Successful Transition from Math Eight to Math I

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Abstract— North Carolina adopted the North Carolina Common Core State Standards (NCCCSS) in K-12 Mathematics and K-12 English Language Arts on June 2, 2010 that were released by the National Governors Association Center for Best Practices and the Council of Chief State School Officers. With the adoption of these state-led education standards, North Carolina is in the first group of states to embrace clear and consistent goals for learning to prepare children for success in college and work. Under the Mathematics Standards, Math I, commonly known as Algebra I, is considered the gatekeeper for students who are college or career ready. There is a significant need to encourage and prepare a higher percentage of minority and non-traditional high school students to pursue careers in the areas of science, technology, engineering and mathematics (STEM) on a national level. High school freshman from schools the twenty-one county region that falls under the school divisions assigned to Elizabeth City State University (ECSU) consistently perform poorly in Math I on the End of Course (EOC) state test annually. This team will seek to examine the challenges to be overcome by eighth grade students to be successful on the Math I state assessment taken at the conclusion of their first semester in five high schools located in three selected school divisions that are in close proximity to ECSU. The Math Team will focus on the skills of North Carolina students that are required to successfully transition from Math 8 to Math I in the North Carolina Common Core Standards for Mathematics.

Index words**:** North Carolina Common Core State Standards for Mathematics (NCCCSS), End of Course Tests, STEM

I. INTRODUCTION

In 2014, mathematics team members from the Center of Excellence in Remote Sensing Education and Research (CERSER) undergraduate research experience (URE) program at Elizabeth State University (ECSU) in northeastern North Carolina embarked on an ambitious research effort titled the *Successful Transition from Math 8 to Math I*. The main purpose of the research documented the practices and perspectives of veteran teachers of Math I (Algebra I) in rural schools populated predominantly by African American students. Over a two-month period, the research team conducted interviews and surveys from twenty-five mathematics teachers in the study. The main goal of this research cited best practices with solutions to meet the challenges of preparing Math I students from Pasquotank, Perquimans, and Washington County School districts located in northeastern North Carolina to enhance the teaching strategies that enabled students in successful participation on the end of course state test.

The purpose of describing the ways the research team developed conceptual frameworks and methodological approaches in their efforts to a responsible study and articulate the roles mathematics teachers play in the lives of their students, two goals came to play a central role:

- Identifying ways in which mathematics teachers in a specific academic and social context assist their students in negotiating identities that have historically been constructed in isolation or in opposition to one another – namely becoming and being an adolescent while simultaneously becoming and being a mathematics learner.
- Identifying the knowledge, professional development, resources, experiences, and rationales mathematics teachers draw on as they engage in this identity socialization work in this particular academic and social context.

II. STATEMENT OF THE PROBLEM

This research observed data on the successful transition from mathematics eight to Math I that presented several views and findings of middle and high school mathematics teachers from three local school districts designed to meet the challenges of students enrolled in face-to-face Math I courses. The data focused on students judged by their schools to be ready to take Math I but who have not mastered skills that equip them to pass the course. Policymakers have persistently called for broadening access to Math I in grades 7 and 8. A 2008 report by the National Mathematics Advisory Panel recommended "all prepared students [should] have access to an authentic algebra course—and [that districts] should prepare more students than at present to enroll in such a course by Grade 8" (2008, p. 23).

This recommendation echoed one made more than 10 years earlier by the U.S. Department of Education, which asserted that all states should invest in expanding access to Math I for middle school students (U.S. Department of Education 1997). These policy statements are built on two bodies of research. One demonstrates that Math I operate as a gateway to more advanced mathematics courses in high school and college.

In schools that do not offer Math I, curriculum offerings may be limited by constraints such as staffing, space, and enrollments—issues that are particularly challenging in small or rural schools, where student populations are low and attracting qualified and experienced teachers is difficult (Hammer, Hughes, McClure, Reeves, and Salgado 2005; (Jimerson 2006). There are some students who are able to learn mathematics at a faster pace. These students may choose to accelerate and take high school mathematics beginning in eighth grade or earlier so they can take college-level mathematics in high school. Students who are capable of moving more quickly deserve thoughtful attention, both to ensure that they are challenged and that they are mastering the full range of mathematical content and skills—without omitting critical concepts and topics. Care must be taken to ensure that students master and fully understand all important topics in the mathematics curriculum, and that the continuity of the mathematics learning progression is not disrupted. In particular, the Standards for Mathematical Practice ought to continue to be emphasized in these cases.

There is research to support that students who took more advanced courses, such as Pre-Calculus in the 11th grade or Calculus in 12th grade, were more successful in college. At the same time, there are cautionary tales of pushing underprepared students into the first course of high school mathematics in the eighth grade. The Brookings Institute's 2009 Brown Center Report on American Education found that the National Assessment of Educational Progress (NAEP) scores of students taking Algebra I in the eighth grade varied widely, with the bottom 10% scoring far below grade level. And a report from the Southern Regional Education Board, which supports increasing the number of middle students taking Algebra I, found that among students in the lowest quartile on achievement tests, those enrolled in higher-level mathematics had a slightly higher failure rate than those enrolled in lower-level mathematics. In all other quartiles, students scoring similarly on achievement tests were less likely to fail if they were enrolled in more demanding courses. These two reports are reminders that, rather than skipping or rushing through content, students should have appropriate progressions of foundational content to maximize their likelihoods of success in high school mathematics. In the Common Core State Standards (CCSS), students begin preparing for algebra in Kindergarten, as they start learning about the properties of operations. Furthermore, much of the content central to typical Algebra I courses—namely linear equations, inequalities, and functions—is found in the standard 8th grade CCSS.

To prepare students for high school mathematics in eighth grade, districts are encouraged to have a well-crafted sequence of compacted courses. The term "compacted" means to compress content, which requires a faster pace to complete, as opposed to skipping content. Both are based on the idea that content should compact 3 years of content into 2 years, at most. In other words, compacting content from 2 years into 1 year would be too challenging for most, and as such content may be omitted. The CCSS have been developed to define clear learning progressions through the major mathematical domains so omitting content is not recommended.

The learning progressions of the CCSS necessitate that students are proficient with the middle school curriculum before beginning high school courses. However, once students begin their high school course, they are not required to enroll in the grade level math. For example, the course sequence for a student taking their first high school course in 8th grade would be:

- 6th grade math (2001 or 2003C), 7th grade math (2001 or 2003C), H.S. Math (course code must have a "Z" as 6th character)
- North Carolina Department of Public Instruction (NCDPI) does not provide specific criteria to place students into compacted courses. However, it is recommended that placement decision be based on solid evidence of student learning using multiple criteria.
- The course code to be used with the compacted courses is 2003C (Accelerated Middle School Mathematics).
- Receiving high school credit is based on SBE policy GCS-M-001. Students who enter high school mathematics in middle school will complete the 4 years of high school math early and earn credit toward graduation; however, students are strongly encouraged to take a mathematics course every year of high school. As such it is important to consider the mathematics course the student will be enrolled in their senior year.
- Students in middle school enrolled in high school courses must take both the grade level EOG and Math I.

III. PURPOSE

The research purpose to find the best practices considered as solutions to meet the challenges of preparing Math I students from Pasquotank, Perquimans, and Washington County School districts to enhance the teaching strategies that enabled student success on the end of course state test. Understanding the factors that influence student success in Math I enhances opportunities for college entrance and career goals that tend to potentially increase participation in science, technology, engineering, and mathematics (STEM).

IV. RESEARCH QUESTIONS

The following research questions guided this study.

1. Does an effective teacher philosophy of teaching and learning enhance student learning?
2. How does understanding student knowledge of math content impact student success?
3. What professional development activities assist in building student test taking skills?

V. METHODOLOGY

A survey research methodological approach was used for this study. Grovesetal. (2004) noted that A survey is a systematic" method for gathering information from (a sample of) entities for the purposes of constructing quantitative descriptors of the attributes of the larger population of which the entities are members" (p. 2). This study was conducted at Elizabeth City State University in northeastern North Carolina with over 2,400 students, and one of the most culturally diverse universities in the state. The research team conducted interviews and surveys from twenty-seven mathematics teachers. The main goal of this research cited best practices with solutions to meet the challenges of preparing Math I students from Pasquotank, Perquimans, and Washington County School districts located in northeastern North Carolina to enhance the teaching strategies that enabled students in successful participation on the end of course state test.

The 25question survey instrument was divided into 5 sections. The data analysis decision for Likert items was made at the questionnaire development stage. Likert questions were unique and analyzed as Likert-type items. The use of means and standard deviations are the appropriate statistical tools to use. The decision between Likert-type and Likert scale was been made to have the appropriate statistics assess the program data. The first section comprised 5 Likert-scale questions that addressed understanding student culture. The second section comprised 5 Likert-scale questions that asked respondents about formal and informal staff development participation. The third section included 5 Likert-scale questions that asked about student response to classroom instruction. Both the fourth and fifth sections asked respondents to formal staff development using 5 Likert-scale questions. The study was approved by the University Institutional Review Board prior to recruitment of students for the study.

A. Analyzing Likert Response Items

To properly analyze Likert data, one must understand the measurement scale represented by each. Numbers assigned to Likert-type items express a "greater than" relationship; however, how much greater is not implied. Due to these conditions, Likert-type items fall into the ordinal measurement scale. Descriptive statistics recommended for ordinal measurement scale items include a mode or median for central tendency and frequencies for variability. The chi-square measure of association is the analysis procedure appropriate for ordinal scale items.

Likert scale data, on the other hand, are analyzed at the interval measurement scale. Likert scale items are created by calculating a composite score (sum or mean) from four or more type Likert-type items; therefore, the composite score for Likert scales should be analyzed at the interval measurement scale. Descriptive statistics recommended for interval scale items include the mean for central tendency and standard deviations for variability. Tables 3-7 provide examples of data analysis procedures for Likert-type and Likert scale data.

VI. SURVEY INSTRUMENT

The 2014 mathematics team conducted a questionnaire and survey to assess the perceived challenges for successful transition from mathematics eight to Math I. The data presented several views and findings by local mathematics teachers from three local school districts. The information gained from the questionnaire and survey instruments were used to inform decisions regarding best practices in Algebra I or Math I for North Carolina to improve student achievement on end of the year assessments. With content input from the faculty mentor, the math team designed a 10-item questionnaire (Appendix A) and a 20-item paper survey instrument (Appendix B) used for data collection with the area mathematics teachers from three school divisions with low end of the year Math I test scores for 2010 and 2012. The questionnaire consists of ten questions were used in a case study format that addressed issues from philosophy of education to evaluation of student work. The survey instrument consists of five sessions. In these twenty-five questions, participants were asked to select their level of agreement with each of the statements first for their math class and second for their science class with 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree.

VII. SAMPLE AND PARTICIPANTS

The data collected and analyzed in this study comes from 27 mathematics teachers from three counties in northeastern North Carolina, Pasquotank Perquimans and Washington, during the spring of 2014 school year. 44% of the teachers taught eight grade math and 56% of the teachers taught Math I. There was a 100 % response rate for teacher questionnaires and surveys. Human Subjects approval was granted for the initial data collection and follow up with the Elizabeth City State University Institutional Review Board indicated no further approval was needed for the data analysis in this study. From the group of teachers 30% were male and 70% were female also 63% of the teachers had been teaching for ten or more years. 37% taught for ten or less years. Members of the ECSU CERSER Mathematics team collected the survey and interview responses from a majority of the teachers personally.

TABLE I.
Frequency Distribution for Participant Demographics

Pasquotank County	**Math I**	**Math 8**
Northeastern High	4	
Pasquotank High	3	
Elizabeth City Middle		3
River Road Middle		2
Perquimans County		
Perquimans Middle		3
Perquimans High	2	
Washington County		
Creswell High	2	
Plymouth High	4	
Washington County Union		7

Survey Results Group A

1A. 74% of teachers agreed that they have awareness of students previous knowledge level before working with a new group of students, 22% said neutral, 4% said disagree.
2A. 67% of teachers agreed that students are expected to master the content before moving onto new topics, 22% answered neutral, 11% disagreed
3A. 56% of teachers agreed that the frequently collaborated with students former math teachers about teaching strategies, 11% answer neutral and 33% disagreed.
4A. 70% of teachers said that they are working at the same level of achievement and using similar teaching methods, 19% answered neutral, and 11% disagreed.
5A. 70% of teachers said that teachers of former students can easily access students learning from their class, 19% answered neutral, and 11% disagreed.

Survey Results Group B

1B. 81% Agreed that they were provided with knowledge that was useful in the classroom to enhance student learning, 7% disagreed and,11% were neutral.
2B. 51% agreed that Workshop sessions were coherently related to each other, 7% disagreed, and 40% were neutral.
3B. 59% agreed that they were focused on too many topics, 18% disagreed, and 22% were neutral.
4B. 59% agreed that they were provided with feed back about my teaching, 25% disagreed, and 14% were neutral.
5B. 70% agree that they were Led to try new things in the classroom that led to student success, 11% disagreed, and 19% were neutral.

Survey Results Group C

1C. 70% agreed to Assessing a problem and choosing a method to use from those already introduced, 11% disagreed, and 19% were neutral.
2C. 52% agreed to performing tasks requiring methods or ideas not already introduced. 18% Disagreed, and 30% were neutral
3C. 70% agreed to explaining an answer or solution method for a particular problem, 11% disagreed, and 19% were neutral.
4C. 74% agreed to analyzing similarities and differences among representations, solutions, or methods, 11% disagreed, 15% were neutral.
5C. 67% Working on mathematics textbook, worksheet, or board work exercises for practice or review. 11% disagreed, 22% were neutral.

Survey Results Group D

1D. 59% agreed to student assessment 33% disagreed, and 11% were neutral.

2D. 59% agreed to Curriculum materials or frameworks, 22% disagreed, and 18% neutral.
3D. 59% agreed to Use of technology in instruction, 11% disagreed, and 33% were neutral.
4D. 41% agreed to multicultural or diversity issues that affect student learning outcomes, 37% disagreed, and 22 were neutral.
5D. 26% agreed that Parent involvement that enhance student performance in Algebra I, 37% disagreed and 37% were neutral.

Survey Group E

1E. 59% agreed about analyzing Algebra I curriculum materials 26% disagreed, 14% were neutral.
2E. 59% agreed about Improving student skill at designing mathematics tasks for individual students, 26% disagreed, 14% were neutral.
3E. 67% agreed that Improving student understanding of knowledge of patterns, functions, or algebra, 26% disagreed, 7% were neutral.
4E. 56% agreed that extending student knowledge of different representations for number concepts, 26% disagreed, 19% were neutral.
5E. 59% Extending students knowledge of different representations for operations or computation, 22% disagreed, 11% were neutral.

VIII. INTERVIEW RESULTS

Middle and high school mathematics teachers in Pasquotank, Perquimans, and Washington County School Districts must take deliberate action at all stakeholder levels to use data-driven analysis for school improvement is required to close the achievement gap. Model an openness and willingness to use data to enhance teaching and learning. Use quantitative and qualitative data sources to improve instruction and better understand student thinking and learning, including test results, portfolios, homework, student conferences, journals, classroom observations, and portfolios. Work collaboratively with other teachers and school leaders to develop documented patterns of evidence of student learning and to identify areas needing improvement.

Identify and share evidence-based instructional techniques that increase student achievement.

INTERVIEW RESPONSE BREAKDOWN

Middle and high school mathematics teachers in Pasquotank, Perquimans, and Washington County School Districts must take deliberate action at all stakeholder levels to use data-driven analysis for school improvement that is required to close the achievement gap:

- Model an openness and willingness to use data to enhance teaching and learning.
- Use quantitative and qualitative data sources to improve instruction and better understand student thinking and learning, including test results, portfolios, homework, student conferences, journals, classroom observations, and portfolios.
- Work collaboratively with other teachers and school leaders to develop documented patterns of evidence of student learning and to identify areas needing improvement.
- Identify and share evidence-based instructional techniques that increase student achievement.

Best Practices: Ways Teachers Can Keep Common Core Standards Math Scores High

Common Core State Standards (CCSS) are changing the educational system throughout the United States and are designed to improve student achievement, teachers need to find ways to provide instruction that keeps math scores high and still follow the CCSS standards.

Best Practice #1: Selecting and using meaningful algebraic tasks

In a study done by the Center for Research on Effective Schooling for Disadvantaged Students at Johns Hopkins University, Epstein and Mac Iver (1992) reported that students who are frequently taught math via problem solving situations have higher math achievement and are more motivated to ask questions to advance their understanding.

Best Practice #2: Stimulating classroom discourse

Meaningful classroom discourse can greatly influence the depth and breadth of the mathematics students learn. A major goal of discourse should be for teachers to listen to the students and to act on what is being said in order to foster mathematical understanding (Burrill, 1995).

Best Practice #3: Creating a positive algebraic learning environment:

The classroom environment is largely dependent on the teacher. Success for all students in algebra must start with teachers believing that all students can and should learn algebra (Enneking, 1995). Teachers must commit themselves to teaching *all* students and be prepared to develop interesting and meaningful lessons that fully engage *all* students.

Best Practice #4: Analyzing teaching and learning in algebra

The best indicator of effective teaching is student learning. Teachers should constantly monitor student learning and make informed instructional decisions on what to do next.

Best Practice #5: Prioritize Classroom Information

The CCSS math program is difficult for many teachers to implement because of the amount of material each grade level is expected to cover. According to Scholastic.com, teachers will need to change strategies and prioritize the class material to cover as much as possible without leaving students behind.

Best Practice #6: Discuss Lesson Plans with Other Teachers

Discussing the lessons plans with teachers in different grade levels provides an opportunity to solve the gap-in-education problem. Teachers can work out a basic plan to account for missing knowledge and focus on introducing subject matter as efficiently as possible without losing the entire class.

Best Practice #7: Provide Creative Educational Solutions

Creative solutions can mean incorporating technological tools to help students learn the application of concepts or it might mean coming up with homework that provides the in-depth lessons that are not possible in the classroom. Students have different styles of learning, so the educational system needs to provide lessons that help every student.

The “best practices” discussed in this paper give Math I teachers a guideline for what is necessary to teach Math I to all students. By using meaningful algebraic tasks, maintaining classroom discourse, creating a positive learning environment, and continually analyzing teaching and learning, teachers will be engaging in some of the best practices for teaching Math I.

IX.CHI-SQUARE

The Chi-Square Test showed a comparison of observed and expected values the results are shown in the table above. From the results it can be shown that the survey instrument overall received close to the expected value for a majority of the responses. Of the 25 questions 60% was in the 90% range for expected response, which is a high yielding result

X. CONCLUSION

Improving the Effectiveness of Middle and High School Teachers

Most education reformers agree that effective teaching is defined by improving student learning. The best way to improve teacher effectiveness is to provide teachers with support and guidance that are grounded in effectiveness—that is, which uses effectiveness data to enhance professional development, teacher education, and encourage student learning.

Teacher effectiveness is defined as demonstrating contributions to growth in student learning. Good middle and high school teachers accomplish other things, including motivating and engaging students, acquiring new knowledge and skills, and collaborating with colleagues. But those accomplishments best serve their purpose when they lead teachers to improve student achievement. Regardless of the assessment instrument, teacher effectiveness is demonstrated when student learning improves (Darling-Hammond 2007; Gordon et al. 2006).

A complex statistical method for determining the impact a teacher or school has on student achievement is called value-added versus other factors, including income level, prior achievement, and school characteristics. Taking such factors into account, value-added analysis estimates the academic growth a student is expected to make for the year and compares it to how the student actually performs on standardized assessments (Harris 2007; Gordon et al. 2006). Effective teachers administer pretests at the beginning of the year or the start of a unit and then administer a post-test at the end, measuring students’ growth in learning along the way. Interim assessments (also known as benchmark exams), aligned with state accountability tests or even periodic classroom (formative) assessments, can provide more frequent effectiveness data than annual tests. They also provide richer information on what skills or topics students are or are not mastering (Perie et al. 2007). In this way, benchmark exams and formative assessments chart a course for student and teacher improvement. Formative assessments have the added benefit of being tied directly to individual teachers and their classroom practice (Darling-Hammond 2007).

XI. FUTURE WORK

In 2014, a team of Center of Excellence in Remote Sensing Education and Research for undergraduate student researchers embarked on an ambitious research effort titled the Successful Transition from Math Eight to Math I research project. The main purpose of the research was to document the practices and perspectives of 'well respected' teachers of Math I in urban schools populated predominantly by African American students. Over a three-month period, the project team conducted interviews and surveys of the twenty-seven mathematics teachers in the study. The main goal of this research related to finding solutions to the challenges of preparing students from Pasquotank, Perquimans, and Washington County School Districts to success on the end of course Math I state test. The purpose of describing the ways the research team developed conceptual frameworks and methodological approaches in their efforts to responsibly study and articulate the roles mathematics teachers play in the lives of their students, two goals came to play a central role:

- Identifying ways in which mathematics teachers use professional development in a specific academic and social context assist their students in negotiating identities that have historically been constructed in isolation or in opposition to one another – namely becoming and being an adolescent while simultaneously becoming and being a mathematics learner.
- Identifying the knowledge, resources, experiences, and rationales mathematics teachers draw on as they engage in this identity socialization work in this particular academic and social context.

The Successful Transition from Math Eight to Math I research team plans to present findings of this research at local, regional, and state mathematics education conferences and submit this manuscripts for IEEE publication.

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