The Bulletin of Society for Mathematical Services and Standards *Online: 2012-09-03*
ISSN: 2277-8020, Vol. 3, pp 28-36
doi:10.18052/www.scipress.com/BSMaSS.3.28

Comparative Effectiveness of Inductive Inquiry and Transmitter of Knowledge Models on Secondary School Students' Achievement on Circle Geometry and Trigonometry

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Keywords: Inductive Inquiry, effectiveness, students, academic achievement, Transmitter of Knowledge, teaching.

ABSTRACT

In this study, the effectiveness of Inductive Inquiry and Transmitter of Knowledge models on students' academic achievement on Circle Geometry and Trigonometry is explored. The main objectives of the study are to expose the groups to Inductive Inquiry and Transmitter of Knowledge models and compare the effectiveness of these modes of teaching in the teaching of circle geometry and trigonometry. The pre-test-post-test experimental design is chosen for this work. It is hypothesized that there would be significant difference between mean achievement scores of these experimental groups on the post-test. The population of the study consisted of all the students of senior secondary two (SS2) class studying in Govt. Sec. School, Bwari, Federal Capital Territory(FCT) Abuja, Nigeria from which a sample of 60 students is drawn using random sampling technique. They were divided into two groups formed through matching on the basis of their pre-test scores; each group consisting of 30 students. One of the groups is randomly chosen as the Inductive Inquiry group and the other as Transmitter of Knowledge group. The independent variable is mode of teaching and the dependent variable is the academic achievement of students. The dependent variable is measured through a 50-item achievement test items generated using the West African Examination Council's (WAEC) past questions. These questions are used as both pre-test and post-test items. It is found that Inductive Inquiry group performed better than the Transmitter of Knowledge group. This result may be investigated for further confirmation. It is recommended that Inductive Inquiry model be used by teachers of mathematics while teaching the subject to senior secondary classes. A blend of models may be used because there is no single model that is exclusively best for teaching all the topics at all levels to all students, considering individual differences among students.

Introduction

The process of teaching and learning is as old as human beings on the earth. It has been carried out by human beings and even by animals to teach their young ones for successful adjustment in the environment. Teaching, as conventionally understood by a traditional teacher, is just the act of disseminating information to the learner in the classroom. If we observe traditional classroom teaching, we find that either the teacher is delivering information or one of the students is reading from the text book and others are silently following him in their own text books. Conventional teaching is simply chalk-talk approach in which students remain passive learners. Instruction is ill organized and rote learning is heavily emphasized. Mostly the results of students are not satisfactory due to the presence of this approach. Ever since the beginning of 20th Century, research on teaching has generated useful knowledge about teaching skills, methods and models that can be usefully employed by teachers to promote students learning.

The century old history of research on effective teaching includes three milestones namely, identification of specific teaching skills, integrating these skills into a systematic pattern of instruction and formulation of general models of instruction. Identified seven skills of effective teaching on the basis of his meta-analysis include use of academic learning time, reinforcement, cues and feedback, cooperative learning, classroom morale, higher order questions and advance organizers. According to Sprinthall and Sprinthall (1990), one of the weaknesses of such a meta-analysis is that the skills do not depict actual patterns of teaching.

The analysis of instruction developed by Flanders (1970) shows how these elements fit together in actual classroom interaction. Teaching elements have also been combined into general models of teaching. A model is a cluster of strategies that is logically consistent with a certain set of assumptions about how students learn best. Sprinthall and Sprinthall have simplified research generated teaching models into three namely, transmitter of knowledge model, inductive inquiry model and intrapersonal model. It is the intension of the researcher to investigate the comparative effectiveness of Inductive Inquiry model and the conventional teaching method.

As the present study sought to compare the effectiveness of the Inductive Inquiry model and transmitter of knowledge model in the teaching of circle geometry and trigonometry at senior secondary school level, some of the available research materials relevant to this study are reviewed below.

Inductive Inquiry model was propounded by Suchman which he tried to make popular, Suchman as cited by Singh, (2005). The basic philosophies behind his model are:

1. Pupils inquire naturally when they are puzzled.
2. They can be conscious of and learn to analyze their thinking strategies.
3. New strategies can be taught directly and added to pupils.
4. Co-operative inquiry helps pupils to learn about the tentative, emergent nature of knowledge and to appreciate alternative explanation.

Suchman provided a systematic structure within which the pupils have to ask questions regarding why events happen the way they do, to collect data and process it logically and to arrive at plausible cause effect relationships. The inquiry training begins by presenting a puzzling event, a problem or a phenomenon when pupils encounter such a situation; they are motivated to solve the puzzle. Such situations can be used to teach systematic procedures inquiry. In Inquiry Training Model, induction encounter is the pre-requisite without which no problem can be posed. Any learning can take place by the learners after inquiring into the problem.

Martorella (1979) found that no conclusion from research has emerged to establish clearly the superiority of inquiry over the traditional approaches. Learning through inquiry is often more enjoyable to the students. Generally speaking, the students are more interested, or more enthusiastic, or just more active in the inquiry process as they are generating more knowledge like social scientists. Inquiry teaching seems to have a positive effect on discipline, retention and attitude towards social studies. Research evidence on inquiry as a method of teaching social studies with respect to student achievement is scanty, fragmentary and inconclusive. Indubitably, more research is needed.

Research concerning the effectiveness of inquiry as compared to the more traditional lecture method has not yet determined the superiority of any method.

Tyrell (1982) reviewed 88 comparisons between traditional lecture and discussion method and noted that 51 percent favored the lecture method and 49 percent favored the discussion method. Subsequently, there was very little difference in achievement scores between them. Tyrell also emphasized the following results which may assist the teacher in planning his / her choice of strategies:

i. When appropriately used, the lecture and inquiry discussion methods are relatively equal in providing knowledge acquisition opportunities.

ii. In one study, the lecture-recitation method was found to be superior in terms of subsequent test scores to inquiry and public issue discussion method. The effectiveness of the approach, however, depended upon students' ability and performance.

iii. Different strategies may be more appropriate for different abilities. Hinrichson and Schaumburg (1975) reported no difference between inquiry and lecture in terms of academic performance.

Schlenker (1970) found that students of inquiry oriented teachers showed a greater fluency in inquiry and critical thinking but showed no difference in content mastery and information retention.

According to Sprinthall and Sprinthall (1990), probably the most common teaching model, and certainly the one with the longest tradition, is that which views teaching as the transmission of knowledge. This view assumes that there exists a well known and finite body of knowledge from which the teacher selects certain facts and concepts to pass on to pupils. This model emphasizes the need to give pupils basic facts and information before they can be expected to think for themselves. They must learn what is already known before they can come up with new ideas that might fit into the existing knowledge. It assumes that learning new information is essentially in linear step-by-step sequence. The teachers' expertise is needed to arrange both the content material to be mastered and the method of presentation.

Some educators have suggested that deductive teaching can be critically important for students with learning disabilities, Brigham and Matins (1999). This method that has a clear and readily apparent structure is easily paced to accommodate student needs and is very familiar to students. But deductive teaching has a trade off. It can be too rigid, a form that does not allow for divergent student thinking nor emphasize student reasoning and problem solving.

The transmitter of knowledge model can be more efficient by means of improving the organization of course content and introducing simulation such as mystery simulation, Singer (1999).

Transmitter of knowledge model is also called deductive model, advance organizer model, mastery learning model and direct instructional model. Thus the transmission of knowledge model, through the use of advance organizers, can provide a clear and systematic approach to teaching. One of the disadvantages of the model is that so much of the work of learning is controlled and directed by the teacher. One study found that low achievers did not understand the directions, spent most of their time watching their peers speed through the assignment, turned in incomplete work and were frequently criticized. It is clear that some students will do better under learning conditions that are fewer teachers' directed and controlled (Sprinthall and Sprinthall, 1990).

In this model, the teacher uses advance organizers. At the outset of a lesson, the teacher presents the pupils with the general rule, the generalization or the main 'point' of the activity. The concrete examples help them understand the connections between the facts and the general point. The teacher would proceed to a presentation of a long series of facts (Sprinthall and Sprinthall, 1990).

This includes, providing the general rules, correlations and then asking students to apply these to solve problems. This is the most common teaching method, where a lecturer represents the principles of the subject followed by a tutorial where the students practice the application of the knowledge they are taught. For a crash course or to transmit large chunks of information, this technique would be more suitable. The technique provides a sequence of instruction that can be applied to solve problems.

This model in some becomes a set of boring monotonous lectures followed by tutorials. Also, the students are asked to derive corollaries from the given facts and principles, Rao and Reddy, (1992). The presentation of examples, finally, is followed by the restatement of the generalized principle. In this sense, the transmission of knowledge model is often called guided discovery. But the researcher is of the view that guided discovery and unguided discovery both come under Bruner's inquiry model to be described later because, according to Prince and Felder(2007) in enquiry based learning also known as guided enquiry, students are presented with a challenge and accomplish the desired learning in the process of responding to that challenge. Through various examples, all pupils are led to the same generalization. Probably the strongest example of his model of transmitting information is the lecture format. Although it can be used with other teaching strategies, this model is most effectively used as a format for lectures or for mini lectures. This model is based on deductive teaching.

Deductive teaching (also called direct instruction) is much less constructivist and is based on the idea that a highly structured presentation of content creates optimal learning for students. The instructor, using a deductive approach, typically presents a general concept by first defining it and then providing examples or illustrations that demonstrate the idea. Examples that do not fit the idea are helpful in confirming the idea. Students are given opportunities to practice, with instructor guidance and feedback, applying and finding examples of the concept at hand, until they achieve concept mastery, Landmark College, (2005).

Objectives of the study

The objectives of the study are:

1. To expose the experimental group to the Inductive Inquiry model.
2. To compare the academic achievement of experimental group taught through the Inductive Inquiry models and the control group taught through conventional teaching on their post test scores.

Scope of the study

The study was delimited to:

1. Only Students of Government Secondary School, Bwari, Federal Capital Territory (FCT), Abuja, Nigeria.
2. Students in senior secondary two (SS2) class.
3. The subject is mathematics- circle geometry and trigonometry.
4. The first three levels of Bloom taxonomy of cognitive domain (that is knowledge, comprehension and application levels of objective).

Significance of the study

The significance and utility of models are universally acknowledged. The latest approach of using teaching models is generally considered not only to increase students' performance in the examinations but also help in improving their attitude towards the subject. The results of the study are of theoretical and practical significance which may be helpful in creating fresh knowledge of teaching effectiveness.

The results of this study might provide indigenous knowledge about the overall relative effectiveness of this model of Inductive Inquiry models. The result of the study may contribute to the theory and practice of teaching not only at the class and school levels but maybe helpful to curriculum developers designing appropriate methodologies for teaching the curriculum contents.

Limitations of the study

Some limitations of this study should be taken into account before generalizing the results of the study. First, the study is conducted in an urban setting therefore; the generalization of the results on rural settings may be limited.

Secondly, the achievement test on Circle Geometry and Trigonometry used in the study for pre-testing and post-testing is the same. The use of parallel test may have given better results.

Research Hypotheses

The null and alternative hypotheses of the study are as follows:

H_{01} There is no significant difference between the mean post-test achievement scores of students taught through the Inductive Inquiry model and those students taught through conventional teaching using Scheffe test.

H_{11} There is significant difference between the mean post-test achievement scores of students taught through the Inductive Inquiry model and those students taught through conventional teaching Scheffe test.

H_{02} There is no significant difference between the mean posttest achievement scores of students taught through the Inductive Inquiry model and those students taught through conventional teaching method using ANOVA.
H_{12} There is significant difference between the mean post-test achievement scores of students taught through the Inductive Inquiry and those students taught through conventional teaching method using ANOVA.

METHODOLOGY

Population and Sample

The target population of the study is 520 senior secondary two (SS2) students studying in Government Secondary School, Bwari of Federal Capital Territory (FCT) Abuja, Nigeria. The study sample consists of 60 students drawn using random sampling technique because this required number of students is available in the school. Government Secondary School, Bwari is a model school in Abuja and the students studying in this school belong to different socio economic strata. They were divided into two groups formed through matching on the basis of their pre-test scores; each group consisting of 30 students. One of the groups is randomly chosen as the Inductive Inquiry group and other as Transmitter of Knowledge group. The independent variable in the study is the model of teaching and the dependent variable is the academic achievement of students. The dependent variable is measured through a 50-item achievement test items generated using the West African Examination Council's (WAEC) past questions. These questions are used as both pre-test and post-test items.
The marks obtained by them were arranged in descending order. The students of equivalent pre-test scores were identified. Each of them assigned to one of the two groups. The same procedure was adopted for each group containing 30 students. These groups were randomly named as Inductive Inquiry group and Transmitter of Knowledge group.

Research instrument

In order to measure academic achievement of the sample in Circle Geometry and Trigonometry, an achievement test was designed and conducted before and after the experiment. It contained fifty multiple choice test items generated using the West African Examination Council's (WAEC) past questions covering the content of circle geometry and trigonometry which was taught during the experiment.
Hundred percent weight-ages are assigned to the topics to learn. Thus, all the 50 items were related to the content material. The time duration of the test is fifty minutes, which is considered appropriate for all the students to complete the test.

PRESENTATION AND ANALYSIS OF DATA

This section deals with the analysis and interpretation of the data pertaining to the study:

Table 1: Mean and standard deviation of pre-test scores of the Inductive Inquiry group and the Transmitter of Knowledge group

Group	N	Mean	S.D	Coefficient of Variation
Inductive Inquiry	30	22.40	3.13	13.9
Transmitter of Knowledge	30	22.53	2.99	13.2

The table 1 indicates that the mean pretest scores of comparison group are 22.40 and 22.53 respectively. Spread (standard deviation) of individual scores around their respective means is 3.13 for experimental group 1 and 2.99 for the experimental group 2.

The variability in the Inductive Inquiry model group (19.2) is more than that of the Transmitter of Knowledge Model group (13.2) as shown by the coefficient of variation. The Inductive Inquiry model group is found to be a bit more variable than the Transmitter of Knowledge Method group, implying that the Transmitter of Knowledge Model group is more homogenous than Inductive Inquiry model group. The equality of the mean scores on the pre-test, among comparison groups is also statistically determined using one way Analysis of Variance (ANOVA) as given in the table 2.

Table 2: Significance of difference between mean pre-test scores of the groups

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	276.717	12	23.060	70.212	0.000
Within Groups	5.583	17	.328		
Total	282.300	29			

Table 2 shows an F value of 70.212 and a significance of 0.000 at 0.05 level of significance. This implies that there is no significant difference in the pre-test mean scores of the groups being compared.

Table 3: Mean and standard deviation of post-test scores of experimental group 1and the experimental group 2

Group	N	Mean	S.D	Coefficient of Variation
Inductive Inquiry	30	38.97	3.0	7.71
Transmitter of Knowledge	30	36.40	3.4	9.34

The table 3 above indicates that the mean post-test scores of the experimental group taught through Inductive Inquiry model is 38.97 and the mean post-test score of the control group is 36.40. The above comparison has a spread of scores around their mean scores; 3.0 for the Inductive Inquiry model group and 3.4 for the Transmitter of Knowledge Method group. It means that the Inductive Inquiry model group has higher average mean score achievement than the Transmitter of Knowledge Model group with an average mean score of 36.40 on the post-test. The coefficient of variation of the Inductive Inquiry model group is 7.71.This is lower than 9.34 of the Transmitter of Knowledge Model group. Scheffe test is applied to compare the mean scores of the groups if there is no significant difference between the mean post-test achievement scores of students exposed
to the Inductive Inquiry model and those taught through Transmitter of Knowledge method. The result is shown in table 4 below.

Table 4: Comparison of the experimental group and the control group on the mean post-test scores through Scheffe test.

Group	Mean	F	p
Experimental 1	38.97	4.6	<0.05
Experimental 2	36.40		

$(df = 1,58)$ $F_{.05} = 4.00$

Entries in table 4 show that mean post-test scores of the Inductive Inquiry model group and Transmitter of Knowledge Model group are statistically significant at 0.05 level of significance. Therefore, the groups are found to be significantly different in their post-test performance. Therefore, the null hypothesis H_{10} that there is no significant difference between the mean post-test achievement scores of the students exposed to the Inductive Inquiry model and those taught through Transmitter of Knowledge model using Scheffe test is rejected.
Further, the difference in post-test achievement among the groups being compared is statistically tested by simple ANOVA, as shown in table 5 below.

Table 5: Significance of difference between mean post-test scores of the groups

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	125.260	12	10.438	0.772	0.671
Within Groups	229.940	17	13.526		
Total	355.200	29			

Table 5 shows that the calculated F-ratio of 0.772 and a significance of 0.671at .05 level of significance. Therefore, the null hypothesis H_{02} that there is no significant difference between the mean post-test scores of students taught through the Inductive Inquiry model and those students taught through transmitter of knowledge model is rejected. This implies that there is a significant difference in the post-test mean scores of the groups being compared.

5.2 FINDINGS

The findings of the study are:
1. The mean post-test scores of the comparison groups are 38.97 and 36.40 with a spread of individual scores around their respective means as 3.0 and 3.4 for the experimental and control groups respectively. The coefficient of variation of the Inductive Inquiry model group $(V = 7.71)$, and Transmitter of Knowledge Method group $(V = 9.34)$,shows that the Inductive Inquiry group in more homogeneous, (table 3).
2. There is statistical significant difference between the mean post-test scores of the group taught through Inductive Inquiry model and that taught through conventional teaching as tested through Scheffe test. Therefore the null hypothesis is rejected (table 4).
3. There is significant statistical difference between the post-test scores of the group taught using Inductive Inquiry model and the group taught using Transmitter of Knowledge Method teaching as tested through one way Analysis of variance (ANOVA), (table 5).

DISCUSSION

This study was conducted to find out the effectiveness of the use of Inductive Inquiry model as compared to the use of Transmitter of Knowledge Model on students academic achievement on circle geometry and trigonometry at secondary level in Govt. Sec. School, Bwari, Federal Capital Territory (FCT) Abuja, Nigeria using Inductive Inquiry model and Transmitter of Knowledge Model groups.
In this study, the students exposed to the Inductive Inquiry model are found to have performed better than the group taught using the Transmitter of Knowledge model. In fact, Inductive Inquiry model and Transmitter of Knowledge model are good models for teaching except the slight difference the former has in being more systematic and logical in its approach. The purpose of the study is to explore the effectiveness of these models on students' academic achievement and draw conclusion on which is more effective in enhancing students' academic achievement. The sample of the study consisted of 60 students of Govt. Sec. School, Bwari of Federal Capital Territory

(FCT) Abuja, Nigeria. The sample was selected on the basis of their pre-test scores through matching. The Inductive Inquiry model group was taught using Inductive Inquiry teaching model while Transmitter of Knowledge Model group was taught through Transmitter of Knowledge method. The analysis was done using Scheffe test and one way analysis of variance (ANOVA) statistical techniques at 0.05 level of significance. The result of this study agrees with those of Shaffer's (1989), Farrell and Hesketh's (2000), and Prince and Felder (2006). However, the result is not in line with the works of Rose and Fong (1997), Kalia (2005) and Pagunen (2007).

As no experimental study can be perfect and flawless, this study may contain some flaws and may be replicated for further confirmation.

CONCLUSIONS

Based on the findings, the following conclusions are drawn:

1. The null hypothesis H_{01} that there is no significant difference between the mean post-test achievement scores of students taught using the Inductive Inquiry model and those students taught using Transmitter of Knowledge teaching model by Scheffe test is rejected and the alternative hypothesis accepted.

2. There is significant difference between the mean post-test achievement scores of students taught using the Inductive Inquiry model and those students taught using Transmitter of Knowledge teaching model, guided by the ANOVA result. The Scheffe test and the ANOVA led to the rejection of no statistical difference postulation. An overall conclusion that can be drawn from this study is that the Inductive Inquiry model is found to be more effective for teaching circle geometry and trigonometry than Transmitter of Knowledge teaching model, considering the results obtained. So, it is advised that Inductive Inquiry model should be used in the teaching of circle geometry and trigonometry.

RECOMMENDATIONS

On the basis of the findings, conclusions and discussions, the following recommendations are made for action and further research:

1. Since the Inductive Inquiry model is effective in the teaching of circle geometry and trigonometry, teachers should be trained to use this model because it is found to be more effective than the Transmitter of Knowledge teaching model as shown in this study.

2. Inductive Inquiry model is a new model for effective teaching that requires thorough understanding and sufficient practice before using it for instruction. In future studies sufficient rigorous training on the model should be provided to the teachers of the experimental group before conducting experiments.

3. The experimental group 1 in this study was taught by the researcher himself. This may have confounded the results. To avoid experimental bias, regular teachers of the same institution should be selected to provide the treatment to the experimental groups after ensuring adequate training and practice in the new methodology. This step may control the critical teacher variable polluting the effect of the independent variable.

4. Similar studies should also be replicated in other schools on students at both secondary and primary school levels for teaching mathematics and subjects other than mathematics in order to confirm and generalize the present result of this study.

5. Since inductive inquiry model is found to be an effective model of teaching circle geometry and trigonometry, the mathematics teachers should be given intensive training on the use of inductive inquiry model, and in the development of instructional material to be employed while using the inductive inquiry model.

6. As the present study centers on Inductive Inquiry and Transmitter of Knowledge models, experimental studies may also be conducted for the evaluation of the effectiveness of other teaching models like cooperative learning and concept attainment models of teaching etc.

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