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Editorial Comment

This issue of UNIZIK Orient Journal of Education contains a very large collection of scholarly view points and research articles on education for national transformation. Forty(40) articles in all touching on different areas of education with emphasis on its transformational powers.

Education is a tool for building an equitable and just society. It provides skills and competencies for economic well-being. In a diverse society like Nigeria, education acts as an integrative force, imparting values that foster social cohesion, communal harmony and national identity. Keeping this in mind, the experiences and researches of authors published in this issue can broaden the knowledge of readers.

Prof Sam O.C. Okeke
Editor-in- chief.

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Prerequisite Strength and Mathematics Aptitude as Predictors of Cognitive Achievement in Geometry.

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Past researches and West Africa Examinations Council chief examiners' reports revealed that students failed geometry than other aspects of mathematics. The reason for this may be traceable to students' strength in prerequisite knowledge and mathematics aptitude. This study therefore investigated the predictive ability of prerequisite strength, mathematics aptitude on cognitive achievement in Geometry. The study adopted correlational design. The sample of the study consisted of 240 Senior Secondary II students selected using multi-stage sampling technique from 3 Local Government Areas in Ibadan Metropolis. Three instruments were used for data collection: Mathematics Aptitude Test(r= .92), Geometry Achievement Test (r= 0.8), Prerequisite Knowledge Test (r= 0.74). Basically, descriptive statistics, Pearson Product Moment Correlation Co-efficient and linear multiple regression analyses were adopted for the analysis of the collected data. The results show that there was significant correlations between prerequisite strength and geometry achievement (r=0.93; p<0.05). There was significant correlation also between mathematics aptitude and geometry achievement (r=0.301; p<0.05). The results also showed that, the two predictor variables: prerequisite strength, and Mathematics aptitude explained the 0.88 per cent of the variance in geometry test scores. However, degree of prediction of each factor differed. The relative predictive strength of prerequisite strength (B= 1.277) was higher than that of mathematics aptitude (B=. 108). Based on the findings, it is therefore recommended that current curriculum that is in use in secondary schools be reviewed to include prerequisites to each topic, that will make students achieve meaningfully in geometry-based topics

Keywords: Prerequisite strength, Mathematics Aptitude, Geometry Achievement.

Geometry is one of the major aspects of mathematics that occupies a central position at any educational level. It concerns positions or locations in space. Karaman and Togrol (2010) stated that Geometry as presented in lower grades mostly involves activities such as connecting points with line segments and recognizing figures such as triangles, squares and rectangles. Such activities involve properties of Euclidean geometry. However, genetically, during the development of child's conception of space, topology constitutes a general foundation from which both projective space and the general metrics from which Euclidean metrics proceeds can be derived (Copeland, 1979).

To help students make the most achievement in a new Geometrical experience, educators need to understand how prerequisite knowledge influence learning. Prerequisite knowledge possesses potency to determine what students learn from the experience. Prerequisite knowledge also forces a theoretical shift to viewing learning as "conceptual change." In the past (Strike & Posner, 1985; West & Pines,1985). Previously learning was considered a process of accumulating information or experience.

Prerequisite knowledge is the bane of transmission-absorption models of learning. Mere absorption cannot account for the revolutionary changes in thought that must occur (Atkinson, 2001). It may be difficult to learn without prerequisite knowledge. For example eliminating prior understanding of lines, angles and points may make delivery of instructional content on Geometrical proofs nonsensical. The aspects of learning, prior knowledge and experience drawn out in these examples have a solid basis in research on learning. There is widespread agreement that prior knowledge influences learning, and that learners construct concepts from prior knowledge (Adeleke, 2007). Atkinson (2001) stated that, because prior knowledge is usually specific to a subject matter, it is difficult to state general facts about prior knowledge across all areas of human interest. Therefore, this article focuses on one area, Geometry learning, in order to provide a detailed explanation on efficacy of prior knowledge.

Geometry being an essential part of mathematics, has witnessed poor performance in the past. Unfortunately, according to evaluations of mathematics learning, such as the National Assessment of Educational Progress (NAEP, 2006), college grade two students in Alexandria fail to understand basic geometric concepts and develop adequate geometric problem-solving skills. This poor performance may be due, partly, to the lack of adequate prerequisite knowledge which focus on recognizing and naming geometric shapes and learning to write the proper symbols for simple geometric concepts and partly aptitude (Adeleke, 2007). In contrast, people believe that elementary geometry should be the study of objects, motions, and relationships in a spatial environment (Clements and Battista 1992).

Research findings however, observed that students' experiences with geometry should emphasize informal study of physical shapes and their properties and have as their primary goal the development of students' intuition and knowledge about their spatial environment. Subsequent experiences should involve analyzing and abstracting geometric concepts and relationships in increasingly formal settings. This is necessary to equip them adequately with prerequisite knowledge needed to achieve meaningfully in geometry topics (Adeleke, 2007).

Prerequisite knowledge may not be the only potent factor that accounts for hundred percent variation in students' achievement in Geometry, mathematical aptitude of the learners may equally be vital. Karaman and Toğrol (2010) state that mathematical aptitude is composed of general intelligence, visual imagery and ability to perceive number and space configurations as mental patterns. Abilities of visual imagery and ability to perceive space configurations are very important for geometry courses. In geometry, there are defined terms as triangle, angle, and circle as well as undefined terms as point, plane, line etc. They are considered undefined terms since the representations of these identities are distinct from their geometric definitions. Everybody knows the meaning of a point and a line, but it is very difficult to put them into words. For example, a point is represented on a paper by a dot, though the dot is not a geometric point since it has some size. However, a point, in geometry, has no length, breadth or thickness and has, no size. The same problem arises with the representation of a plane. Because of above mentioned reasons, the representation of plane and space geometry shapes may bring the difficulties of identification of their properties and ambiguity for decoding the drawn shapes. Students may have these kinds of difficulties especially in geometry lessons. These difficulties may arise from the deficiency of specific ability related to geometry lessons.

In a related study Benbow (1992) investigated the relationship between the academic achievement in mathematics and aptitude of students. Thirty four out of the thirty seven variables studied by Benbow (1992) Showed significant differences favouring the high aptitude students. Fischer (1995) used 226 male and female subjects to investigate the relationship between logical reasoning, computational reasoning and mathematical achievement. The results of the study showed that logical reasoning, which accounted for ten percent of the variance on performance, significantly affected mathematics achievement.

Differences in academic aptitude are likely to influence performance of college student , and may be related to prerequisite knowledge (Thompson, 2004). His view supports that of Bloom (1981) that aptitude and other predictors will predict achievement on a learning task to the extent to which they include indices of relevant prerequisite knowledge. Thus, the association between relevant prerequisite knowledge and performance identified in earlier research may arise. To be sure, earlier studies with secondary students have indicated that learning outcomes are improved by relevant prerequisite knowledge and mathematical aptitude (Schneider & Bjorklund, 1992; Abadom,1993). Relevant aptitudes are influential in part because it enhances interest in a topic and also facilitates meta-cognitive processes in students (Tobias, 1994, 1995). Two prior studies have reported that Scholastic Aptitude Test (SAT) scores were modestly correlated with measures of relevant prerequisite knowledge in mathematics and with final summative test in the subject (Griggs & Jackson, 1988). These constitute the foundation on which this study that investigated topic 'Predictive Study of Prerequisite Strength, Mathematics Aptitude and Cognitive Achievement in Geometry' is laid.

Statement of the Problem

Geometry, has been an aspect of mathematics that provides a strong support for different fields of learning such as natural and applied sciences, engineering and architecture. Past research findings revealed poor understanding majority of the learners have been experiencing in geometry. Several attempts have been made by researchers on the influence of prerequisite knowledge and aptitude to understanding of mathematics. Insignificant few of such attempts really focused on geometry, to provide better understanding as well as explanation on how students learn the aspect of mathematics . This study therefore, sought to research into how prerequisite knowledge and mathematics aptitude can assist in providing explanation to achievement of learners in geometry.

Objectives of the Study

The objectives of the study were to:

- explore the existing correlation between prerequisite knowledge, mathematics aptitude and geometry achievement.
- establish composite contribution of prerequisite knowledge and mathematics aptitude to geometry achievement.

- estimate the magnitude of the predictive strengths of prerequisite knowledge and mathematics aptitude on geometry achievement

Research Questions

Three research questions were raised to address the objectives of the study.

1. How significantly correlated are Prerequisite Strength, Mathematics Aptitude and Cognitive Achievement in Geometry?
2. Do Prerequisite Strength and Mathematics Aptitude have joint contribution to Cognitive Achievement in Geometry?
3. Do Prerequisite Strength and Mathematics Aptitude significantly predict Cognitive Achievement in Geometry significantly?

Method

Research Design

This study is an *ex-post facto* (non-experimental) research that adopted a correlational approach. This design is appropriate because the variables are not manipulated. This study used a multi-stage sampling technique. Three Local Government Areas (LGA) were randomly selected from the five existing ones in Ibadan metropolis. Stratified sampling technique was also employed and the selected LGAs formed the strata. Six schools were selected from the three strata: two schools from each LGA. One Senior Secondary two (SS2) class was randomly selected from each of the selected schools while forty (40) students were selected from the class, since all of them offered Mathematics. Two hundred and forty (240) students, comprises 130 males and 110 females were used for the study. Three instruments were used for this study. They are:

(1) Mathematics Aptitude Test(MAT)
(2) Geometry Achievement Test (GAT).
(3) Prerequisite Knowledge Test (PKT)

Mathematics Aptitude Test: This is a 75-item test with yes or no response format adopted from Barrett and Williams, (1997). It tests student's aptitude on manipulation of shapes and figures in space. Construct validity of the instrument was established using factor analysis. Principal Component analysis revealed that each of the items in the Spatial Reasoning Test is meaningfully loaded (factor loadings ranged between 0.339 and 0.669) towards one of the seven identified sub components of the test. Also the reliability coefficient of 0.92 for the instrument was established by the researcher using Cronbach Reliability Alpha Analysis, thus the internal consistency of the instrument was ensured. A sample of 97 SSII students from a coeducational school similar to the target sample was used for the validation exercise.

Geometry Achievement Test: This is a validated 20-item multiple-choice test with four options. Kuder Richardson formula 20 was used to establish the internal consistency of the instrument. The reliability coefficient is 0.8 and the average difficulty index (p) is 0.4. The content validity of GAT was established by using the scheme of work for mathematics to develop the items on Geometry across the cognitive domains-knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom, Madaus, & Hastings, 1981). A sample of 119 SSII students similar to target sample from co-educational secondary schools in Ibadan metropolis who have completed bearing in their mathematics syllabus were used for the test item analysis of GAT.

Prerequisite Knowledge Test: The test comprises 80 items developed by the researcher. The test covered Fraction, Decimal and Algebraic Fraction, Algebraic process, Angles and Triangle, Trigonometry, Specifying bearing, Presentation of bearing with diagram, Cosine rule and Sine rule validated by Adeleke (2010) as prerequisite to Geometry. Split half reliability coefficient (r) estimated on the entire test was 0.74

The researcher went to the 6 selected schools for the administration of the three tests to the selected SS2 students. Data collection lasted 2 weeks. Descriptive statistics—mean and standard deviation with Pearson Product Moment Correlation analysis were used as statistical tools to provide an answer to research question one, while, Linear Multiple Regression was employed by the researcher to provide answers to research questions two and three.

Results

Research Question One:

How significantly correlated are Prerequisite Strength, Mathematics Aptitude and Cognitive Achievement in Geometry?

Table1: Correlation between Prerequisite Strength, Mathematics Aptitude and Cognitive Achievement in Geometry

Variable	Mean	Std. Deviation	N	r	p-value	Remark
Prerequisite Strength	15.1429	8.48391	240	0.93	.000	S
Maths Aptitude	51.5274	7.58385	240	0.301	.000	S
Geometry Score	10.4497	11.39052	240			

S-Significant Correlation at 0.05 level

Table 1: shows that there was significant correlations between prerequisite strength and geometry achievement ($r=0.93$; $p<0.05$). There was significant correlation also between mathematics aptitude and geometry achievement ($r=0.301$; $p<0.05$).

Research Question Two:

Do Prerequisite Strength and Mathematics Aptitude have joint contribution to Cognitive Achievement in Geometry?

Table 2: Regression Summary of Composite Contribution of Prerequisite Strength, Mathematics Aptitude and Cognitive Achievement in Geometry

R=.938

R Square=.881

Adjusted R Square=.88

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	31309.77	2	15654.89	877.864	.000
Residual	4244.235	238	17.833		
Total	35554.01	240			

Table 2 shows that the multiple correlation coefficients (R) indicating the relationship between teacher prerequisite strength, mathematics aptitude and geometry achievement was 0.938. The adjusted R square was 0.88, meaning that 88 percent variation in Geometry Achievement of the students is accounted for by prerequisite knowledge and mathematics Aptitude. Further verification on the significance of contribution of prerequisite knowledge and mathematics Aptitude to geometry achievement using regression ANOVA produced $F_{(2,238)}= 877.864$; $p<0.05$. This indicates that there was significant composite contribution of prerequisite knowledge and mathematics Aptitude to students' geometry achievement.

Do Prerequisite Strength and Mathematics Aptitude significantly predict Cognitive Achievement in Geometry?

Table 3: Coefficients indicating Prediction of Cognitive Achievement in Geometry by Prerequisite Strength and Mathematics Aptitude.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-14.478	2.254		-6.423	.000
Prereqisite Strength	1.277	0.032	0.922	39.805	.000
Maths Aptitude	0.108	0.044	0.056	2.428	0.016

Table 3 shows that the two independent variables were found to be significant predictors of students' cognitive achievement in Senior Secondary geometry. The most potent predictor between the two independent variables was prerequisite strength, B=1.277; Std. Error =0.032; t=39.805; p<.05. The predictive strength of mathematics aptitude to geometry achievement was found to be significant, B=0.108; Std. Error =0.044; t=2.428; p<.05.

Discussions

The study shows that there was a significant correlation between prerequisite strength and geometry achievement. It was also found that prerequisite strength is a significant predictor of geometry achievement. The prerequisite strength often reveals the extent of preparation each learner has made before coming to learning situation. Such preparation in turn boosts the achievement of the learner. The result is highly revealing. Teachers should strive to teach for permanence through retention testing. The study corroborates the position of Thompson. (2004), that achievement of students in college subjects may be related to prerequisite knowledge. The finding is also a proof of Bloom, (1981) proposition that, aptitude and other predictors will predict achievement on a learning task to the extent to which they include indices of relevant prerequisite knowledge. Thus, the association between relevant prerequisite knowledge and achievement in geometry is justified. Atkinson's, (2001) Position that, prerequisite knowledge is the bane of transmission-absorption models of learning, and that mere absorption cannot account for the revolutionary changes in thought that must occur, provides credence to the finding.

There was significant correlation also, between mathematics aptitude and students' geometry achievement and mathematics aptitude is a significant predictor of geometry achievement . Relevant aptitudes are influential in part because it enhances interest in a topic and also facilitates meta-cognitive processes in students (Tobias, 1994, 1995). Two prior studies, Griggs & Jackson, (1988) and Adeleke (2007) that reported that, Scholastic Aptitude Test (SAT) scores were modestly correlated with measures of relevant prerequisite knowledge in mathematics and with final summative test in the subject lend credence to the findings.

Significant composite contribution of prerequisite knowledge and mathematics Aptitude to students' geometry achievement was established in this study. Implicit in this finding is the fact that, Prerequisite knowledge, as strong as it is could not account for 100 percent variation in secondary students' geometry achievement but when combined with mathematics aptitude, the influence became stronger. The finding therefore corroborates the outcomes of earlier researches that used college students, and reported that learning outcomes are improved by relevant prerequisite knowledge and mathematical aptitude (Schneider & Bjorklund, 1992; Abadom,1993)

Educational Implications

and educational evaluators. Based on the results of the study, it has become so clear that students that lack basic prerequisite strength to a reasonable level are bound to achieve less in the overall summative test. The study tends to support that, if students' achievement in mathematics topics will be improved, one of the basic factors to look into is extent of strength of students in relevant prerequisites to the topics. There is a need to look into the way the mathematics curriculum is sequenced. Necessary prerequisites should be planned along with mathematics

curriculum. In the past so much efforts have been put together to explain variations in leaning outcomes based on factors that exist outside the students such as home, school and environment variables. The areas worthy to concentrate on based on these findings are the alterable variables that reside in the learners, that can account significantly for the variation in learning outcomes. The findings have shown the direction parents should explore in their efforts while involving themselves in their children's learning activities. Boosting mathematics aptitude may seems difficult for teachers, but identifying level of aptitude of learners will go a long way in supporting the less endowed.

Recommendations

Based on the findings of the study the following recommendations are made.

1. The current curriculum that is in use in the secondary schools should be reviewed. The reviewed version should include basic prerequisites to each topic, that will make learners achieve meaningfully in the topic, as well as the enhancement strategies for assisting the slow learners.
2. Less endowed students should not be left to themselves in mathematics class, several strategies should be devised by mathematics teachers in particular and other subject teachers in general to support the low aptitude students in mathematics.

Conclusion

The results and findings of this study should go beyond being additional data for understanding Educational theories but as a new chapter in research endeavour. Enhancement of prerequisite knowledge should be given priority before any geometry topic is taught. If the teaching approach is changed for the better, more students will learn mathematics and mathematics – related subjects sufficiently, and the dream of technological advancement may likely come true for a developing Country as Nigeria.

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