
Factors Influencing Students' Performance in Mathematics for Better Teaching-Aids Design

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ABSTRACT

The purpose of the study was to investigate factors affecting students' mathematics performance for better teaching-aids design. Sample of 160 students were involved in the study. Students' questionnaire (SQ) was the major instrument for data collection, while three research questions were stated to guide the study. The descriptive statistics used to analyze the data include frequency count and simple percentages. The quality of teaching and learning mathematics has been one of the main challenges and concerns of educators. Teaching-aids design is an effective way to alleviate problems related to the quality of teaching and learning mathematics. Knowing the factors affecting mathematics performance is particularly important for making the best design decisions. Results revealed that gender was not found as an important factor affecting mathematics performance of students. Also, results showed that teaching-aids strategies/methods, teacher competency in mathematics education, motivation, parental education and socio-economic status were the most influential factors that should be considered in the design decisions.

Keywords: Mathematics; Performance; Teaching-aids Design; Students

INTRODUCTION

As in the past, most people in Nigeria today still believe that mathematics is all about computation. However, computation, for mathematicians, is merely a tool for comprehending structures, relationships and patterns of mathematical concepts, and therefore producing solutions for complex real life problems. This perspective of mathematicians has gained more attention and importance with rapid advancements in information and communication technologies. It has become necessity for people of all ages to reach, analyze, and apply the mathematical knowledge effectively and efficiently to be successful citizens in our information age. In particular, students need to be well-equipped with higher-order mathematical knowledge.

The quality of teaching and learning in mathematics is a major challenge for educators. General concern about

mathematics performance has been evident for the last 20 years. The current debate among scholars is what students should learn to be successful in mathematics. The discussion emphasizes new teaching-aids design techniques to produce individuals who can understand and apply fundamental mathematic concepts. A central and persisting issue is how to provide instructional environments, conditions, methods, and solutions that achieve learning goals for students with different skill and ability levels. Innovative teaching-aids approaches and techniques should be developed to ensure that students become successful learners.

Teaching-aids is an effective way to alleviate many pressing problems in education. Teaching-aids/Instructional design is a linking science – a body of knowledge that prescribes instructional actions to optimize desired instructional

outcomes, such as achievement and effect” (Reigeluth, 1983, p.5). Teaching-aids alone cannot produce better learning and achievement. The teaching-aids designer must know crucial factors that affect student learning and build a bridge between goals and student performance. Identifying these factors will help to utilize limited resources including financial resources and time more effectively (Libiensi & Gutierrez, 2008). In an effort to understand the factors associated with mathematics achievement, researchers have focused on many factors. (Beaton & Dwyer, 2002). The impact of various demographic, social, economic and educational factors on students’ mathematics performance continues to be of great interest to the educators and researchers.

Socio-economic status is determined to be a predictor of mathematics achievement. Studies repeatedly discovered that the parents’ annual level of income is correlated with students’ mathematics achievement scores (Jeynes, 2000). Socio-economic status was found significant in primary math and science achievement scores (Ma & Klinger, 2000). A number of studies showed that parents with higher socio-economic status are more involved in their children’s education than parents of lower socio-economic status. This greater involvement results in development of positive attitudes of children toward school, classes, and enhancement of academic achievement (Epstein, 1987). It is believed that low socio-economic status negatively influences academic achievement, in part, because it prevents students from accessing various educational materials and resources, and creates a distressing atmosphere at home (possible disruptions in parenting or an increased likelihood family conflicts) (Majoribank, 1996; Jeynes, 2002). For these reasons, socio-economic status of a student is a common factor that determines academic achievement.

Parents’ educational level has been shown to be a factor in academic

performance. Parents serve as a role model and a guide in encouraging their children to pursue high educational goals and desires by establishing the educational resources on hand in the home and holding particular attitudes and values towards their children’s learning. In this case, the educational attainment of parents serve as an indicator of attitudes and values which parents use to create a home environment that can affect children’s learning and achievement.

Students whose parents had less than high school education obtained lower grades in mathematics than those whose parents had higher levels of education (Mazzeo, 2000). Research has shown that parents’ educational level not only impact student attitudes toward learning but also impact their mathematics achievement scores. Many mathematics curricula overemphasize memorization of facts and underemphasize understanding and application of these facts to discover, make connections, and test math concepts. Memorization must be raised to conceptualization, application and problem-solving for students to successfully apply what they learn. An impressive body of research suggests that curriculum that considers students to be incapable of metacognitive actions (e.g., complex reasoning) should be replaced with the one that sees students who are capable of higher-order thinking and reasoning when supported with necessary and relevant knowledge and activities (Bransford et al., 1994).

Being successful in mathematics involves the ability to understanding one’s current state of knowledge, build on it, improve it, and make changes or decisions in the face of conflicts. To do this requires problem solving, abstracting, inventing, and proving (Romberg, 1983). These are fundamental cognitive operations that students need to develop and use it in math classes. Therefore, instructional strategies and methods that provide students with learning situations where they can develop

and apply higher-order operations are critical for mathematics achievement.

Teachers not only need knowledge of a particular subject matter but also need to have pedagogical knowledge and knowledge of their students (Bransford et al., 2000). Teacher competency in these areas is closely linked to student thinking, understanding and learning in mathematics education. There is no doubt that student achievement in mathematics education requires teachers to have a firm understanding of the subject domain and the epistemology that guides mathematics education as well as an equally meticulous understanding of different kinds of instructional activities that promote student achievement.

School context and its facilities could be an important factor in student performance. In fact, identifying factors related to the school environment has become a research focus among educational practitioners. For instance, research suggests that student performance is associated with a safe and orderly school climate (Reynolds et al., 1996). Researchers also found a negative impact on student achievement where deficiencies of school features or components such as temperature, lighting, and age exist. In a study by Harner (1974), temperatures above 23° C (74° F) adversely affected mathematics skills. In terms of the condition of school building, Cash (1993) found student achievement scores in standard buildings to be lower than the scores of students in above standard buildings.

Self-directed learning could be a factor in students' math achievement. Mathematics learning requires a deep understanding of mathematical concepts, the ability to make connections between them, and produce effective solutions to ill-structured domains. There is no perfect, well-structured, planned or prescribed system that lets students think and act mathematically. This can be done if, and only if, students play their assigned roles in their learning progress. The teacher's role is to engage students by

helping to organize and assist them as they take the initiative in their own self-directed explorations, instead of directing their learning autocratically (Strommen & Lincoln, 1992). Arithmetic ability was determined by various studies as a critical factor on students' math achievement. For instance, in a study by Kaeley (1993), arithmetic ability gave the highest correlation coefficient with mathematics achievement. Similarly, student achievement scores were found to be most strongly predicted by level of ability (Schiefele & Csikszentmihalyi, 1995).

Broussard and Garrison (2004) examined the relationship between classroom motivation and academic achievement in elementary-school-aged children (122-first grade and 129-third grade participants). Consistent with previous studies, they found that for a higher level of mastery, motivation was related to higher math grades.

The teacher's role in students' motivation to learn should not be underestimated. In helping students become motivated learners and producers of mathematical knowledge successfully, the teacher's main instructional task is to create a learning environment where students can engage in mathematical thinking activities and see mathematics as something requiring "exploration, conjecture, representation, generalization, verification, and reflection" (Carr, 1996, p.58).

Purpose of the Study

The main purpose of the study was to investigate factors affecting students' mathematics performance for better teaching-aids design. This study has the following specific objectives:

1. To investigate the influence of demographic factors on students' mathematics performance
2. To investigate the influence of teaching factors on students' mathematics performance
3. To investigate the influence of individual factors on Students' mathematic performance

Research Questions

This study sought answers to the following research questions:

1. Is there a perceived influence of demographic factors on students' mathematics performance?
2. Is there a perceived influence of teaching factors on Students' mathematics performance?
3. Is there a perceived influence of individual factors on Students' mathematic performance?

RESEARCH METHODOLOGY

This study adopted the survey method of research design to investigate factors affecting mathematics performance of students. The choice of this survey design was to conduct the research using a controlled sample size from a target population for the purpose of generalization (Nworgu, 1997). The target population comprised of all the undergraduates mathematics students in five (5) public universities located in North Central Nigeria, totaling 200 students. Out of which a sample of 32 undergraduate mathematics students (males and females) were drawn using random sampling technique from each of the five (5) public universities making the total of 160 sample. The sample size was reached via Kredji and Morgan method of determining sample size (Baba, 2005).

A Likert-scale was conducted in this study for the data collection. The first part

consisted of three questions (gender, age and grade level) to learn about students' demographic distribution. For demographic purposes. The second part was adopted from Dursun & Dede (2004)'s study to determine the effectiveness of demographic, teaching (instructural), and individual factors on students' mathematics performance. In the second section of the survey instrument, three questions were asked to examining demographic factors, four questions for teaching factors, and three questions for individual factors on students' mathematics performance. Likert-scale items with response categories ranging from "very effective" to "ineffective" were designed for the second part of the survey.

The data collection instrument was organized and pilot-tested by the researchers to obtain reliability. Prospective students were reached through randomly visits to mathematics classes of public universities in North central region, Nigeria. All students in these mathematics classes volunteered to participate in the study. Printed survey instruments were distributed to the students and all were completed and returned. The analysis of the collected data was done by using count and simple percentages.

RESULTS

The results of the study are in line with the stated research questions as tabulated below:

Research Question 1: Is there a perceived influence of demographic factors on students' mathematics performance?

Table 1: Effects of Demographic Factors on Students' Mathematic Performance

Demographic Neutral Factors	Very effective	Effective	Less effective	Ineffective
Gender	15(9.3%)	20(12.5%)	41(25.6%)	50(31.3%) 34(21.3%)
Parents'edu.level	20(12.5%)	44(27.5%)	42(26.2%)	51(31.8%) 5(3.1%)
Socio-Economic status	18(11.4%)	55(34.4%)	41(25.6%)	35(21.8%) 11(6.8%)

From table 1 above, the first research question investigated students' perceptions whether or not demographic factors such as gender, parents' educational level, and socio-economic status have an effect on mathematics performance. Students' responses were reviewed to identify the most frequently answered response for demographic factors. Most of the students, 31.3%, indicated that the gender has no effect

on students' mathematics performance. In contrast to the gender, 27.5%, of the students indicated that parents' educational level, and 34.4% of participants also stated that socio-economic status, were effective factors on the mathematics performance of students.

Research Question 2: Is there a perceived effect of teaching factors on Students' mathematics performance?

Table 2: Effects of Teaching Factors on Students' Mathematics Performance

Teaching Factors	Very Effective	Effective	Less Effective	Ineffective	Neutral
Curriculum	50(31.3%)	35(21.9%)	30(18.8%)	27(16.8%)	18(11.2%)
Teaching methods	65(40.6%)	58(36.3%)	20(12.5%)	11(6.9%)	6(3.7%)
Teacher competency in Math Education	70(43.7%)	63(39.4%)	15(9.4%)	8(5.0%)	4(2.5%)
School Context and Facilities	60(37.5%)	60(37.5%)	25(15.6%)	10(6.3%)	5(3.1%)

From table 2 above, Students' responses were reviewed to identify the most frequently answered response for teaching or instructional factors. Students indicated that all teaching factors were very effective on the mathematic performance of students. Among the teaching factors, teaching strategies and methods emerged as the most influential

factor on the mathematics performance of students.

Research Question 3: Is there a perceived effect of individual factors including self-directed learning, arithmetic ability, and motivation on Students' mathematic performance?

Table 3: Effects of Individual Factors on Students' Mathematics Performance

Individual Factors	Very Effective	Effective	Less Effective	Ineffective	Neutral
Arithmetic ability	75(46.8%)	40(25.0%)	25(15.6%)	15(9.4%)	5(3.1%)
Self-directed learning	67(41.8%)	53(33.1%)	19(11.9%)	15(9.4%)	6(3.8%)
Motivation	80(50.0%)	35(21.9%)	26(16.3%)	10(6.3%)	9(5.6%)

From table 3, students' responses were reviewed to identify the most frequently answered response for individual factors. Students indicated that they believe all individual factors identified in this study were very effective on the mathematics performance of students. Motivation

emerged as the most effective/ influential factor on the mathematics performance of students.

DISCUSSION OF FINDINGS

It is accepted that changing the quality of teaching and learning mathematics

in positive direction is one of the major challenges and concerns of educators and teaching aids designer/ instructional designers. They ought to seek innovative and alternative ways to meet the evolving demands and needs of students in mathematics education. Identifying the factors that possibly affect the mathematics performance of students could help teaching-aids designers and instructors (teachers) to select the best teaching strategies to design the most effective and efficient instruction. Existing studies suggested many variables that can have effects on the mathematics performance of students.

Effects of demographic factors such as gender, parents' education level and socio-economic status on mathematics performance were investigated. Gender was not found an important factor influencing the mathematics performance of students. Similar results were found by Beaton et al., (1996). Parents' education level was found to be an effective factor in achievement of students in mathematics courses similar to the results of Coleman, (1966) and Mazzeo, (2000). Parents with higher level of education could be a role model for their children to accomplish high levels of achievement in mathematics courses. Similar to Jeynes (2002), Socio-economic status in this study was reported as an important factor affecting the mathematics performance of students in mathematics courses. Parents with high income seem to provide richer instructional resources to their children which may eventually help to improve the mathematics scores of students.

In terms of demographic factors, the results revealed that parents' education level and socio-economic status were two vital factors for mathematics performance. These are the factors that teaching aids designers should not ignore since they are important for mathematics performance. Students from different socio-economic strata with different levels of parent education may exhibit very different attitudes, needs, and other

characteristics for learning and studying mathematics. Thus, performance of those students in mathematics courses depends on teaching-aids design that can successfully transmit crucial mathematical skills and knowledge to students from different backgrounds.

Important factors in mathematics instruction and student performance include curriculum, teaching strategies, methods, teacher (mathematics) competency, school context and facilities. The mathematics curriculum contains specific subject-matter and teaching design principles to enable students to develop logical and mathematical skills needed to understand fundamental mathematical concepts. In other words, designing teaching-aids based on a curriculum that is in harmony will promote students' performance in mathematics. Teaching strategies and methods are important for the performance of students. School context and facilities are also reported to influence mathematics performance in this study. School safety and facilities (Reyonds et. Al., 1996), temperature of the class (Harner, 1974), features of the school buildings (Cash, 1993), were also reported to influence the performance of students. Collectively, these results point out that attention should be given to school context and facilities to improve the mathematics performance of students.

CONCLUSION

Conclusively, knowing and understanding the opinion of mathematics students is important to identify factors they perceive to be effective for performance in mathematics. Findings of this study revealed three factors that contribute to mathematics performance: teaching strategies and methods, teacher competency in mathematics education, and motivation. Further investigation of these three factors, through experimental studies, should enable teaching-aids/instructional designers and

mathematics educators to continue to improve mathematics teaching.

The findings also suggest that different teaching-aids/ instructional design strategies should be studied and applied in different contexts. Experiment with new instructional design models in a variety of different circumstances is vital to optimize mathematics teaching/instruction. One-size-fits-all teaching-aids design strategies are not as efficient as those that are customized to meet specific learner needs. It is important to embody diagnostic and prescriptive tools to determine the best-fit design for each individual learner, and to make learning more meaningful based on known critical factors that affect mathematics performance.

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