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EFFECT OF STUDENTS' SUBJECT AREAS ON PSYCHO-COGNITIVE OUTCOMES IN MATHEMATICS

ABSTRACT

This study examined the 'effect of Students' Subject Specializations on their Psycho-Cognitive outcomes'. Three hundred and four students selected through purposive sampling using homogeneous approach constituted the sample for the study. They provided data on their subject areas, psychological and cognitive outcomes in mathematics. The data collected was analyzed using ANOVA and Post hoc test (multiple comparison) to test the significance of the differences at the 0.05 level of significance. All the null hypotheses were rejected.

The cognitive, ego-enhancing, and affiliative needs as well as achievement of students in mathematics were found to be significantly affected by their subject areas. Also, science students were found to have higher cognitive and ego-enhancing needs than other students. The commercial students were found to be better in affiliative needs and academic achievement in mathematics than science and art students.

Based on the findings of this study, it is recommended that apart from classroom teaching, mathematics teachers should organize various mathematics oriented activities that will boost cognitive, ego-enhancing and affiliative needs of their students

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across different subject areas. Since mathematics is needed to pursue most of the courses in higher institutions, mathematics teachers should initiate strategies and innovations that will make art students learn mathematics.

Background

The dilemma facing senior secondary school students in deciding their future careers and destinations are influenced by subjects offered. The subject choice dilemma is influencing students' interests, motives and educational outcomes or post secondary school destinations meaningfully (Tawaiyola 2002). This dilemma is connected with learning disabilities of the adolescents. Some of them have typically endured many years of failure and frustration. They are fully aware of their failure to acquire functional skills in the operations and applications of mathematics. Chapman, (1988) cited in Jones, Wilson and Bhojwani (1997) concluded that students who come to doubt their abilities in subject like mathematics tend to blame their academic failures on those deficits; generally consider their low abilities to be unchangeable; expect to fail in the future, and give up readily when confronted with difficult tasks. Unless interrupted by successful experiences, continued failure tends to confirm low expectations of achievement, which in turn sets the occasion for additional failure. Consequently, when they are faced with decision to choose their subjects for specialization, ability in mathematics becomes a major determinant. Ability in mathematics and students' subject areas are likely to cause variations in each other. There is need to look into how some of the dilemma associated with senior secondary school subject choices impact on other important decisions. According to Tawaiyola (2002) the process of subject choice and its impacts are not clearly understood despite years of investigation by various researchers in different countries using different methodologies.

One major variable that demands close attention of researchers is the student achievement needs. Achievement need can be viewed as the ability to behave according to one's own intentions in a flexible way (Kuhl and Kraska 1995). With respect to learning, achievement need bridges the gap between academic performance and two of its determinants namely cognitive abilities and achievement motivation. Some students are sufficiently capable and motivated to perform well on a learning task, but they have problems in initiating and maintaining the required task-relevant behaviour. Kuhl and Kraska (1995) reported that many findings from neuro physiological,

cognitive, and clinical research support the assumption that this non motivational type of under achievement can be attributed to an impairment of a separate mental function or subsystem that mediates the flexible and context-sensitive initiation, maintenance, and termination of self-generated intentions. Self-regulatory mechanism plays vital roles in students achievement need and this varies from student to student. Kuhl and Kraska further explained that self regulatory mechanisms are processes that modulate the interaction between an organism's sub systems. The most important self-regulatory mechanisms which are presumed to serve this purpose are encoding control; action control; emotion control; motivation control; attention control; intention control; coping with failure; and self-reflective thinking. They gave an example to support their view that, a child who decides to finish his homework (possibly in mathematics) can maintain this intention through self regulatory support. If he has cognitive representation of the following facts. "I want to do my homework although I don't feel like doing it at the moment". Achievement need of a child and his achievement in mathematics depend on how he can regulate himself.

Another variable of interest that may bring variation in learning outcomes is individual differences. Individual differences in cognitive development certainly affect the achievement of academic skills. The report presented by Méheut and Psillos (2004) during the 2001-2003 Esera Conferences reveals the impact students' subject choice could have on their psycho-cognitive outcomes. During these conferences, Méheut and Psillos emphasized that students' scientific knowledge can influence their conception of mathematics and mathematical phenomena. And that mathematics cognitive, ego-enhancing, and affliative needs as well as cognitive achievement of students are likely the products of such conception (Méheut and Psillos, 2004). Currently, more attention should be given to students' subject areas and how this affects their learning outcomes especially in mathematics.

There are research studies that concluded that students vary in their psychological behaviours as well as in their cognitive outcomes (Elby, 2001; Hammer, 2000; Viennot, 2001, 2002, 2003a, 2003b). These variations must be as a result of some factors. Does subject choice of a student affect his psycho-cognitive outcomes? This calls for empirical verification.

This study therefore, sought to verify whether psycho-cognitive outcomes of students in mathematics are affected by their subject areas. It aims at finding out empirically the effects subject areas have on psycho-cognitive

outcomes measured in terms of Ego enhancing, cognitive need, affiliative need, achievement score in mathematics.

Research Hypotheses

The following null hypotheses will be tested at the 0.05 level of significant

H_{o1}: Student's cognitive need in mathematics will not be significantly affected by their subject areas.

H_{o2}: There is no significant effect of students' subject areas on their ego enhancing need in mathematics

Ho_3: Students' need for affiliation in mathematics will not be significantly affected by their subject areas.

Ho4: There is no significant effect of students' subject areas on their achievement scores in mathematics.

METHODOLOGY

Research Design

This study adopted an ex-post facto research procedure because of the exploratory nature of the research. The independent variable, which is subject area, was not in any way manipulated.

Sample

Purposive sampling using the homogeneous sampling approach was used to select a public secondary school in Ibadan metropolis. This facilitated the selection of participants who were very similar in experience were taught by the same mathematics teacher and sat for the same internal examination. The subjects used for this study were three hundred and four senior secondary school Two (SS2) students. This number covered students of different age, backgrounds, sex, and subject combinations.

Research Instrument

Mathematics Achievement Need (MAN)

The Students' Mathematics Achievement Need was adopted from Abadom-Bakare (1993). The instrument comprised 37 items; 15 of which measured cognitive need of students, 14 items measured ego-enhancing need while 8 items measured affiliative need of students. It had a 4 points scale that is 4-Strongly Agree; 3-Agree; 2-Disagree and 1-Strongly Disagree for each of the positive items while the points are reversed for negative items.

Data Analysis

The analysis of Variance (ANOVA) was used to establish significant effect of the independent variable (Students' Subject Specialization) on the dependent variables (cognitive, ego enhancing and affiliative needs and achievement score). Post hoc (Scheffe) was used for further verification for any effect found to be significant

RESULTS

In this section, the results of the four hypotheses tested are presented in tables 1 – 4.

Hypothesis One

Student's cognitive need in mathematics will not be significantly affected by their subject areas.

Table 1: **Analysis Of Variance of Students' Mean Scores in Cognitive, Ego Enhancing and Affiliation Needs Based on Subject Areas.**

		Sum of squares	Df	Mean square	F	Sig.
Cognitive	Between groups	671.370	2	335.685	12.589*	.000
	Within groups	8052.682	302	26.665		
	Total	8724.052				
Ego enhancing	Between group	967.715	2	483.857	14.438*	000
	Within group	10121.125	302	33.514		
	Total	11088.839	304			
Affiliation	Between groups	77.012	2	38.506	3.073*	0.048
	Within groups	3783.992	302	12.530		
	Total	3861.003	304			

* - Significant at 0.05 alpha level of significance.

Table 2: Post Hoc Tests: Multiple comparisons

Dependent variable	(i)Students course area	(j) students' course area	Mean (i-j)	Std	Sign.
Cognitive need	Arts	Science	-4.0994	82	000
		Commercial	-2.8805	7941	002
	Science	Arts	4.0994	8200	000
		Commercial	1.2189	6655	189
	Commercial	Arts	2.8805	.7941	.002
		Science	-1.2189	.6655	.189
Ego - enhancing	Arts	Science	-4.8610	.9194.	000
		Commercial	-2.4681	7461	022
	Science	Arts	4.8610	.9194	000
		Commercial	2.3929	.7461	006
	Commercial	Arts	2.4681	.8902	.022
		Science	-2.3929	7461	.006
Affiliation	Arts	Science	-1.437	.5621	1.00
		Commercial	-1.0224	.5443	.173
	Science	Arts	1.437	.5621	1.00
		Commercial	-1.0081	.4562	.089
	Commercial	Arts	1.0224	.5543	.173
		Science	1.0081	.4562	.089

From table 1, F-ratio is 12.589 ($p< 0.05$), which is significant at 0.05 alpha level of significance. This means that the null hypothesis is rejected. Therefore, students' cognitive needs in mathematics was significantly affected by their subject areas.

Further verification using post hoc test as shown in table 2 reveals that the mean cognitive need score of science students on mathematics is higher than that of the commercial students while that of the Art students is the lowest.

Hypothesis Two

There is no significant effect of students subject specialization on their ego enhancing needs on mathematics.

Table 1 reveals that F-ratio is 14.438 ($p<0.05$). this is significant at 0.05 alpha level of significance, hence the null hypothesis is rejected. Therefore,

there is significant effect of students' subject areas on their ego-enhancing needs on mathematics. Out of the three groups, post hoc test reveals that science students are still the best, followed by commercial and lastly by Art students in ego-enhancing needs.

Hypothesis Three

Student's affiliation needs on mathematics will not be significantly affected by their subject areas. Also in table 1 the F-ratio is 3.073 ($p< 0.05$) thus the null hypothesis is rejected at 0.05 alpha level of significance. Therefore, students' affiliation needs on mathematics was significantly affected by their subject areas. Post hoc test reveals that commercial students are the best in affiliation need, followed by science and lastly by Art students.

Hypothesis Four

There is no significant effect of students' subject areas on their cognitive achievement in mathematics

Table 3: Analysis of Variance of Mean Achievement Score in Mathematics Based on Subject Areas.

	Sum of Square	df	Mean Square	F	Sig.
Between groups	9281.793	2	4640.896	44.719*	000
Within groups	21.378.676	206	103.780		
Total	30660.469	208			

* - Significant at 0.05 alpha level of significance

Table 3 reveals that F-ratio is 44.719 ($p<0.05$) significant at 0.05 alpha level of significance. Hence, the null hypothesis is rejected. Thus, there was significant effect of students' subject areas on their cognitive achievement in mathematics.

Table 4 : Post Hoc Test: Multiple comparisons

Dependent Variable	(i) students course area	(j) students course area	Mean Difference(i-j)	Std. Error	Sig
Achievement	Arts	Science	-1.7800	1.97931	.674
		Commercial	-14.1339	.7116	.000
	Science	Arts	1.7600	1.9793	.674
		Commercial	-12.3740		.000
	Commercial	Arts	14.1339	1.7116	.000
		Science	12.3740	1.7330	.000

From the post hoc test in table 4, the best group in cognitive achievement is commercial followed by science and lastly by Art students.

DISCUSSIONS ON THE FINDINGS

Cognitive needs of students in mathematics was found to be significantly affected by students' subject areas. Level of application of mathematics in different subject areas varies. Student's self-efficacy in solving mathematical problems depends on this demand. This corroborates the opinion of Pajares and Miller's (Jones et al 1997) that students' judgments of their ability to solve specific types of mathematics problems were useful predictors of their actual ability to solve those problems. Two important issues emanate from this finding, first, judgments of cognitive needs are task specific and generally accurate. Second, student judgment of cognitive needs may provide insights that will be valuable supplements to teacher assessments of performance skills. The student that sees the need for meaningful academic achievement in mathematics will perform better in the subject. This supports the finding of Chapman (1988) in Jones et al.(1997) that students who come to doubt their abilities in subject like mathematics give up readily when confronted with difficult mathematics task. The reasons behind this, bother on their level of preparedness, perseverance and self-will to succeed. The result also shows that ego-enhancing needs of the students was significantly affected by students subject areas. This finding corroborates that of Tawaiyola (2002) that the interests and motives (ego boosting and affiliation) of students are strongly associated with their choice of subjects at the senior secondary school level. Investigations into subject choice among 11 and 12 year old students by Ainley, Robinson, Harvey-Beavis, Elsworth and Flemming

(1994) revealed that intrinsic reasons such as student enjoyment and interests are strongly associated with subject choice. Those students who need meaningful achievement in mathematics to boost their ego amidst colleagues and parents strive to achieve more.

Affiliation Needs of the students in Mathematics was also found to be significantly affected by their subject areas. Subject areas as a subject of investigation has generated wealth of information contained in research reports, journal articles and other publications (Elby, 2001; Hammer, 2000; Viennot, 2001, 2002, 2003a, 2003b). While these investigations differ in methods, scope, contexts and population from which study samples are drawn, the findings arrived at are usually or generally similar. What appears from the literature to be a common finding according to Tawaiyola (2002) is that, the psychological outcomes of students are strongly associated with the subjects they choose to study in their senior secondary school years. For any student to cope in sciences and function effectively amidst classmates, knowledge of mathematics is needful. The need of mathematics for association therefore is a motivational factor on its own.

Students' subject areas was found to significantly affecting their academic achievement in Mathematics. This finding also corroborates the view of Tawaiyola(2002) who concluded that the cognitive achievement of students is strongly associated with their subject choices. This is found to be so even in Mathematics. Most students always consider their strength in mathematics before making their subject choice. As students' achievement in mathematics predicts subject areas so the latter does the former.

CONCLUSION AND RECOMMENDATION

The current economic reforms dictated by technological changes and globalization indicates a problematic future. The preparation for tomorrow's challenges should not exclude the formal education sector. Beyond teaching within the four walls of the classroom, mathematics oriented activities e.g Mathematics club with challenging programmes, quiz competition and similar programmes that will boost students' cognitive, ego, and affiliative needs in mathematics should be organized across different subject choices. This is needful because the application of the knowledge of mathematics to everyday life can never be over emphasized. Also, we are now in the world of innovations, therefore mathematics teachers should initiate strategies and innovations that will make students learn mathematics better especially the art students. The mathematics curriculum designers should make it dynamic

to incorporate aspects, which are relevant to the current needs of the society and suited to the diverse post-secondary school destinations. The curriculum should be flexible enough to allow students to study mathematics oriented subjects across disciplines and increase their chances of studying subjects that they may be interested in, in the future. Current practices of channeling students into science or art areas need to be reviewed as this has a limiting or restrictive effect on students performance in a major subject like mathematics. Having multiple skills or qualifications across more than one specialized area or discipline would broaden career and life options for this population who have many years ahead of them. With double opportunities in which every student in secondary school is having to write two major examinations (WAEC and NECO final examinations), students can cut across different specialization areas. Practicing mathematics teachers should desist from 'you can never know it' attitude they put up while teaching Art students and see how the cognitive, ego enhancing and affiliative needs of the students across the subject areas are improved. This is necessary as long as these are found to account for variations in achievement in Mathematics. The findings also have implication for effective counseling in schools. Motivational talks should be organized from time to time to boost psychological needs of the students in Mathematics.

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