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Original Paper

Identifying Factors Affecting the Mathematics Achievement of Students for Better Instructional Design in UK

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Abstract

Mathematics is said to be logical, reliable and a growing body of concepts which makes use of specific language and skills to model, analyse and interpret the world. It is a human activity which involves creativity, discovery of patterns of shape and number, the modelling of situations, the interpretation of data and the communication of ideas and concepts. This paper attempts to examine factors affecting the mathematics achievement of students for better instructional design in UK. This study used descriptive survey design. Simple random sampling technique was further applied to obtain Mathematics teachers, students and principals targeted. The total population of this study was 142 persons. The study sampled 105 respondents. The collected data was analyzed using descriptive statistics, correlation, and regression analysis through the statistical package for social science (SPSS) version 21. The data collected were analyzed using descriptive statistics and multiple regression. The results of the findings indicated that the demographic factors were more correlated with students Students' Mathematic Achievement (r = 0.722; p= 0.000). Multiple linear regression analysis showed that demographic factors contributed to 69.9% of variation on the performance, hence plays a vital role in students' mathematics achievement in UK.

Keywords

demographic factors, mathematics achievement and students

1. Introduction

Mathematical skills have long been recognised as essential not only for academic success but also for efficient functioning in everyday life (Scott, 2008). By studying mathematics, we train accuracy, consistency, and mental discipline, which are essential skills needed for effective and responsible problem solving and decision making in everyday life. Due to the global awareness of the importance

of mathematical knowledge on the one hand, and the concern expressed for many years at various levels of education about underachievement in mathematics, the performance of students in mathematics from primary school to higher education is still a topic of concern (William, 2004).

Knowledge of mathematics has often been cited as crucial for several disciplines in higher education, including technical fields, engineering, economics, and finance, as well as agriculture, pharmaceuticals, and health sciences (Josiah, 2014). Since mathematical knowledge offers widespread application, social sciences university programs around the world require their students to take at least one mathematics course. Their students gain essential mathematical knowledge and develop the analytical and computational skills they need in their field of specialisation. Unfortunately, mathematics in university courses has often been identified as a significant obstacle for students and as one of the main reasons for dropping out of university. This problem is particularly pronounced in non-scientific university programs, where the failure rate in mathematics can easily exceed 30 percent (Pietsch et al., 2003). Since poor performance in mathematics indirectly affects the overall academic performance of students, there is an urgent need to investigate the factors that have contributed to poor performance in mathematics in higher education.

The quality of teaching and learning in mathematics is a major challenge and for educators. General concern about mathematics achievement 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 instructional design techniques to produce individuals who can understand and apply fundamental mathematic concepts (Ching-Fu, 2009). 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 instructional approaches and techniques should be developed to ensure that students become successful learners.

It is important for educators to adopt instructional design techniques to attain higher achievement rates in mathematics. (Rasmussen & Marrongelle, 2006). Considering students' needs and comprehension of higher-order mathematical knowledge, instructional design provides a systematic process and a framework for analytically planning, developing, and adapting mathematics instruction (Alexander, 1989). "[Instructional design] is an effective way to alleviate many pressing problems in education. 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).

In an effort to understand the factors associated with mathematics achievement, researchers have focused on many factors (Kifer, 2002). The impact of various demographic, social, economical and educational factors on students' math achievement continues to be of great interest to the educators and researchers. For instance, Israel et al. (2001) concluded that parents' socioeconomic status is correlated with a child's educational achievement. Another study by Jensen and Seltzer (2000) showed that factors such as individual study, parents' role, and social environment had a significant influence on "further education" decisions and achievements of young students'. In another study, Meece, Wigfield

and Eccles (1990) investigated cognitive motivational variables that influence high school students' decisions to enroll in advanced math courses. Their findings revealed that math ability perceptions affect students' valuing of math and their expectations for achievement.

The concerns here are not that students should never learn to compute, but that students must learn how to critically analyze mathematical problems and produce effective solutions. This requires them to learn, how to make sense of complex math concepts and how to think mathematically (Cobb et al., 1992). 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. Research has also revealed evidence that curricula in which students' knowledge and skills grow is significantly connected to their learning, and therefore their achievement (Grootenboer et al., 2007).

Instructional design is a challenging procedure requiring the consideration of all elements of the learning to bring about the desired change (Colakoglu & Akdemir, 2008). 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 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 achievements of students could help instructional designers and instructors to select the best instructional strategies to design the most effective and efficient instruction. Existing studies suggested many variables that can have effects on the math achievement of students. Opinions of mathematics department students were collected in this study to identify the factors affecting achievement of students in math courses. Also opinions of freshman, sophomore, junior and senior students in the math department were compared in this study.

To determine the predictors of mathematics achievement among various groups of individuals, a large body of studies have been conducted over the past several decades. Since education is a complex process with many variables interacting in a way that affects how much learning takes place (Warren, 1996), the authors express the diverse and complex nature of factors associated with mathematics performance. To provide a comprehensive and consistent insight, some authors try to classify the factors into various categories with related properties. Papanastasiou (2000) distinguishes between internal and external factors influencing mathematics performance. Internal factors are those related to the test (exam) material, while external factors refer to the environment which surrounds the individual as well as to his unique persona (e.g., socio-economic level and educational background of the family, the school climate, the language background, and students' attitudes toward mathematics). It is against

that background that this study attempted to assess identifying factors affecting the mathematics achievement of students for better instructional design in secondary schools in England

This study sought to achieve the following research hypothesis:

H_{01} There is no significance effect between demographic factors on students' Mathematic Achievement in UK.

2. Method

This study evaluated factors identifying factors affecting the mathematics achievement of students for better instructional design in secondary schools in England research survey design in building up this project work the choice of this research design was considered appropriate because of its advantages of identifying attributes of a large population from a group of individuals. The design was suitable for the study as the study sought factors influencing Mathematics in Mathematics in Canadian high schools.

This study was conducted in Wales in UK in 3 selected high schools. Wales is a country that forms part of the United Kingdom of Great Britain and Northern Ireland (known as the UK). It is situated in the northwestern part of the continent of Europe. This study will be conducted in Swansea District where it has 14 secondary schools. The study selected 3 secondary schools which are Bishop Gore School, Pontarddulais Comprehensive School and Morriston School.

In this study, the accessible population comprised one hundred thirty-three (133) students and twelve (6) Mathematics teachers and 3 principals from the selected schools. The total population was 142 persons.

In addition, the study used the following formula proposed by using Yamane (1973) to determine the sample size because that is too large waste scarce resources and could expose more participants than necessary to any related risk. Thus, the study used Yamane formula to calculate a sample size because it is the most appropriate for this study.

Using Yamane formulae

$$n = \frac{N}{1 + (N)(e^2)}$$

Where:

n = sample size

N = the population size

e = the acceptable sampling error (5%) at 95% confidence level

Thus; $n = 142/ (1+142) (0.05)^2$

n=104.7=105 respondents

In this study the researcher used questionnaires for the students, teachers and interview guide for the principals and documentary review as secondary data. Closed–ended questions were used where the answers were divided into categories such discrete, distinct and relatively few in number. It is easier for respondents to answer because they had only to choose categories. In that way a chance for irrelevant

answers is limited to the minimum, because appropriate answer categories were provided. The main respondents were being teachers that was given the questionnaire as they were enough time to respond to the questions based on specific objectives.

The questionnaire used as the research instrument was subjected to face its validation. This research instrument (questionnaire) adopted was adequately checked and validated by the supervisor his contributions and corrections were included into the final draft of the research instrument used.

After the data was collected, the researcher turned to the task of analysing. The analysis required a number of closely related operations such as establishment of categories, the application of those categories to raw data through coding, tabulation and drawing statistical inferences. The researcher classified raw data into purposefully and usable categories. Descriptive statistics and inferential statistics were used for data analysis. Quantitative data was analysed to obtain frequencies, percentages and averages.

Data collected on both questionnaires were used to answer the question of whether teaching learning strategies, student study habit, resources, their availability and the school curriculum implementation enhance the understanding of the Mathematics geometry concept, and to what extent they do so. The analysis was done using SPSS program. Correlation and regression analysis were conducted to ascertain the relationship between the study variables. The regression model to be tested is:

The regression model to be tested is: $Y=\beta 0+\beta 1X_1+\varepsilon$

Whereby Y =Students' Mathematics achievement

a= Constant

X_1 = demographic factors

έ = error term

β1, represent regression coefficients. These helped in the generalization of the findings on the relationship between organizational culture and employee performance. Multiple regression analysis will be computed to establish whether the research questions will be statistically supported or not at a 95% confidence level.

3. Results

In this study the research sampled 105 respondents of selected in Swansea District in Wales. The data collected from the respondents were analysed in tabular form with simple percentage for easy understanding. A total of 102 questionnaires were distributed and 3 high school principals were interviewed.

3.1 Descriptive Statistics

In this research the study attempted to determine identifying factors affecting the mathematics achievement of students for better instructional design in secondary schools. The respondents were asked to rate the statements by indicating the extent to which they apply to their organization in 5-point Likert scale as shown on: 5. Strongly Agree (SA), 4Agree(A), 3. Neutral (N), 2. Disagree (D) and 1.

Strongly Disagree (SD). Besides, the mean and deviation were used for interpretation of the findings where mean (M) is the average of group of scores and it is sensitive to extreme score when the population samples are small. Moreover, the Standard Deviation (SD) was also used to measure the variability in those statistics as it shows how much variation is there from the average (mean).

Table 1. Demographic Factors and Students' Mathematic Achievement

Statements	Mean	Std Dev
Gender	4.5	0.81
Parental educational level	3.2	0.68
Socio-Economic Status	4.0	0.55

Table 1 investigated students' perceptions whether or not demographic factors including gender, parents' educational level, and socio-economic status have an effect on mathematics achievement. Participants' responses were reviewed to identify the most frequently answered response for demographic factors. Most of the participants strongly agreed that gender is the first demographic factor with a mean of 4.5 and standard deviation of 0.81. The second demographic factor is socioeconomic status with a mean score of 4.0 and standard deviation of 0.55. Lastly another demographic factor is parental educational level as the majority of respondent agreed (M=3.2, Std=0.68). From the results, it implies that the majority of respondents strongly agreed and agreed that all of the above are key elements of identifying factors affecting the mathematics achievement of students for better instructional design.

These findings are relevant since Hathella (2021) in his study on How Demographic Features and Attitudes of Student Affect the Mathematics Performance of Students? , he concluded that there are significant associations between mathematics performance and the demographic factors: residence, school type, parents' educational level, and father's occupation while the remaining factors; gender, mother's occupation, family income, and some family members didn't show significant relationships with mathematics performance. Results revealed a strong and significant association between mathematics performance and attitudes of students towards mathematics.

Table 2. Instructional Factors on Students' Mathematic Achievement

Factors	Mean	Std
Curriculum	4.18	0.57
Instructional Strategies and Methods	4.56	0.97
Teacher Competency in Math Education	4.54	0.67
School Context & Facilities	4.15	0.71

The Table 2 above indicates the effect of instructional factors on students' mathematic achievement. The study revealed that the effectiveness of instructional factors including curriculum, instructional strategies and methods, teacher competency in math education, and school context and facilities on the mathematic achievement. Participants' responses were reviewed to identify the most frequently answered response for instructional factors. Participants indicated that all instructional factors were very effective on the mathematic achievement of students (See Table-3) as strongly agreed and agreed by all most the whole respondents. Among the instructional factors, instructional strategies and methods emerged as the most influential factor on the mathematic achievement of students with a mean score of 4.56 and positive significant correlation standard deviation of 0.97.

3.2 Correlation Analysis

The findings of the correlations between the independent variables and the dependent variables are summarized and presented in Table 4.

Table 3. Correlation between Demographic Factors and Students' Mathematic Achievement

		Demographic factors	**Students' Mathematic Achievement**
Demographic factors	Pearson Correlation	1	
	Sig. (2-tailed)		
	N	102	
Students' Mathematic Achievement	Pearson Correlation	.722**	1
	Sig. (2-tailed)	.000	
	N	102	102

**. Correlation is significant at the 0.01 level (2-tailed).

According to the findings reported in Table 3, the Pearson correlation analysis showed that demographic factors (r=0.722, p=0.000) is positively and significantly related to Students' Mathematic Achievement. The correlation was deemed to be statistically significant since the p-value was less than 5%. The findings therefore showed that there is a positive and statistically significant relationship between demographic factors and Students' Mathematic Achievement.

3.3 Multiple Regression

The study used multiple regression to test the following hypothesis:

H_{01} There is no significance between demographic factors and Students' Mathematic Achievement in UK.

Table 4. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.836[a]	.699	.689	.25384

a. Predictors: (Constant), demographic factors.

Table 4 shows the quantity of variance that is explained by the predictor variables. The first statistic, R is the multiple correlation coefficient between all the predictor variables and dependent variable. In this model, the value is 0.836, which indicates that there is a great deal of variance shared by the independent variables and dependent variables. The next value, R Square=0.699, is simply the squared value of R. Adjusted R square =0.699, indicating that approximately 69.9% of the variance in the supply chain performance is explained by the logistics management practices. The Std. Error of the estimate is 0.25384, which means that, on average, the predicted values from the model are expected to deviate from the actual values by approximately .25384.

Table 5. Analysis of Variance (ANOVA)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14.344	3	4.781	74.204	.000[b]
	Residual	6.186	96	.064		
	Total	20.530	99			

a. Dependent Variable: demographic factors.

b. Predictors: (Constant), Students' Mathematic Achievement.

Table 5 indicated standard regression which provides the significance of the prediction of individual predictor variables on the dependent variable. That variable is demographic factors. The table shows the output analysis and whether there it has a statistically significant difference group mean. As seen, the model (F=74.204, p=0.000) was found to be significant at 5% since the p-value (p=0.000) was less than the 5% threshold Therefore, demographic factors significantly influence Geometry achievement.

Table 6. Regression Coefficients and Significance of the Independent Variable

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.094	.200		5.479	.000
	Demographic factors	.196	.071	.248	2.772	.007

a. Dependent Variable: Students' Mathematic Achievement.

Source: Field research, 2023.

Information presented in Table 6 evidenced that all the indicator variables used in this research to study the demographic factors were all statistically significant. This implied that they individually have significant contributions Students' Mathematic Achievement. The regression model was thus formulated as $Y=1.094+ 0.196\ X_2 +\varepsilon$ Where y= Students' Mathematic Achievement, X_1, represented the demographic factors. The regression coefficients are useful to know which of the different independent variables is more important in contributing to the Students' Mathematic Achievement. They are used in comparison of effect of any independent variable on the dependent variable.

4. Discussion

From the findings, the study revealed that parents' educational level and socio-economic status are two important factors in mathematics achievement. These are factors that instructional designers should not ignore because they are important for mathematics achievement. Students from different socio-economic backgrounds and with different levels of parental education may exhibit very different attitudes, needs and other characteristics in learning and studying mathematics. Therefore, the performance of these students in mathematics courses depends on instructional design that can successfully transfer important mathematical skills and knowledge to students from different backgrounds. Furthermore, Significant factors in math instruction and student achievement include curriculum, instructional strategies, methods, teacher (math) competency, school context and facilities. The mathematics curriculum contains specific subject-matter and instructional design principles to enable students to develop logical and mathematical skills needed to understand fundamental mathematical concepts. In other words, designing an instruction based on a curriculum that is in harmony with instructional design can scaffold student learning and promote their achievement in mathematics

These findings concurred with Kimball (1989) who stated that effects of demographic factors including gender, parents' education level and socio-economic status on math achievement were investigated. In contrast to other studies, gender was not found an important factor influencing the math achievement of students. Similar results were found by Beaton et al. (1996) and Mullis et al. (1997). Parents' education level was found to be an effective factor in achievement of students in math courses similar. Parents with higher level of education could be a role model for their children to accomplish high levels of achievement in math courses.

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