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EFFECT OF STRUCTURED AND GUIDED INVESTIGATION TECHNIQUES ON THE INTEREST OF COLLEGE STUDENTS IN MATHEMATICS IN NIGERIA

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Abstract

The main concern of the study is the attractiveness of the students to mathematics. The population for the study consisted of NCE students at teacher training colleges in Oyo State, Nigeria. Three hypotheses, tested at a significance level of 0.05, guided the study. The Mathematics Interest Inventory (MII) served as an instrument for data collection. The experiment to determine the coefficient of internal consistency of the MII items was performed using Cronbach Alpha. The reliability coefficient calculated for MII was 0.91. ANCOVA was used to test the hypotheses. The study found that both guided and structured interviews arouse students' interest, but that the guided interview teaching method arouses students' interest more effectively than the structured interview technique in mathematics. The study also found that there was an influence of gender on students' interest in mathematics, with boys being favoured. There were no interaction effects of treatment and gender on the interest of college students in mathematics. Therefore, the effectiveness of the guided inquiry technique on students' interest in mathematics was independent of gender. It was therefore recommended that the Ministries of Education, and the National Commission for Colleges of Education (NCCE) should regularly organize workshops, seminars and conferences for Mathematics teachers to deepen and improve their knowledge and skills in using the teaching techniques with guided inquiry improvement, among other recommendations.

Keywords: *Guided Query, Interest, Structured Query.*

Introduction

Interest is an ongoing tendency to pay attention and enjoy some activity. It is considered an emotionally oriented behavioural trait that determines trade students' enthusiasm for completing educational programs or other activities (Chukwu, 2012). Osuafor (2011) described interest as that attraction that compels a student to respond to a particular stimulus. For others, it is a phenomenon arising from an individual's interaction with the environment (Hidi & Renninger, 2016; Silvia, 2016). This postulate is also the starting point for a pedagogical interest theory (Prenzel, 2012 ; Schieele et al., 2013), also called “person-object theory of interest” (Krapp, 2012). Interest represents a specific and distinguished relationship between a person and an object. Such objects can be concrete, actual, factual, or abstract ideas. Here too, such an interest can exist for a short or long term. Educational research can help to better understand how interest in education in general and in mathematics in particular arises, how it grows, disappears, and how it can sustain and stimulate learners' attention and interest (Krapp, 2012). Interest does not arise through coercion, but through the willingness of the individual to learn. Interest is therefore an affective behaviour

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that can be aroused and maintained in teaching and learning through a suitable teaching strategy. Student interest and success in any learning activity are maintained through the learner's active participation in all aspects of the learning process. Ogwo and Oranu (2016) and Ngwoke (2014) emphasized that student achievement is minimal when the teacher stimulates students' interest in learning. Therefore, it is important for science teachers to use teaching methods such as B. Inquiry-based instruction that ensures students' active participation in learning, and stimulates interest while improving performance in the chosen field of study.

Inquiry-based teaching is one of the most effective ways to actively involve learners in the learning process. According to Agboola and Oloyede (2017), it creates situations where learners take over the role of the scientist. This is because students take the initiative to observe and question phenomena, provide explanations for what they see, design and perform tests to support or refute their theories, analyze data, draw conclusions from pulled experimental data, design and build models, or any combination of these. Eick and Reed (2012) claimed that the inquiry-based teaching method is a project-oriented pedagogical strategy based on social-constructivist learning theory. It is a method that evokes critical thinking skills. That is, mentally engaging in a cognitive process to understand conflicting factors in a situation (Davis, 2016). Therefore, inquiry helps students develop higher thinking skills by making students relate new knowledge to their prior knowledge, think both abstractly and concretely, apply specific strategies to new tasks and understand their thinking strategies (Hmelo & Ferrari, 2017). In the investigation situation, the students not only learn concepts and principles, but also self-control, responsibility and social communication.

The inquiry-based teaching method is most appropriate for science, technology, and engineering courses for other scientists than the traditional teaching method (Eickand, 2002; Alvarado & Herr, 2003; Glenda , Hebrank, et al., 2005); Adeoye & Raimi, 2006; Prince & Fields, 2007; Owodunni & Ogundola, 2013). There are several techniques of inquiry-based teaching, with the differences between these techniques being based on the way the teaching method is carried out. Colburn (2000) suggested that the differences between the techniques lie in the level of teacher involvement. These techniques include affirmative, structured, guided, and open inquiry techniques. In the confirmation request, people are told the question and the procedure (method) in which the results are known in advance, and confirmation of the results is the subject of the request. The confirmation request is useful for reinforcing a previously learned idea. This survey technique is best suited for elementary school. In the structured investigation, the question and the procedure (the method) are made available to the persons. However, the task is to generate an explanation that is supported by the evidence gathered in the procedure, whereas in the guideline survey, the individuals are only asked the research question and the task is to identify the procedure (the method) and the question and the result to design to test the resulting explanations. This type of request is more open-ended than a structured request. Finally, in open-ended investigations, people formulate questions, develop procedures for conducting an investigation, and report their findings. McGraw Hill (2017) explained that the teacher's role is to provide the students with the materials to be examined. The majority of authors agree that the open-ended survey method is so complex that it is unsuitable for use at the secondary level (Denise, 2019; Adeyemi, 2000).

Some key elements of inquiry technique that enhance the effective teaching/learning process in an inquiry class include the presentation of the concept. This is the explanation of a concept or principle underlying a given problem to be solved by teachers for students (Ashton, 2018). Another

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research tool is the use of waiting time. This waits a few seconds after students are asked questions, giving them time to think before answering such a question. Another element is the inclusion of authentic life experiences by the teachers in the teaching activities. This also provides real situational and contextualized knowledge of new information students are learning. The use of scaffolding tools such as interactive journals and question prompts are elements that also encourage inquiry-based teaching (Kinchin & Hay, 2000). Additionally, collaborative learning, where students explore their understanding and misunderstanding together, helps them reflect on what they already know, what they need to know, and how they would present and defend their ideas in response to a classroom situation (William, 2014). All of these elements are necessary tools to help the teacher convey the skill requirements of the modern auto mechanic.

Mathematics encompasses the activities of human endeavour, but in general, it is a discipline that helps develop an individual's scientific thinking skills. The basic goals of mathematics in secondary schools, which today include the ability to recognize numbers and perform basic functions, data collection and interpretation, critical thinking and problem solving, are no longer realized (Denise, 2019; Adeyemi, 2000). One of the reasons for this may be the poor foundation that mathematics is already on from the students' secondary level, which leads to poor performance of students in the subject. One of the reason these students perform poorly may be the influence their age group has on them.

Gender differences in scientific interest depend strongly on domains. There is well-documented evidence that women turn away from science subjects such as physics, chemistry, and mathematics during schooling more than men (Häussler & Hoffmann, 2010; Jones, Howe, &Rua, 2010; Labudde, et al., 2010). However, recent studies also indicate that the differences between girls and boys in terms of achievement and interest in science are very small (Martin et al., 2018; Organization for Economic Co-operation and Development (OECD), 2019).

Research Hypotheses

The following hypotheses were formulated to guide the study and are tested at a significance level of 0.05:

H_{01}: There is no significant difference between the effect of treatments (structured and guided investigation techniques) on students' mean interest ratings.

H_{02}: There is no significant difference between the influence of gender (male and female) on students' average interest rating.

H_{03}: There is no significant interaction effect of treatments given to students taught investigative techniques and their gender on their mean interest register scores

Methodology

A quasi-experimental design with a pre-test and a post-non-equivalent comparison group design was chosen. The study population consisted of NCE II mathematics students at the Colleges of Education in Oyo State who are; Federal College of Education (Special), Oyo; Emmanuel Alayande College of Education, Oyo; Teacher Training College, Lanlate; Mufu Lanihun College of Education, Ibadan and Best Legacy College of Education, Ogbomosho. The sample size for this study included all 100 NCE II mathematics students at the five Colleges of Education in Oyo State.

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20 students were randomly selected from each school. The reason for choosing year II is that the students have gone through the mathematics curriculum of year I and were able to solve the examination tasks.

The instrument used for data collection in this study was the Mathematics Interest Inventory (MII). The instrument was developed by the researcher to test students' interest in mathematics. Face and content validities were determined by experts in mathematics, testing and measurement, and language education. After face and content validation, the items were reviewed based on their comments, and thirty statements consisting of 15 positive and 15 negative items were finally selected to form the MII. Therefore, Section A of the questionnaire contains items related to the respondents' biographical data, while Section B contains the list of thirty items that range on a four-point Likert scale from “Strongly Agree” (SA), “Agree ’ (A), , 'disagree (D) and disagree (SD). Cronbach Alpha was used to determine the internal consistency of the instrument elements. The instrument was applied to 20 mathematics students at Normal Schools in Ilesa, Osun State, an area that was not part of the study area. The reliability coefficient calculated for the instrument was 0.85.
The following conditions were specified to minimize experimental bias:
both experimental groups were taught the same material;

i. the same ability test was performed on both groups simultaneously to avoid experimental bias:
ii. the students had no previous knowledge about their participation in the experiment:
iii. the researcher was not directly involved in the conduct of the test.

All lesson plans used for the study were created by the researcher to control for invalidity that could be caused by teacher variability. For the participating teachers, the researcher organized a two-week intensive course on the application of the teaching techniques of structured and guided research and its lesson plans
The study was conducted in three phases as described below:
1.The first phase was the pre-test phase. It was the phase in which the instrument was administered to the subjects in the two experimental groups. This phase of the study was conducted in the first week of the experiment. This exercise provided baseline data on cognitive performance
2.The second phase, the trial or trial phase, included the two experimental groups that were taught using the developed investigative technique. During the treatment, the students were divided into groups of three and four. The workshop activities were organized in such a way that each group was provided with a vehicle, clutch assembly, brake components and transmission assemblies (depending on the subject covered), full tool kit, paintbrush and petrol. Each of the two lesson plans used for the study included at least one inquiry-based teaching method, and one guided research method.
3.The experimental group, taught using the Structured Inquiry method, was given probing questions or problems and a complete step-by-step process or procedures for the students to follow to find or achieve solutions to the problems. On the other hand, the experimental group taught with the guided investigation teaching technique was not provided with complete procedural steps (as in the structured investigation technique) for solving the problems, but the teacher additionally provided the problems to be solved and the explanation of the principle of operation to provide

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practical material needed to solve the solution. Students were expected to figure out the procedures or steps needed to solve the problems posed.
Each experimental group was taught for 10 weeks. Practical lessons are held once a week in all the schools used for the course. For this purpose, each of the test groups was instructed for several hours. The third phase was the post-test phase
The data obtained from the students' results were analyzed using analysis of covariance (ANCOVA) to test the hypotheses of a non-significant difference

Result

The results of data analysis in these study areas are as follows:
H_{01}: There is no significant difference between the effect of treatments (structured and guided investigation techniques) on students' mean interest ratings.

Table 1-Analysis of Covariance (ANCOVA) for Test of Significance of Three Effects: *Treatments Gender and Interaction of Treatment and Gender on Students' Interest*

Source of Variation	Sum of Squares	df	Mean Square	F	Sig
Covariates	8.83	1	8.83	1.28	0.26
Pre-test	8.83	1	8.83	1.28	0.26
Effects	44.17	2	22.08	3.20	0.04
Treatment	.50	1	0.50	0.07	0.79
Gender	44.14	1	44.14	6.40	0.01
2-way Interactions	2.14	1	2.14	0.31	0.58
Treatment*Gender	2.14	1	2.14	0.31	0.58
Explained	60.61	4	15.15	2.20	0.07
Residual	1311.21	87	15.07		
TOTAL	1371.82	99	13.86		

***Significant at sig of 0.05**

Table 1 shows that the calculated F value for the treatment is 0.07, with a significance of F at 0.79, which is greater than 0.05. Therefore, the null hypothesis that there is no significant difference between the effect of treatments (structured and guided techniques) on students' interest in mathematics is maintained at a significance level of 0.05.

H_{02}: There is no significant difference between the influence of gender (male and female) on students' average interest rating.

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Table 2 - Analysis of Covariance (ANCOVA) for Test of Significance of Three Effects: *Treatments Gender and Interaction of Treatment and Gender on Students' Interest*

Source of Variation	Sum of Squares	df	Mean Square	F	Sig
Covariates	8.83	1	8.83	1.28	0.26
Pre-test	8.83	1	8.83	1.28	0.26
Effects	44.17	2	22.08	3.20	0.04
Treatment	.50	1	0.50	0.07	0.79
Gender	44.14	1	44.14	6.40	0.01
2-way Interactions	2.14	1	2.14	0.31	0.58
Treatment*Gender	2.14	1	2.14	0.31	0.58
Explained	60.61	4	15.15	2.20	0.07
Residual	1311.21	87	15.07		
TOTAL	1371.82	99	13.86		

***Significant at F< 0.05**

Table 2 shows that The F-calculated for gender stood at 6.40 with a significance of F at 0.01 which is less than 0.05. The null hypothesis is therefore rejected at a 0.05 level of significance. With this result, there is a significant effect of gender (male and female) on students' interest in mathematics. H_{03}: There is no significant interaction effect of treatments given to students taught investigative techniques and their gender on their mean interest register scores

Table 3 - Analysis of Covariance (ANCOVA) for Test of Significance of Three Effects: *Treatments Gender and Interaction of Treatment and Gender on Students' Interest*

Source of Variation	Sum of Squares	df	Mean Square	F	Sig
Covariates	8.83	1	8.83	1.28	0.26
Pre-test	8.83	1	8.83	1.28	0.26
Effects	44.17	2	22.08	3.20	0.04
Treatment	.50	1	0.50	0.07	0.79
Gender	44.14	1	44.14	6.40	0.01
2-way Interactions	2.14	1	2.14	0.31	0.58
Treatment*Gender	2.14	1	2.14	0.31	0.58
Explained	60.61	4	15.15	2.20	0.07
Residual	1311.21	87	15.07		
TOTAL	1371.82	99	13.86		

***Significant at F< 0.05**

The interaction effect of treatment and gender has an F-calculated value of 0.31 with a significance of F of 0.58 which is greater than 0.05. This result means that there is no significant interaction effect of treatments given to students taught mathematics with inquiry techniques and their gender concerning their mean scores in the Interest Inventory.

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Summary of findings

The following findings emerged from the study based on the data collected and analyzed and hypotheses tested.

i.There was no significant difference between the effect of treatments (structured and guided techniques) on students' interest in mathematics.

ii.There was a significant effect of gender (male and female) on students' interest in mathematics.

iii.There was no significant interaction effect of treatments given to students taught mathematics with inquiry techniques and their gender with respect to their mean scores in the Interest Inventory.

Discussion of findings

Finding revealed that both structured inquiry and guided inquiry techniques are effective in improving students' interest in mathematics but the effect of Guided inquiry technique on students' interest in mathematics is higher than the effect of structured inquiry techniques. This finding indicates that Guided inquiry technique is more effective in stimulating students' interest in mathematics than the structured technique. However, the Analysis of covariance of the treatments effects on interest presented in Table 1 showed that there was no significant difference between the effects of treatments (Structured inquiry and guided techniques) on students' interest in mathematics. Thus, the difference between the Guided inquiry technique and structured inquiry technique on students' interest in mathematics was not found significant. Orion, Hofstein, et al.,(2017) assumed that students' practical, outdoor or field work helped them develop responsibility and a sense of caring for the environment. This finding is in agreement with previous research that reports outdoor learning is popular with students (Orion et al., 2017), raises curiosity (Hartney & Rogers, 2017), and engenders fun (Orion et. al, 2017).Although there was no overall significant difference between the groups, guided inquiry students planned their project, and they were exposed to change and expressed anticipation (Yen & Huang, 2016),where as structured inquiry students were led by the teacher, thus they were less exposed to change, more passive than their guided inquiry peers, and did not express feeling so f anticipation. Without anticipation, there is often no disappointment and no surprise (Castelfranchi & Lorini, 2003).

Furthermore, another salient finding from this study is that it was found that male students taught mathematics with Inquiry techniques had higher mean scores than female students in the Mathematics Interest Inventory, revealing that there is an effect attributable to gender on the interest of students taught mathematics with Inquiry techniques. However, analysis of covariance of test of significant difference between the effect of gender on students' interest in mathematics as presented in Table 2 showed that there was no significant difference between the effect of gender (male and female) on students' interest in mathematics. This means that the observed difference in them earns interest scores of male and female students was not statistically significant. The finding is corroborated by Osberg et al., (2017). The interaction effect of treatment and gender was not found to be significant. This implies that the effectiveness of Inquiry techniques on students' interest in mathematics is independent of gender.

Conclusion

The influence of technological advancement in automobiles has rendered traditional skills inadequate for work in the automobile industry. Greater stress need therefore be placed on

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providing students with broad learning and problem-solving skills in order to prepare them for a wide range of challenges posed by technological advancement which has occasioned the need to seek for alternative instructional method such as guided inquiry to teach the modern work place skills requirements of the industry. Moreover, it has been discovered that the persistent poor academic achievement and low interest of students in mathematics courses in teacher training institutions is as a result of the inappropriate teaching methods adopted by teachers (Aina, 2000).

Recommendations

Based on the findings of this study, the following recommendations are made:

- Mathematics teachers should adopt the use of Guided inquiry technique to the teaching of mathematics in such a way that students are allowed ample opportunity to interact freely with one another in the Guided inquiry space so as to increase students interest in mathematics and invariably improve both their psychomotor and cognitive achievement
- Workshops, seminars and conferences should be organized by Ministry of Education and NCCE to enlighten technical teachers and improve their knowledge and skills on the use of Guided inquiry techniques for improving students' interest in Science education generally and mathematics in particular.

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