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Effects of Direct and Indirect Instructional Strategies on Students' Achievement in Mathematics

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Abstract

This is a quasi experimental research designed to determine the effects of Direct and Indirect instructional strategies on Mathematics achievement among junior secondary school students. The population consisted of students in a Public Secondary School in Owerri, Imo State. A sample of 102 students from two (2) intact classes (A & B) was drawn using simple random sampling (Balloting) on class basis. Group A students were taught Mathematics using Direct Instructional strategy, while Group B students were taught using Indirect Instructional strategy. The treatment lasted for 10 weeks of 20 sessions. Three research questions and three null hypotheses

guided the study. Mathematics Achievement Test (MAT) was administered on the subjects at the end of treatment. The MAT was validated and its reliability test produced co-efficient of 0.86. Data collected were analyzed with Mean (x), Standard Deviation (SD), t-test analysis. Results got after data analysis indicated that direct instructional strategy has a better effect on students achievement in Mathematics compared to indirect instructional strategy; significant difference existed between direct and indirect instruction on students achievement in Mathematics; and gender is a significant factor in determining the effect of direct and indirect instructional strategy on students' achievement in Mathematics, in favour of the males. Based on these results, recommendations were made for the adoption of direct instructional strategy in teaching Mathematics in secondary schools.

Introduction

There is widespread concern over the standard of education in Nigeria, most especially owing to poor performance of students in external examinations. Achievements of students in the examinations are worrisome, especially in the key subjects, largely, English Language and Mathematics. For mathematics, the society is getting frustrated concerning the low level of achievement in this subject. This is because of the nature of Mathematics in critical thinking, and its logical and systematic manner of approach which demands mental work on the part of the learner to grab, assimilate and understand the concept. It also requires the ability to apply the concept learnt in other similar problem areas, analyze, synthesize and be able to solve problems emanating from every area of the subject. Mathematics application is important in everyday life and is a major tool for the present world of science and technological advancement. Any nation that desire to compete and develop at par with other nations of the world must ensure that her citizens learn and are proficient in the application of mathematical concept to solve everyday challenges.

Owing to poor level of achievement in Mathematics, several approaches in teaching and learning Mathematics have been designed and practiced at one point or the other. One of these teaching approaches is direct instructional strategies. According to Wikipedia (2010), Direct instructional strategy is "an educational technique that challenges the mantras of modern bureaucrats and shows that even the most disadvantaged children can excel, if only the schools will teach them". He described direct instruction as a rigorously developed, highly scripted method of teaching that is fast-paced and provides

constant interaction between students and the teacher. Moreover, Gagnon and Maccini (2011) posit that direct instruction is a specific method of teaching that focuses on what to teach in respect to the design of the curriculum and how to teach which focuses on specific teaching techniques.

Direct instruction has six teaching functions which include review of previously learned skills and homework; presentation of the general principles of the new materials in a clear and organized manner; guided practice of new lesson taught with supervision of the teacher; correction and feedback to reduce students' errors; independent practice to monitor performance and provide additional explanations or re-teaching as needed; and weekly and monthly reviews for addressing and maintenance of skills acquired by the students (Rosenshine and Steven, 1986; Rosenshine, 1996; Gagnon and Maccini 2011; Moore, 2011)

Kozloff, LaNunziata, Cowardin, and Bessellieu (2000), posit that direct instruction was propounded by Siegfried Engleman, Carl Bereiter and Wes Becker who all worked with disadvantaged children (Becker & Carnine, 1981; Bereiter & Engelmann, 1966). Direct instruction has been and developed for over four decades now for the teaching elementary through secondary language, reading, mathematics, history, higher-order thinking (reasoning), writing, science, social studies and legal concepts (Adams & Englemann, 1996; Kameenui & Carnine, 1998). According to Valiathan (2009), "Direct Instruction is used to describe learning material in which the teacher or expert transmits information directly to learners structuring learning time to reach a clearly defined set of objectives as efficiently as possible." Direct instruction is described as teacher-directed and fast-paced, using a highly structured presentation of antecedents and consequences (Gersten, Woodward, & Darch, 1986). This meticulously developed, highly scripted method allows constant interactions between the student and the teacher. The responsibility for student learning rests directly with the teacher's design and delivery of instruction, which includes frequent opportunities to respond during the initial teaching sequence (Texas Guide for Effective Teaching, 2010).

Direct Instruction according to Binder and Watkins (1990) is "based on the assumption that disadvantaged children can "catch up" with their more affluent peers if they are provided with effective and efficient instruction". The main purpose of a direct instruction is to meet the unique needs of low achievers or students who are struggling in school or students with special

needs. It is a teacher-directed teaching method. It is meant to accelerate student progress, which is to bring students to mastery of subject taught as quickly as possible. Direct Instruction realizes the goal of teaching more in less time by using teaching procedures that maximize the time students spend in instruction and by developing materials that seek (whenever possible) to teach a "general case." A general case strategy is one that uses the smallest possible number of examples to produce the largest possible amount of learning.

Other studies on direct instruction found that it was used in elementary schools and the effect of it was evident on 9th Grade where students were still one year ahead of children who has been in control (non-Direct Instruction school in reading, and seven months ahead of control children in Mathematics. Similar results confirmed the efficacy of Direct Instruction where students taught with the method out-perform the children who had received only traditional method of instruction. Darch, Gersten and Taylor (1987) and Meyer, Gersten and Gutkin (1983) also found that students taught with Direct Instruction method have higher rates of graduating high school on time, lower rates of dropping out, and higher rates of applying and being accepted into college.

Conversely, Pearson Education (2010) opined that Indirect Instruction is an approach to teaching and learning in which the process of learning is inquiry, the result is discovery, and the learning is context of a problem. Brenau (2002), is of the view that indirect instruction is after the teaching of concepts, patterns, abstractions, analysis, synthesis and evaluation. Indirect instruction embraces learner-centred approach, passive teaching and recognizes small group instruction. Indirect instruction encourages the teacher to begin the lesson with advance organizers that provide overall picture and that allow for concept expansion. It focuses on student response using induction and/or deduction to refine and focus generalization. Pearson Education Inc. (2010) further stated that indirect instruction is an approach to teaching and learning in which the process of learning is, the result is discovery, and the learning context is a problem. This means that during indirect instruction, the learner acquires concepts, patterns, and abstractions through the processes of generalization and discrimination, which require the learner to rearrange and elaborate on the stimulus material.

Expository information of Direct Instructional strategies and Indirect Instructional Strategies is not enough in confirming the efficacy of these

methods. The desire to determine the effects of direct and indirect instructional strategies is important to determining what approach will encourage further interest in studying Mathematics and helping the student to achieve high success rate in mathematics. This prompted the need to carry out this research.

Purpose of the study

Purpose of this study is to determine the effects of Direct and Indirect instructions on students' achievement in Mathematics.

Specifically, the study was also designed to:

1. determine the effect of direct and indirect instructional strategies between subjects in experimental group as measured by their pre-test and post-test scores.
2. determine the influence of gender on the effects of direct and indirect instructional strategies on Junior Secondary School Students achievement in Mathematics.

Research questions

1. What is the effect of direct and indirect instructional strategies among junior secondary school students achievement in Mathematics as measured by their pre-test and post-test scores in the Mathematics Achievement Test (MAT)?
2. What is the difference in Mathematics achievement of subjects in the control and experimental groups as measured by their post-test scores in the Mathematics Achievement Test (MAT)?
3. To what extent is gender a factor in the effects of direct and indirect instructional strategies on Mathematics achievement of subjects as measured by their post-test scores in the Mathematics Achievement Test (MAT)?

Hypotheses

The following null hypotheses were tested at 0.05 alpha levels.

1. The effects of direct and indirect instructional strategies on the subjects in Mathematics achievement do not differ significantly as

measured by their post test scores in the Mathematics Achievement Test (MAT)

2. The difference in Mathematics achievement of subjects in experimental and control groups is not significant as measured by their post test scores in Mathematics Achievement Test
3. The difference in Mathematics achievement of male and female students in the experimental group is not significant as measured by their post-test scores in Mathematics Achievement Test.

Method

The researcher adopted quasi-experimental research design in conducting this study, with the aim of determining the effects of direct and indirect instructional strategy on students' achievement in Mathematics. The randomized, control pre-test/post-test experimental design was adopted. Three (3) research questions were postulated and answered while three (3) hypotheses were tested at 0.05 level of significance. The population for the study was all the 231 Junior Secondary school class two (2) in Comprehensive Secondary School Umuma Isiaku of Imo State, Nigeria. However a sample of 102 made up of 55 males and 47 females from two intact classes were used for the study. The sample was drawn using random sampling (balloting). The treatment using the two instructional strategies lasted for 11 weeks of 33 sessions at the third term of 2010/2011 academic session. 10 weeks of 33 sessions were used for teaching while the last one week of 3 sessions were used for revisions and assessment. The topics taught using the two instructional strategies covered all topics in the students 3rd term Scheme of work. The two intact classes were grouped into A and B. Group A had direct instructional strategy applied to it while Group B had indirect instructional strategy applied with the control group taught with the conventional teaching method. After the treatment, Mathematics Achievement Test (MAT) of 50 items was administered on the students and scores 50 marks to determine the extent of intellectual functioning of students in Mathematics. MAT was an objective test which was validated by experts, in Mathematics, in Educational Psychology and Measurement and Evaluation. Pearson Product Moment Correlation statistics (r) which was used to test the reliability produced a reliability co-efficient score of 0.86. Students' test scores were analyzed using Mean (x), and Standard Deviation (SD), for the research questions while t-test wass used to test the hypotheses.

Results

Results got after data analysis were presented in the table below.

Table 1: Mean (x) and Standard Deviation (SD) of effects of direct and indirect instruction on Junior Secondary school students Mathematics achievement

Instructional Strategy	Pre-Test			Post-Test		
	N	X	SD	N	X	SD
Direct	34	21.24	3.85	34	41.74	5.67
Indirect	34	24.29	2.68	34	32.77	6.81

Data in Table 1 showed that the pre-test and post test mean scores of students taught with direct instructional strategy were 21.24 and 41.74 respectively, while those taught with indirect instructional strategy had their pre-test and post-test mean scores as 24.29 and 32.77 respectively. Table 1 therefore indicated that in all the experimental groups, the post test scores were higher than the pre-test scores. The subjects taught using direct instructional strategy had higher mean score compared to those taught with indirect instructional strategy. The above result is an indication that direct instructional strategy led to higher achievement in Mathematics than indirect instructional strategy.

Table 2: Mean (x) and Standard Deviation (SD) of difference in Mathematics achievement between students in the Control and Experimental groups

Group	N	X	S.D
Direct	34	41.74	5.67
Control	**34**	**19.85**	**4.19**
Indirect	34	32.77	6.81
Control	**34**	**19.85**	**4.19**

Data in Table 2 showed that subjects in all the experimental groups obtained higher mean (x) achievement scores than their counterparts in control group. This means the treatment procedures has positive effect on Mathematics achievement of students in the experimental groups than those in the control groups.

Table 3: Mean (x) and Standard Deviation (SD) of influence of gender on the effects of direct and indirect instruction on students' achievement in Mathematics

Instructional Approaches	Gender	N	X	S.D
Direct	Male	19	45.68	2.89
	Female	15	36.73	4.13
Indirect	Male	18	37.72	5.29
	Female	16	27.19	2.79

Data in Table 3 showed that male and female subjects taught with direct instructional strategy obtained 45.68 and 36.73 in MAT respectively. Again, male and female subjects taught with indirect instructional strategy scored 37.72 and 27.17 in MAT respectively. The males in the experimental groups scored higher than the females. This is an indication that greater effect of direct and indirect instructional strategies was found among the males than the females.

Table 4: t-test analysis on effect of direct and indirect instructional strategies on student achievement in Mathematics

Instruction	N	X	S.D	Df	Cal t	Crit t	Remark
Direct	34	41.74	5.67	66	5.90	1.96	Rejected
Indirect	34	32.77	6.81				

Information in Table 3 revealed that the t-calculated value of 5.90 is greater than the critical t value (1.96) at 0,05 level of significance and df of 66. Based on this result, the null hypothesis one was rejected; implying that significant effect of treatment (direct and indirect instruction) was found in students' achievement in Mathematics, in favour of those taught with direct instruction.

Table 5: t-test analysis of difference in Mathematics achievement of students in experimental and control groups

Instructional Approach	N	X	S.D	Df	Cal t	Crit t	Remark
Direct	34	41.74	5.67				
Control	34	20.50	2.92	66	19.41	1.96	Rejected
Indirect	34	32.77	6.81				
Control	34	20.50	2.92	66	9.64	2.04	Rejected

Data in Table 5 showed that all the calculated t-values 19.41 and 9.64, showing extent of difference between subjects in experimental and control groups are respectively greater than the t-critical values of 1.96, at 0.05alpha level and the same df of 66. The null hypothesis two was therefore rejected. This implied that significant difference in Mathematics achievement existed between students in the experimental and control groups in favour of those in the experimental groups.

Table 6: t-test analysis of difference in Mathematics achievement of males and female students in the experimental groups due to gender

Instructional Strategies	**Gender**	**N**	**X**	**S.D**	**Df**	**Cal t**	**Crit t**	**Remark**
Direct	Male	19	45.68	2.89	32	7.43	2.04	Rejected
	Female	15	36.73	4.13				
Indirect	Male	18	37.72	5.29	32	7.13	2.04	Accepted
	Female	16	27.19	2.79				

From Table 6 above, it was observed that all the calculated t-values of 7.43 and 7.13 were respectively greater than the t-critical values (2.04), at 0.05 alpha level and dfs of 32. Null hypothesis 3 was rejected on the basis of this result. This implied that there was significant difference in Mathematics achievement of male and females students in the experimental group in favour males. .

Discussion

This study investigated the effect of Direct and Indirect instructional strategies on students' achievement in Mathematics. Results got indicated that subjects taught using direct instructional strategy had higher mean (41.74) score compared to those taught with indirect instructional strategy that scored 32.77.

The above result is an indication that direct instructional strategy is more effective than indirect instructional strategy in achieving improved Mathematics achievement among students. The result of the hypothesis one also showed significant effect of direct and indirect instructional strategy, in favour of subject taught with direct instructional strategy. This position was corroborated by Kozloff et al (2000) who stated that direct instruction was found to be superior to both controls schools and to every other model in fostering basic reading and mathematics skills, higher-order cognitive-conceptual skills, and even self-esteem. This showed that direct instructional strategy help in improving students' intellectual functioning as its main goal is to ensure individual student's mastery of the subject matter.

In the same vein, results also indicated that a marked significant difference in students' achievement in Mathematics existed among students in the experimental and control groups. Subjects in all experimental groups obtained higher mean (x) score than their counterparts in the control groups. The difference between students in the experimental and control groups was found to be significant. The treatment received (direct and indirect instructional strategies) in the experimental group must have led to this result. in favour of subjects taught with direct instructional strategy.

This study also investigated the effect of gender in determining the effect of direct and indirect instruction on students' achievement in Mathematics. Results got after data analysis indicated that gender played a significant role as male students performed better than their female counterparts. The difference that existed in the Mathematics achievement of experimental students due to gender was found to be significant, in favour of the males. This was corroborated by Kolawole who found that male students performed better than their female counterpart in Mathematics.

Furthermore, significant difference was found in the influence of gender on the effect of direct and indirect instruction on students' achievement in Mathematics three, in favour of the males. This implied that gender is a

factor to consider in determining the effectiveness of direct and instructional strategies geared towards achievement of students in Mathematics.

Conclusion

From the findings of this study, it was concluded that:

- Specifically, direct instructional strategy had better effect on students' achievement in Mathematics compared to indirect instructional strategy.
- Significant effects of direct and indirect instruction on students' achievement in Mathematics was found
- Gender is a significant factor in determining the effect of direct and indirect instruction on students' achievement in Mathematics.

Recommendations

Based on the finding of this study, the following recommendations were made:

- Teachers should be trained in the use of direct instructional strategy to improve intellectual functioning of the students and ensure better performance in their studies.
- Female students should be encouraged to show more interest in the study of Mathematics for improved achievement.
- School administrator should hold seminar and workshop on direct instructional strategy for teachers so that they can adopt it for effective classroom instruction and students academic achievement.

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