several articles and the book, The Teaching Gap: Best Ideas from the World's Teachers for Improving Education in the Classroom (1999). Their studies led to the development of a set of widely disseminated compact discs, workshops and training sessions for teachers and teacher educators, designed to guide participants towards more effective mathematics instruction based upon the educational practices in countries that were successful in the TIMSS studies. Many teachers thereby embraced practices that were inquiry-based and included problem-solving in an environment that fostered safe exploration.

Secondly, in 1999, then Secretary of Education Richard W. Riley established a National Commission on Mathematics and Science Teaching for the 21st Century. The Commission was chaired by astronaut and former Senator John Glenn (thus, this group was also known as The Glenn Commission) and was charged with creating an action plan that would improve the quality of teaching in mathematics and science at all grades nationwide. Later that year, the report, Before It's Too Late, was released, indicating that there was a systemic weakness in what came to be known as the STEM areas of education. STEM is an acronym for Science, Technology, Engineering and Mathematics. This confirmed the findings of the TIMSS reports. It was this report that helped stimulate the creation of the No Child Left Behind (NCLB) legislation in early 2002.

One of the significant elements of the NCLB legislation was an increased amount of attention focused on testing as a measure of accountability in compliance with the legislation. This testing became high-stakes for districts and individual schools, as federal monies were tied to success. Thus, teaching that was specifically geared to success on standardized tests was pervasive throughout the schools in New Jersey. Many teachers who claimed to believe in the validity of inquiry-based mathematics teaching reverted to more traditional methods for fear that students would not learn enough to be successful in these high stakes tests. (Schorr & Bulgar, 2002a; 2002b; 2003; Schorr, Bulgar, et.al. 2002; 2004.) Therein lays the dilemma for teachers who believe in what has become known as teaching mathematics with a reform perspective versus traditional and procedural teaching that had been the norm in this country for many years.

Many teachers and administrators have demonstrated that they do not have the confidence to pursue the former type of study for fear that high stakes test scores will plummet, even when they proclaim a belief that inquiry-based, problem-solving instruction builds strong mathematical reasoning. For many teachers, extensive professional development had guided their practices from traditional[1] means of teaching to those practices that build conceptual understanding and mathematical reasoning in their students. Not only were these teachers expected to develop the necessary teaching skills, but also in many cases this required that they dispel their notions of what mathematics classroom environments are like based upon their own robust internal models (Schorr & Lesh, 2003). Teachers have strong models of what teaching should be, at least initially based upon their own experiences as students. Therefore, in reaching conclusions for this paper, a Models and Modeling[2] framework was applied.

The models that teachers have are usually based upon their own experiences as students. These models are very robust, but can be altered through active involvement. Teacher development that effectively modifies teachers' internal models needs to include enhanced subject matter knowledge, knowledge of how children learn the subject matter and how to create environments where students' depth of understanding will flourish (Schorr & Lesh, 2003). If we look at teachers who have actively participated in activities (called Model Eliciting Activities or MEAs) that have resulted in the changing of their beliefs about the way mathematics should be taught, we can understand that because the original models were so robust, the changes remain fragile for a while. Therefore, the newly developed ideologies are vulnerable when teachers face great challenges such as high-stakes testing.

The explorations into how students build computational knowledge that were part of the design of this study were built around the context of fractions. In the process of analyzing data for another study (Bulgar, 2009),it became apparent that the subjects had, in fact, invented their own strategies for understanding and fluently computing problems involving the division of fractions, thought to be among the most difficult elementary and middle school topics in mathematics (Ma, 1999). Since the context in which this study took place is fractions, some exploration of existing literature regarding the difficulties that students encounter when studying fractions for understanding, as well as an exploration of teaching, is considered to be pertinent.

Historically, many students have experienced great difficulty in solving problems involving fractions (cf. Tzur, 1999; Davis, Hunting & Pearn, 1993; Davis, Alston, and Maher, 1991). When considering these difficulties, Towers (1998) states that traditionally, the teacher has been seen as separated from the student, and that teaching and learning have been regarded as discrete entities. Towers' research (1991) examines the role of teacher interventions in the development of students' mathematical understanding, and her findings suggest that children can overcome some difficulties traditionally related to fractions, when appropriate conditions are in place. These conditions exclude didactic teaching of algorithms without understanding the underpinnings of the tasks, and achieve little more than procedural competency, which is easily confused or forgotten.

Lamon (2001) attributes some of the difficulties students have with fractions to their limited ability to extend the meaning of a fraction to its various possible interpretations. She states that a fraction can be

1. Traditional in this paper refers to the type of didactic classroom environment described by Cuban (1993).

2. It is necessary to distinguish between the conceptual "models" that are embodied in the representational media that teachers and students use, and the "mental" models that reside inside the minds of teachers and learners (Lesh and Doerr, 2003). In this work, the robust internal models that all teachers build about teaching will be considered. (Schorr & Lesh 2003).

interpreted as i) a part/whole comparison ii) an operator: iii) a ratio or a rate iv) a quotientor v) a measure. She goes on to suggest that teachers need to provide students an assortment of activities that will enable them to experience each of the meanings of a fraction if they are to be able to flexibly and seamlessly move among the interpretations as they are called for in various problem solving situations.

When internal models are initially constructed to serve in a specific context, remnants of those early models remain and are generalized and transferred to similar problems (Lesh, Lester & Hjalmarson, 2003). Consistent with this notion, Tirosh (2000) discusses intuitively based mistakes by saying that children's experience with the partitive model limits their ability to extend their understanding to division to fractions. This is especially true of problems where the divisor is larger than the dividend. Ott, Snook & Gibson (1991) note that textbooks and classroom examples further limit the experiences of students and their ability to extend their knowledge of partitive division to division of fractions. In order for students to be successful with division of fractions, they must also become familiar with the quotative model of division, which rarely appears in textbooks.

Various conditions affect conceptual change, many involving a departure from traditional mathematics teaching, where students were expected to be passive recipients of knowledge. This is the cornerstone of many test preparation strategies. Students must be given enough time to deeply explore problems (Maher & Martino, 2000). The nature of the mathematical constructions that students build is such that students must take an active role in their development and that takes time. If children did not contribute to their own knowledge, then when we studied their ideas and the development of their thinking, we would, in essence, be studying only teaching (Steffe, 2000).

Method

Research Question and Hypothesis

The hypothesis that guided the work in this paper is that students who are permitted to study mathematics with a focus on inquiry, discovery and innovation also develop the skills needed to be competent and in fact are often much more successful in test performance than their peers, who were taught by traditional means. This would counter many beliefs held by traditionalists who insist that students should be taught mathematics in a very didactic way, with an emphasis on procedural learning. Additionally, it would refute the argument that has influenced many teachers, which is that success on standardized testing can only be achieved through direct teaching of procedures that do not require contextual, deep understanding.

Also explored in this study is an explanation of why teachers who are committed to the teaching mathematics in a non-traditional manner, lapse into procedural, didactic teaching when faced with standardized test preparation.

Data

The initial data collection was formulated for a study of the use of representations (Bulgar, 2009). During the data analysis, it was noted that students seamlessly and flexibly applied skills that enabled them to compute decontextualized problems relating to division of fractions, even though they had not previously experienced such computation in class. The significance of this awareness is that it confirms that students can and do develop computational fluency as they build mathematical reasoning through problem-solving, even though computation is not taught directly. This could have great impact upon teachers who struggle to balance their beliefs about teaching mathematics with the fear of student failure on standardized testing.

In the spring of 2010 and the spring of 2011, through implementation of a grant, the author was able to observe a group of middle school teachers as part of two graduate courses being taught to these teachers. During the spring, test preparation becomes part of the mathematics curriculum. When the work was completed, a questionnaire about the relationship between teaching and testing was administered. There is a log of the observations in the classrooms visited and the mentoring that took place during both semesters. That log will provide a secondary source of data to be examined. The purpose of including this cohort of teachers in this study is to emphasize that teachers who are fully committed to inquiry-based teaching revert to traditional methods as a form of test preparation. This adds the following question, which is explored through models and modeling theory. Why do teachers revert back to more traditional forms of teaching as a means of test preparation, even though they are convinced that superior teaching methods exist?

Setting, Subjects and Tasks

The first data set was collected in a suburban parochial school that attracted students from several surrounding towns. All of the students were female and in sixth grade at the time of the study. The author was the mathematics teacher for these students during both fifth and sixth grade. Over the course of the two years of schooling, these students were not taught any algorithms and the classroom culture was such as to allow for safe exploration of problems that would help students develop mathematical reasoning. The data for this paper were collected as the students worked on a series of fraction division tasks. Some were problem solving tasks and some were computational tasks that were to be solved using a representation of their choice.

The secondary data set, consisting primarily of an observation log, mentoring log and anecdotal information was collected by the author as part of the implementation of a NJ State grant[3]. These data were collected during the spring of 2010 and the spring of 2011, the times customarily devoted to standardized test preparation. This school is in an urban setting and has consistently done poorly on standardized tests. It is a large district having 3 middle schools. At the time of this writing, scores for the most recent testing were not available.

Results and Discussion

Sixth Grade Students

Since this same group of students, with two exceptions, had been instructed by the same mathematics teacher the year prior, many longitudinal aspects of the teaching and learning of mathematics can be examined.

One of the activities completed in the fifth grade, in May 2001, was one called Holiday Bows[4] (Bellisio, 1999, Bulgar, 2002, 2003, 2004, 2009). In this activity, students are asked to determine how many bows of varying fractional sizes could be made from a variety of natural number sized ribbons. Two salient elements of this problem assignment should be noted. Firstly, in compliance with what was at that time the State Standards for Mathematics in NJ (NJCCCS, 2002) students were experiencing division of fractions in the classroom for the first time. In fifth grade, students were limited to understanding division of a natural number by a common fraction only. Students were given actual ribbons, meter sticks, scissors and string and were permitted to use any additional materials in the classroom that might be helpful.

Students were asked to find the number of bows that could be made from the above lengths of ribbon when the bows required 1/2m, 1/3m, 1/4m, 1/5m, 2/3m or 3/4m of ribbon to be constructed.

Since this problem was assigned in the spring of fifth grade, the classroom culture had been well-established. Students were familiar with not being told how to proceed, but were merely given a task to complete in which the

Singapore	604
Korea, Republic of	587
Chinese Taipei	585
Hong Kong SAR	582
Japan	579
Belgium-Flemish	558
Netherlands	540
Slovak Republic	534
Hungary	532
Canada	531
Slovenia	530
Russian Federation	526
Australia	525
Finland	520
Czech Republic	520
Malaysia	519
Bulgaria	511
Latvia-LSS	505
United States	502 (19th)

Figure 1. Rankings of the Results of the Third International Math and Science Study

3. This work was supported by Federal Grants numbered 09-CC22-G03 and 10-CC23-G03 and managed by the New Jersey Department of Education. Any opinions, findings, and conclusions or recommendations expressed in this paper are solely those of the author and do not necessarily reflect the views of Rider University, Hamilton School District, the United States Department of Education or the New Jersey Department of Education.

4. This problem was initially designed by Dr. Alice Alston and studied in depth by Carol Bellisio in 1999 and Sylvia Bulgar in 2002.

mathematics they developed became a tool for finding the solution to the problem. They could avail themselves of various materials that were found in the classroom. They were accustomed to responding to inquiries as the instructor and any visitors in attendance observed, but clearly understood that their questions relating to procedures were inappropriate. Without being asked, they freely offered explanations of their thinking and expected to write about their findings. The problem was not presented as a division problem, but merely as one that needed a solution.

The first problem given to the students the following school year, in sixth grade, was called Tuna Sandwiches. This problem was created by the author for two purposes. The first was to see if what had been learned about division of fractions in the previous year was retained and the second was to see how students transferred what they had learned in the previous year to a problem that might most easily be represented by an area model. That is, the intention was for the fractions to be based on a portion of a region, rather than a portion of a length as is the case in the linear model that was useful in finding a solution to the Holiday Bows problem.

Providing students with alternate possibilities to build representations gives them the opportunity to establish flexible thinking. This type of mathematical flexibility is particularly important if students are to use knowledge across a wide spectrum of ideas. Fosnot and Dolk (2001) note, "The generalizing across problems, across models, and across operations is at the heart of models that are tools for thinking."(p.81).

Fosnot and Dolk (2001) also indicate that just because we create a problem with certain models in mind, we cannot be assured that these models will be used by students. By creating a problem that was intended to be fundamentally similar in structure to the Holiday Bows yet embodied in a different type of representation, an area model, the notion of flexibility could be explored as well as an examination of the durability of the knowledge the students had demonstrated during the previous year. Again, this problem was not introduced as an example of fraction division.

Students submitted their final letters clearly explaining their solutions. They used charts and drawings to help clarify their thinking and also demonstrated multiple ways in which they thought about the solutions.

Apparently the students had been able to understand various methods for solving the problem. (See Bulgar, 2009, for details regarding the various representations

Name (optional): ______________________________ Grade(s) taught: ________________

- Which of the following do you believe is the most effective means of teaching mathematics?
  1.|__| Through memorization of algorithms
  2.|__| Through demonstration of procedures followed by practice
  3.|__| Through demonstration of procedures, using explanations of why algorithms work, followed by practice
  4.|__| Through inquiry and discovery
  5.|__| Through inquiry and discovery followed by practice
  6.|__| Other (explain) ____
- Did you do anything this year or last specifically to prepare your students for testing? ______
  If so, what did you do? ____
- What is your opinion of the effectiveness of the test preparation? Explain. ______________
  ____
  ____
- Were your students successful on the Standardized tests, this year and last? Explain. _______
  ____
- In general terms, were your students successful in mathematics class? Explain ___________
  ____
- Do you believe the Standardized Test is a good measure of a student's mathematical ability?
- Why or why not? ____
  ____
  ____

Do you have any other comments regarding connections between teaching and testing and between specifically targeted teachings for testing? __________________________________
____
____

Figure 2. Survey for Middle School Teachers

	Ribbon Length of Bow	Number of Bows
I. White Ribbon	Ribbon Length of Bow	Number of Bows
1 meter	1/2 meter	
1 meter	1/3 meter	
1 meter	1/4 meter	
1 meter	1/5 meter	
II. Blue Ribbon	Ribbon Length of Bow	Number of Bows
2 meters	1/2 meter	
2 meters	1/3 meter	
2 meters	1/4 meter	
2 meters	1/5 meter	
2 meters	2/3 meter	
III. Gold Ribbon	Ribbon Length of Bow	Number of Bows
3 meters	1/2 meter	
3 meters	1/3 meter	
3 meters	1/4 meter	
3 meters	1/5 meter	
3 meters	2/3 meter	
3 meters	3/4 meter	
IV. Red Ribbon	Ribbon Length of Bow	Number of Bows
6 meters	1/2 meter	
6 meters	1/3 meter	
6 meters	1/4 meter	
6 meters	1/5 meter	
6 meters	2/3 meter	
6 meters	3/4 meter	

Figure 3. The Holiday Bows Task

used.) Their drawings and writing shed light on how they thought about the problem. When the class shared results, students were able to extend their own understanding by making connections with the ideas of their peers. Those students who did not use a representation to solve the Tuna Sandwiches problem explained their solutions in terms of a linear notion, reinforcing that original models or their remnants for understanding often remain at the core of understanding due to their potency (Schorr & Lesh, 2003).

Approximately six weeks after the students had begun their work on Tuna Sandwiches, they were assigned two non-contextual problems, one at a time, to see how they approached solutions. The first problem was: $2 \div \frac{3}{4}$. In addition to finding a numerical solution, students were instructed explain how they arrived at their solutions. This problem followed the structure of the ones the students had worked with contextually in both fifth and sixth grade. That is, it consisted of a natural number being divided by a common fraction, which up until that point had been the most difficult type of problem they had experienced while working with division of fractions.

One issue that often arises in division of fractions is the need to change the unit while finding the solution. These students did not encounter such a misconception since their solutions were anchored in their concrete constructions. They gave meaning to the numbers. For example, when students divided two meters of ribbon into bows that required 3/4 m for each bow, they were able to understand that the solution represented $2\frac{2}{3}$ bows.

All of the students built linear models, which is interesting because they had used a linear model during the previous year while working on ribbons and bows and more recently most used an area model to solve the Tuna Sandwiches problem. In terms of conceptual understanding this is consistent with the findings of Lesh, Lester & Hjalmarson (2003), who specify that when internal models are altered, they are fragile at first and so the learner may revert back to original models.

The second of the non-contextual problems was the students' first exposure to finding the quotient of a common fraction divided by a mixed numeral, as well as the first time they had been given any type of problem wherein the divisor was greater than the dividend, thereby yielding a quotient that was less than one. As stated previously (See Tirosh, 2000 above), this type of division involving fractions is especially difficult for students to understand. Because students' school experiences leave them most familiar with the partitive model for division, that is, breaking a quantity into a given number of parts, they often have difficulty dividing a quantity (the dividend) by a larger quantity (divisor). They have minimal or no experience for an understanding of how $\frac{5}{8}$ can be divided by 2 ½. The partitive understanding leads students to ask the division question as, "How many times can 2 ½ be found in $\frac{5}{8}$?" Without sufficient partitive explorations in their experiences with whole numbers, students find it difficult to make sense of such a problem.

There were three significant objectives in assigning a problem with these characteristics using only symbolic notation during the sixth grade. The first was to see whether or not the knowledge demonstrated in the past regarding division of fractions was durable. The second was to see if the knowledge was flexible enough to be able to be extended and applied to a problem involving division of a common fraction by a mixed numeral and thirdly, to see if the students would make use of previously employed representations when the specific context was removed. Again, students were encouraged to use any tools and skills they had to make sense of the problem. The latter is important for students to be successful in the computational requirements of standardized testing.

After looking at the students' work, it appears that they all tried to make sense of the meaning of the expression, $\frac{5}{8} \div 2\frac{1}{2}$. All of the students arrived at the correct numerical solution, ¼, but some did so by using what they knew about inverse operations and reinterpreted the expression so that it fit into their zone of proximal knowledge (Vygotsky, 1978). Thus, they reinterpreted the given problem, $\frac{5}{8} \div 2\frac{1}{2} = \square$ to mean that $\frac{5}{8} = \square \times 2\frac{1}{2}$, All of the students justified their solutions using a linear model. This is also consistent with the research leading to The Theory of Understanding (Pirie & Kieran, 1994) in which the researchers indicate that to move an idea forward, one moves backwards at first, but with a deeper understanding of when that inner circle of understanding was initially approached. Viewing this inner circle of understanding in a more resilient manner aids the learner in moving forward past the original starting point. Thus, students moved backwards to their understanding of multiplication in order to make sense of fraction division.

The work of Olivia and Eve indicates that they recognized that division is the inverse operation of multiplication. They state, "Therefore the answer is ¼ because ¼ of 2 ½ is 5/8." They began to build their model and their explanation by constructing 2 ½, which is the divisor and continued by constructing 5/8, which is the dividend and then defined ¼ as the portion that 5/8 is of the divisor, 2 ½. While this method will always work because of the relationship between multiplication and division, it reinforces the research above that claims that it is especially difficult for students to visualize a quotient that is less than one (Tirosh, 2000).

Regardless of the teachers' personal feelings regarding testing, all but one in the observed cohort felt compelled to involve students in some form of rigorous test preparation. The ten teachers ranged from first year teachers (in the spring of 2010) to seasoned teachers with upwards of ten years of experience. The log from the mentoring in classrooms indicates a strong attempt on the parts of all ten teachers to teach through inquiry and to develop a student-centered[5] environment in the classroom. Generally, there were many projects observed that students could use to build mathematical reasoning skills. In some cases, ideas were offered to fine-tune these efforts, based on what was observed.

However when it came to direct test preparation, there was a variety in the reactions to the mandate to use the commercially prepared test booklets. Only one teacher of the ten did not use the booklets at all. She felt confident in her ability to help the students to succeed within the context of her regular classroom activities. For a first year teacher, she displayed a remarkable ability to engage students and maintain classroom management.

One teacher with over a decade of math teaching experience viewed the test preparation booklet compliance as something external to his classroom work, but something that was required.

He "…discussed that our next visit is scheduled to be a test-prep day and he would switch it. I suggested not changing it so we could work on making the test prep more student-centered and inquiry oriented."

SB (Mentoring Log for HZ March 17, 2010)

This teacher was pleased to learn how the work in the practice booklet could be converted to more engaging work for his students.

Another tenured teacher was very focused on her students being successful on the test because of the school-wide and district-wide pressure. The log indicates, *"Most of the activities done at this point in time are selected based upon their expected appearance on the ASK[6] tests."*

SB (Mentoring Log for JE April 19, 2010)

During the following school year, the log for the same teacher indicated the following.

"During our conference we discussed test preparation plans and how it would impact the teaching from now until early May. There will be two days of practice testing. While this will familiarize the students with the format, it will not be done early enough to be used diagnostically. Next year there are tentative plans to do the practice tests early enough for this to take place. We discussed the possibility of one way to use the experience positively. Students could self-diagnose based on where they felt they had the most difficulty and one day the lesson could consist of centers geared to these topics."

SB (Mentoring Log for JE March 16, 2011)

The practice tests mentioned above had a negative impact on the students.

5. Student-centered, in this paper, refers to a focus on what students demonstrate to need from a lesson or activity, rather than what teachers, without consideration of individual students, deem as the procedures that should be followed in teaching. That is, teachers are open to reinforce or extend lessons based on what students' interests and needs are. It requires teachers to listen and observe extremely carefully to what students say and do, so as to facilitate an appropriate intervention when necessary. It also includes students in making choices with regards to how they proceed and encourages invented strategies and independent ways of thinking and knowing.

6. The ASK Test is the New Jersey Assessment of Skills and Knowledge

"We discussed the apparent apathy among the students. Most are consistently unprepared and disengaged. This seems to have gotten worse since they had the practice NJASK test. The test was very difficult and [she] hypothesized that they felt demoralized. The test is in four weeks (including one week of spring break), and there is a lot of pressure on teachers for their students to perform."

SB (Mentoring Log for JE April 4, 2011)

Another experienced teacher used packets of pages from the test preparation booklets, and helped students who were having difficulties.

"… students would work in their packets, which were test preparation for upcoming standardized tests in volume of various shapes, using the formulas. At that time, both [KR] and the special education teacher would position themselves at different tables to help anyone who needed extra practice on surface area. [They] walked around asking each student if he or she needs some extra help…"

SB (Mentoring Log for KR March 17, 2010)

Finally, another teacher, who had come to the middle school from the high school, voiced her frustrations about the focus on standardized testing.

"[She] believes that the students are catching on [to] the mathematics that is being taught. She also talked about the pressure to have students perform well on the NJASK test. Though she would prefer to move more slowly, going into some topics more deeply, she feels compelled to "cover" more material than she could if she were to do so.

SB (Mentoring Log for CP April 4, 2011)

It appears that there are several teachers in this particular middle school who feel the pressure to have their students perform well on the standardized testing. In a school, such as the one discussed here, where students have historically not done well, teachers are especially reluctant to deviate from the district's notion of test preparation.

Conclusions and Implications

The surge of teaching reform based upon successful education programs in other countries and the body of research generated have prompted the United States to take action towards improved teaching and learning of mathematics. With the education landscape being greatly impacted by an increase in standardized testing and the high stakes attached to this testing for students, for teachers, for administrators and for the tax payers of districts supporting their schools, all of these stakeholders recognize the gravity of the need for students to achieve high scores. This has left many teachers and school administrators with a dilemma regarding the effectiveness of their newly acquired teaching methods; they are challenged by the fear that students will not demonstrate their knowledge when tested as well as if they used more traditional means of test preparation.

The students in this study were able to solve problems that were decontextualized and therefore demonstrated that they could invent strategies for computation. This is the nature of many problems that are found on standardized tests. Even though the students had not been shown a procedure to compute these problems, they were able to reason effectively to present a solution. Accuracy was universal. Students were even able to extend their knowledge to areas which were far beyond their realm of experience (division problems where the quotient was less than one.) They demonstrated their constructions of sense-making about the meaning of these problems. It is these are skills that will help students succeed on standardized tests. All of the students in this sample did very well on the standardized tests they took at the end of both years, scoring in percentiles ranging from the 80s to the high 90s, though no time was devoted to acquiring procedural knowledge in the forms of algorithms and no time was spent specifically on "preparing for the test." This should provide teachers and school administrators with evidence that students can and in fact are successful on standardized tests if they have been taught mathematics in a manner that fosters inquiry and discovery.

Teachers claim to prefer teaching mathematics through inquiry, discovery and problem-solving. They notice, and it is evident in parts of the mentoring log, that students are more engaged by these methods than they are by experiencing didactic, traditional means of teaching. Yet, when teachers are engaged in test preparation, they see that portion of their curriculum as separate and discrete from the successful, engaging strategies that have been shown to build mathematical reasoning in their students. Therein lays the paradox that is central to this paper.

We can look to the theory of Models and Modeling for answers about why this dichotomy exists. Many teachers have internal models of what teaching should look like, based upon their early experiences as students. Active participation in professional development that contests these traditional notions of education and instills the belief in the value of teaching through inquiry, discovery and student-centeredness is necessary to alter the internal models of teaching that we have. Yet, remnants of these initial robust models remain. The more fragile the newly developed models are, the more likely teachers are to revert to their original models of teaching when they are presented by challenge (Schorr & Lesh, 2003). It is not surprising then that all but one of the teachers in this study, who are outstanding professionals, found themselves "teaching to the test" in spite of it being contrary to their beliefs. It is interesting to note that the only teacher who did not use test preparation materials was the youngest of the group, in her first and second years of experience at the time of this data collection. It is very likely, therefore, that her own experience as a student was not laced with as much traditional teaching as the experiences of her peers.

How do we support teachers and administrators facing these controversial issues? In this paper, it was demonstrated that without didactic practices, students can and do learn to create their own knowledge in mathematics. They were able to tackle very difficult problems that they had not experienced before. They were able to invent strategies to solve decontextualized problems so that they could become proficient in computation. Significantly, when an error was made, the student rectified it independently. Students took responsibility for their own knowledge. It is not until teachers and administrators thoroughly accept that good teaching is the key to test success, without any "test-besting" practices or the use commercially prepared materials that we will see these dilemmas dissipate.

Currently, there is an outcry for test reform as well. It has been stated that the format of standardized tests need to be better aligned with teaching standards. In June 2010, NJ joined most of the country in accepting the CORE Standards for Mathematics (NJCCSS, 2010). In response to this less traditional curriculum, new assessments are being created by the Partnership for the Assessment of Readiness for College and Careers (PARCC) that will be better aligned with not only the content of the new Standards, a guide for what to teach, but with the Standards of Mathematical Practice, a guide for how to teach. The author has been selected to represent NJ in joining a total of 24 states to create and support these assessments. Students, parents, teachers, school administrators and policy-makers are stakeholders in the work that will be done by PARCC. That work is scheduled to begin in late July of 2012. It is the fervent hope of the author, that the issues raised in this paper will be brought to the forefront of those meetings and to school districts throughout the country.

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