Math Island at Brewer Elementary School: A learner-centered model for education

Vikki K. Collins, Ph.D.
Associate Professor, Early Childhood Coordinator
Troy University, Phenix City, Alabama.
vccollins@troy.edu

H. Marguerite Yates, Ph.D.
Chair, Education Department
601 Broad Street
LaGrange College
(706) 880-8203

Abstract: This paper examines a learner-centered model for the teaching of elementary mathematics established at an urban Georgia school that serves a highly mobile, diverse population of approximately 475 students. The school was on its state's list of schools needing improvement because students continued to perform poorly on standardized tests. Math Island, a support center for students designed to facilitate the conceptual understanding of mathematics, was created, and professional development programs were implemented to assist teachers in developing their pedagogical and content expertise in the teaching of mathematics. The school made substantial progress after these initiatives were employed and was removed from the Needs Improvement list in 2005-06 and 2006-07.

Introduction

In agreement with the National Council of Teachers of Mathematics (NCTM) document, Principles and Standards for School Mathematics (National Council of Teachers of Mathematics, 2000), the Georgia Department of Education (GADOE) determined that all children in state public schools must learn essential mathematical concepts and processes with understanding. The Georgia Performance Standards (GPS) were created and addressed the issues of rigor, focus, and the teacher’s role in classroom instruction. Content strands in the GPS for elementary students included number and operations, measurement, geometry, data analysis, and algebra. Reading across the curriculum emphasized reading mathematics for all students. The GADOE also decided that mathematics instruction must be learner-centered rather than teacher-centered since teachers must focus on what students are learning in mathematics (Georgia Department of Education, 2005-2006).

A teacher-centered model of instruction has traditionally characterized elementary mathematics education. In this model, a teacher dispenses knowledge to passive students in a competitive and individualistic culture. Students are considered to be learners focused on obtaining the “right” answers. Teaching and assessing are viewed as separate processes as the teacher monitors student learning with the use of objectively scored examinations (Huba & Freed, 2000).

Although the teacher-centered model remains pervasive, a learner-centered model has been found to promote learning more effectively (Marzano, 2003). In a learner-
centered model, attention is given to the knowledge, skills, attitudes, and beliefs that learners bring to the educational setting while building onto their conceptual and cultural knowledge (University of Southern California, 2008). Students are actively involved in the construction of knowledge using the general skills of inquiry, communication, problem solving, and critical thinking. A teacher serves as a facilitator in a collaborative, supportive environment. Teaching and assessing are interdependent with direct assessment through performances, papers, projects, and portfolios (Huba & Freed, 2000).

The change to a learner-centered model for elementary mathematics education has been strongly endorsed by Ms. Paula Thompson, math specialist, at Brewer Elementary School. An urban Title I school in Columbus, Georgia, Brewer Elementary serves a highly mobile, diverse population of approximately 475 students in grades prekindergarten through fifth. The school was on its state’s list of schools needing improvement because students performed poorly on standardized tests. To help implement the GPS, Brewer Elementary adopted America’s Choice School Design (America’s Choice, 2009) to help build mathematical skills, problem-solving abilities, and conceptual understanding. The design complied with the requirements of the federal No Child Left Behind (NCLB) Act of 2001 and focused on standards-based curriculum and instruction such as that required by the GPS. America’s Choice also offered extensive training for teachers and technical assistance in its design (America’s Choice, 2009).

Using the components of the GPS and America’s Choice, Thompson and Principal Jan Grogan created Math Island in one of the school’s classrooms. With a student-centered approach to mathematics, Math Island functioned as a stimulus for conceptual understanding. This paper examined the effectiveness of Math Island on students’ conceptual understanding as measured by GADOE standardized test scores and is limited to limited to mathematics achievement at Brewer Elementary.

Review of Literature

According to Burns (2007), a lack of conceptual understanding contributes to a serious risk of student failure in mathematics. Essential to the successful teaching of mathematics is helping students to make connections among mathematical ideas rather than having them acquire disconnected mathematical facts. Students’ prior learning must serve as the basis for their new mathematical understandings (Vacca & Vacca, 2007) and conceptual understandings must be embedded in students’ explanations. Mere answers without evidence of students’ reasoning are insufficient for judging conceptual understanding (Burns, 2007).

Carter (2009) stated that conceptual understanding is enhanced through writing. By integrating mathematical content during Writing Workshop, students were better able to create and understand stories about mathematical topics. Thought-provoking questions required students to make inferences about content and to examine what they were studying in complex ways (Strong, Silver, & Perini, 2001). The use of illustrations with the mathematical content also seemed to assist in math comprehension and in learner-centered reflection on problem solving strategies (Carter, 2009).

Another strategy to build conceptual understanding in mathematics involved the utilization of study groups (Sloane, 2007). Interaction between students encouraged the
Math Island was organized to serve approximately 475 students in prekindergarten through fifth grade. The urban Title I school served as an elementary science magnet for the school district with approximately 25% of the students being culturally diverse. With a mobile student population and a stable faculty, Brewer students had experienced low standardized test scores, especially in mathematics.

To implement a learner-centered model for mathematics instruction and assessment, Math Island emphasized conceptual understanding by students. There were opportunities to access students’ prior knowledge, engage students in mathematical writing, offer opportunities for student study groups, and include the use of games and manipulatives in daily lessons.

Thompson, the math specialist, scheduled weekly visits by all classes to Math Island and included special education students. In Math Island, Thompson fostered active involvement by students to consider the GPS and concentrate on conceptual understanding. Students became actively engaged in the pursuit of authentic problems or investigations; an investigation could involve determining the number of pockets in the room, measuring the height and width of a table, or designing a bar graph for students’ favorite ice cream flavors. Manipulatives such as base ten blocks, coins, pattern blocks, tangrams, spinners, rulers, fraction bars, dominoes, grids, geoboards, geometric plane and adoption of symbol systems, including those for mathematics (Drew & Rankin, 2007). Flexible student-centered study groups focused on the development of specific skills and concepts. The study group format denoted a learner-centered recognition of individual readiness and differences. Study groups also functioned to offer stimulating challenges to learners (Sloane, 2007).

Mathematical understandings are also enhanced through play. A hands-on approach promoting active engagement utilized open-ended toys and materials (Eisenhauer & Feikes, 2009). The use of concrete and virtual manipulatives furnished students motivating and meaningful opportunities to explore mathematical concepts (Rosen & Hoffman, 2009). A learner-centered strategy encouraged the use of play and developmentally appropriate materials and experiences to foster mathematical understanding by students (Feikes, Schwingendorf, & Gregg, 2008).

Together with active involvement by students in a supportive environment with a collaborative teacher, the learner-centered model of mathematics education required an interdependence of teaching and assessing. To maximize student achievement, ongoing assessment and continual adjustments in the classroom were necessary (McTighe & O’Connor, 2005). In keeping with the tenets of standards-based education and high-stakes testing under NCLB (Vacca & Vacca, 2005) proficiency assessments also measured student progress.

Innovations in teachers’ practice and collective efficacy were necessary to effectively promote learner-centered conceptual understanding. Collective efficacy denoted the perceptions of teachers that they, as faculty members, can implement a program of change necessary to have positive effects on the achievement of students (Goddard, 2001). Darling-Hammond (1997) noted that innovations in teachers’ practice need to be fostered through learning opportunities that last longer than one day.

Program Implementation

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solid figures, and algebra tiles were easily accessible to expedite investigations. Textbooks were available as resources for students.

Open-ended questions stimulated discussion and analysis during investigations. “How did you calculate the number of pockets in the room? Why did you use these units to measure height and width? What category on the bar graph illustrated the least and why?” Students’ written work, diagrams, pictures, and charts analyzed the investigations and covered the walls in Math Island. “The children worked together in study groups during their investigations. They ‘talked math’ as they worked. The students got excited about math. They also wrote about math. It was important that they write about their results since reading and writing go across the curriculum and are necessary in math,” said Thompson.

As learning progressed, continual assessment furnished valuable information concerning student achievement. The interdependence of teaching and assessing focused the learners on the strengths and weaknesses of their progress in mathematics. Teachers reviewed and analyzed students’ daily work and classroom assessments. Teachers brought student work samples to weekly grade level meetings to compare and adopted common classroom assessment tools. In an effort to meet Adequate Yearly Progress (AYP) as required by NCLB, teachers examined and reviewed standardized test data. Remembering the state and national standards for mathematics, teachers analyzed student work searching for samples that met standards. As they continually assessed and reviewed students’ progress, the teachers at Brewer Elementary began to create lessons based on the results of student assessments. Thompson attended the weekly grade level meetings to assist teachers with instructional strategies in areas needing improvement and to strengthen conceptual understanding. She followed up with individual classes’ needs during their visits to Math Island. Students’ papers, projects, and portfolios of their written work completed in Math Island demonstrated the interdependence of assessing and instructing.

In a learner-centered model for mathematics education, a teacher serves as a facilitator in a collaborative, supportive environment. Grogan and Thompson realized that changes in teachers’ professional practice were required to enhance the classroom environment concerning mathematics in order to improve students’ conceptual understanding. Thompson attended monthly trainings offered by America’s Choice and participated in local, regional, and national conferences in mathematics.

To enhance teachers’ professional practice, Thompson and Grogan realized the importance of developing the collective efficacy of teachers. To promote collective efficacy and to enhance teachers’ professional practice, a plan for professional learning included visits from a math consultant with the Georgia Council of Teachers of Mathematics, training for all teachers in the GPS, a summer workshop on conceptual understanding that involved approximately 90% of the teachers, monthly early release days that furnished additional time for professional learning, and a weekly faculty book study. Thompson promoted professional learning by modeling math lessons, coaching teachers and conferring with them concerning questions or specific problems of practice.

During the early months of professional learning, Thompson encountered sporadic resistance from some teachers. She felt the resistance might have been due to fear of change. “Some of the resistance may have been due to fear of not getting to everything. Coverage was a big issue. Also, some teachers were just overwhelmed,” she
said. “There were teachers afraid of math.” Thompson said, “But they were willing to try.” Only two or three teachers remained resistant as professional learning and students’ visits to Math Island continued. Thompson and Grogan continued to encourage and support professional learning by teachers.

Results

The learner-centered model adopted in Math Island at Brewer Elementary began to show results. The teachers collected informal data from observing and listening to students in the classroom and from reviewing students' work products and projects. Teachers noted an increase in students' use and understanding and implementation of math strategies. Teachers also noted an increased incidence of favorable comments among students, thereby indicating an increase in students' confidence and feelings of success toward math activities. As teachers reviewed students’ written work, they noticed increases in length and complexity of students' mathematics writing. A review of work products and projects demonstrated greater comprehension and involvement by students.

Formal data from Georgia standardized tests furnished a measure of AYP, one of the cornerstones of NCLB that measures year-to-year student achievement on statewide assessments. To meet AYP, each school must meet the following criteria: 95% participation, academic performance (Annual Measurable Objective), and second indicator. To ensure statewide measurement of academic performance in Georgia, the A+ Education Reform Act of 2000 required that all students in grades one through eight take the Criterion-Referenced Competency Test (CRCT) in the content area of mathematics. The CRCT measured how well students acquire the skills and knowledge described in the GPS. The assessments provided information about academic achievement at the student, class, school, system, and state levels (Georgia Department of Education, 2005-2006).

Based on the results of the 2003-2004 Overview Report, Brewer Elementary did not meet AYP. While students met the factors for academic performance, they did not meet the criteria of 95% participation and the second indicator, percentage exceeding CRCT math scores. The school continued in the status of Needs Improvement, offered school choice, and offered supplemental services as required by NCLB (Georgia Department of Education, 2005-2006).

The results of the 2004-2005 Overview Report showed improvement. Brewer Elementary met AYP. Students met the factors for academic performance, for 95% participation rate, and for the second indicator, attendance rate. The school did, however, stay in the status of Needs Improvement, offered school choice, and offered supplemental services (Georgia Department of Education, 2005-2006).

The 2005-2006 Overview Report revealed that Brewer Elementary met AYP and that the school was no longer in the status of Needs Improvement. For the second straight year, students met the factors for academic performance, for 95% participation rate, and for the second indicator, attendance rate (Georgia Department of Education, 2005-2006).

Beginning with the 2004-2005 Overview Report, the state of Georgia issued performance highlights for schools that had at least 80% of students who met or exceeded standards. During 2004-2005, Brewer Elementary students in grades one, two, and three were included for mathematics performance (Georgia Department of Education, 2005-2006). See Table 1 below. For 2005-2006, students in grades one, two, and five were
included for mathematics performance (Georgia Department of Education, 2005-2006). See Table 2 below.

Table 1  
Mathematics performance highlights  
2004-2005  

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Percentage</th>
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</tr>
<tr>
<td>2\textsuperscript{nd}</td>
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</tr>
<tr>
<td>3\textsuperscript{rd}</td>
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</table>

Table 2  
Mathematics performance highlights  
2005-2006  

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Percentage</th>
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<tr>
<td>5\textsuperscript{th}</td>
<td>91.94</td>
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</tbody>
</table>

Discussion

Therefore, the Brewer students in first and second grades demonstrated sustained achievement in mathematics; and students in third and fifth grades exhibited achievement in mathematics for one academic year. A total of 75% of third grade students met or exceeded standards in 2005-2006. A total of 78% of fifth grade students met or exceeded standards in 2004-2005. Students in fourth grade met or exceeded standards at 47% in 2004-2005 and at 59% in 2005-2006 (Georgia Department of Education, 2005-2006).

While limited to Brewer Elementary, the findings seem to support the effectiveness of Math Island on students’ conceptual understanding as measured by GADOE standardized test scores. It is recommended that the learner-centered model of instructing and assessing be implemented in other locales, in additional curricular areas, and in various grade levels. Further research using additional measurements, as well as the CRCT, could prove beneficial.

Based on the results of informal and formal assessment data, Math Specialist Paula Thompson supported the change to a learner-centered model for elementary
mathematics education. At Brewer Elementary, students are actively involved in the construction of knowledge; teachers are facilitators in a collaborative, supportive environment; and teaching and assessing are interdependent processes in classrooms. Thompson remarked, “With the improvements we have made, students are coming back to Brewer from other schools. Math Island is really an awesome place for students to be for mathematics.”

References


