

CHAPTER I

INTRODUCTION

Context of the Study

Students progress through mathematics as a series of topics that rely heavily on acquired skills and knowledge (National Council of Teachers of Mathematics, 2000). Guided instruction to build an understanding of numbers and computing simple addition begins early in a child's primary education. The mathematics curriculum then expands to build skills in the areas of subtraction, multiplication, and division. As a student progresses through the primary grades, the student explores topics such as greatest common factor, fractions, and volume, in which the individual's success is often determined by past experiences. This progression continues through middle, secondary, and post-secondary mathematics where topics like algebra, geometry and calculus require more automaticity of basic computational skills. Thus, a tremendous amount of emphasis is placed on the mastery of skills in order to succeed at the next level.

This spiral curriculum (Dondertman, Ciancone, & Toronto Board of Education [Ontario]. Continuing Education Dept., 1991; Harden & Stamper, 1999; Reyes & Fletcher, 2003) has allowed educators to introduce new topics using past knowledge as a foundation upon which to build. A little over a decade ago, student assessments designed to measure mastery of lower level skills suggested that elementary students were performing at a high level, indicating that students were capable of the transition into the more advanced mathematics courses. However, results of both fourth and eighth grade students participating in the Trends in International Mathematics and Science Study (TIMSS) in 1995 indicated that a closer examination of how we teach mathematics in the

United States might be needed (Ferraro & Van de Kerckhove, 2006). Results indicated that several countries significantly outperformed the United States. A close analysis of this report suggested that an achievement gap along cultural and socio-economic lines existed within the United States schools. This created a political reaction and concern about the possible inflation of test scores. Ultimately the introduction and implementation of the No Child Left Behind Act (NCLB) called for more accountability in the reported results of schools. NCLB further requires that we not only improve the reporting of results but also address eliminating the visible achievement gaps seen (Sanders, 2003). There is a connection between NCLB and the National Council of Teachers of Mathematics (2000) core principle of equity, one that ensures a standard under which all children are entitled to an opportunity to learn mathematics.

The current version of the TIMSS Report (2007) underlines the results at both the fourth and eighth grade level from three different testing periods between 1995 and 2003. Though the results of eighth grade students showed an overall improvement in test scores and a decrease in the gap between cultural groups, the overall increase in average scores was less than fifteen points. The United States is still over a hundred points behind the average scores of the top countries on this list and is considered to be in the "middle-of-the-pack" in terms of international performance.

Fourth grade assessment scores showed similar results in the improvement of performance among the cultural groups. Although eighth grade overall results suggested improvement, fourth grade results actually showed no change in scores. Further the United States' performance at the fourth grade actually decreased relative to other countries.

This lack of improvement at the lower grade levels indicates a need to make a closer examination of the system and to identify possible reasons why middle school performance is improving while elementary performance remains unchanged. A very narrow approach has already suggested that lower performance at the elementary level can result in higher math anxiety (Brady & Bawd, 2005; Brown & Quinn, 2006; Cates & Rhymer, 2003; Furner, Yahya, & Duffy, 2005; Ma, 2003; Malinsky, Ross, Pannells, & McJunkin, 2006; Micallef & Prior, 2004) and possibly be a contributing factor in students becoming at-risk of dropout (Barton, 2006; Mishel & Roy, 2006). Some mathematics educators have suggested that a closer look at the students' skills during this transitional phase is needed, perhaps suggesting some students simply lack the basic skills introduced early in the curriculum cycle.

“Reteaching”

As all of these pieces linking curriculum, teaching, and student performance come together, the methods used by a mid-sized public school district to ensure that younger students have acquired the skills necessary to succeed were explored. This exploration identified a method known as "reteaching," a process in which students are identified through regular assessments as not being proficient in pre-determined objectives. Once identified, the student is given additional instruction to cover that particular mathematical objective and given an opportunity to practice those skills through additional problems. After "reteaching," the student is then reassessed to document that the learner has in fact demonstrated that particular skill effectively.

EDU

In 1994, Dr. John Orr of the University of Nebraska-Lincoln led a team to adopt a new calculus curriculum (Unknown, 2007). The existing materials had emphasized working and solving problems using computational skills to find the solutions. The proposed curriculum emphasized the application of calculus to real problems. Research on Bloom's taxonomy (Rule & Lord, 2003; Warner, 2004; Lam & McNaught, 2006) suggested that overall student success would decrease in the proposed calculus curriculum because of limited student computational skills.

Dr. Orr grew weary of this dilemma and created an online assessment tool (now called EDU) as a possible solution. This Web-based system allowed students to work through homework problems, quizzes, and tests that focused on the needed computational skills. EDU was designed to allow students to engage in the problems at any time of day and receive immediate feedback about their performance. Though other online systems offered similar solutions, EDU provided the ability to randomly modify variables within individual problems when delivered to the student. This randomization allowed less programming by the site administrator and created the opportunity that the software could create unique problems for individual students in a large enrollment class such as freshman calculus.

Freshman students were asked to come into a proctored computer lab at the midpoint of the semester to take a "Gateway" examination. Students answered several questions relying on the computational skills necessary to succeed in the course. Students were allowed to repeat the exam until they demonstrated eighty percent proficiency. Students were provided opportunities to work analogous problems from their personal

computer in a non-evaluated environment. The opportunities to provide similar online practice and online assessments allowed instruction to focus on the application of calculus.

Success with the system has grown to become the gold standard for second and third semester calculus courses as well, ensuring that students are acquiring the necessary skills to succeed with end of semester projects. Word of this success spread quickly to other courses with large student populations. Political Science, Sociology, and Psychology began using EDU in a similar manner creating randomized Keller Plan assessments, sometimes referred to as Personalized Systems of Instruction (Koen, 2005), proctored through the computer labs.

K-12 and EDU

The word of EDU's success in freeing up instructional time to focus on the application of knowledge while improving students' basic skills through practice problems spread quickly to the local public school district. Over time, Dr. Charles Friesen, a district technology coordinator and himself a former mathematics instructor, considered EDU as a pre-college tool. Dr. Friesen often engaged in discussions with mathematic educators throughout the district about the lack of basic skills demonstrated by high school students, particularly students in advanced mathematics classes. While teaching a summer high school mathematics course, Dr. Friesen decided that using EDU might give struggling students additional practice with basic skills such as addition, subtraction, multiplication, division, and fractions. His hope was that, through repeated practice of these basic skills, students would gain confidence in their abilities and be able

to extend this into more advanced mathematics areas such as algebra and geometry. He created a very large problem set that quickly could be customized for practice depending upon the individual student's needs.

Dr. Friesen did not study the use of EDU systematically. However, he did believe that participating students were performing basic computational operations with higher proficiency and that most of them were succeeding in the advanced mathematics course. This success prompted Dr. Friesen to implement the identical system with middle school students in a summer program during the following year. Once again, EDU showed promising signs.

Introducing EDU into the Individualized Elementary Mathematics Curriculum

Closer examination of the materials developed by Dr. Friesen revealed an emphasis on skills introduced within the elementary curriculum. Dr. Friesen's success at the middle and secondary levels suggests that EDU might be a technology tool for elementary students who require reteaching of specific mathematics objectives. The ability to adapt materials through an assessment tool designed to meet the needs of a mass audience provides an opportunity to improve individual learning.

Purpose of the Study

The existing literature on elementary mathematics intervention programs used in traditional classrooms is limited. Therefore, the purpose of this study is two-fold. First, to examine some of the mathematics interventions used by a school district to provide baseline information on reteaching. This information will describe the procedures used

to identify students needing additional instruction, discuss the individualized instruction provided to the students, examine the supportive materials students are given to improve performance, and examine the amount of practice students use to improve performance of specific mathematics objectives.

Second, this study will examine the overall effectiveness of customized Web-based practice in improving student performance of identified mathematics objectives and preparing them for reassessment. Fifth grade students will execute similar problems used in the traditional intervention practice but delivered through the EDU online assessment system. Furthermore, a focus on repeated practice and the use of feedback will be explored in improving the reassessment scores of the student.

Research Questions

To establish a better understanding of the impact a Web-based system might have upon improving student performance, one must consider the baseline information of students who follow traditional instructional practices. However, in a review of the literature of mathematics interventions with elementary students, there was no supporting information that discussed the environment or materials used in a traditional inclusive classroom. This lack of materials suggests that two separate sets of research questions guide this study: questions about reteaching and questions about the use of EDU.

Questions about Reteaching

1. What is the process of reteaching?

2. How do classroom teachers identify and address student needs in the process of reteaching?
3. What supportive materials are given to students who need reteaching?
4. How much additional practice does the student need to improve performance during reteaching?

Questions about EDU

1. Can EDU be modified to fit the individual instructional intervention needs of an elementary mathematics student?
2. Can the use of EDU have similar results in improving the mathematics performance of elementary students identified for reteaching?
3. Can repeated practice through the use of EDU feedback provide a higher degree of efficacy of mathematics?

Significance of the Study

This study will document attempts to improve the mathematical skills at the elementary level. By successfully addressing the early underperforming students' learning of mathematics, one hopes for decreased math anxiety and/or improved performance later in their education. Addressing skill levels at the time skills are introduced suggests that further exploration of intervention programs can provide a partial solution to improving student performance.