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Effects of Extended Teacher Wait-Time on Senior Secondary School Students' Academic Achievement In Mathematics in Asa High School Abia State Nigeria

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Abstract
The study investigated the effects of extended teacher wait-time on senior secondary school students' academic achievement in mathematics in Asa High School in Ukwa-West Local Government Area of Abia State. The research design employed to carry out this study was case study. A simple random sampling was used to select a unit of SS1 intact class. The sample size was twenty. Three (3) research questions and two (2) hypotheses guided this study. The instrument used for data collection was a non-participant observation technique in which video recording was used to capture all the teaching sessions in phases 1 and 2. Frequency counts, phi-coefficient and percentage mean were used to answer the research questions while chi-square statistics and t-test were used to test the hypotheses at 0.05 alpha level with df =1 and 18 respectively. The result of the study showed that mathematics teachers employed an insufficient teacher wait-time of less than 3 seconds, and that there is a moderately positive relationship between students' accuracy of responses and teacher wait-time. The result also showed that there is a significant difference between the academic achievement of students taught mathematics using insufficient and extended teacher wait-time and this difference was in favour of ETWT group. Based on the findings of the study, it was recommended that mathematics teachers under training should be trained on the effective use of extended teacher wait-time of between 3-5 seconds during micro-teaching and also inspectors should lay emphasis on the use of Extended Teacher Wait-time (ETWT) when they go for classroom instruction supervision.
Keywords: Teacher wait-time, questioning behaviour, mathematics, students' academic achievement.

Introduction

There are so many different teaching methods that are advocated for delivering instruction in the classroom. They range from the traditional teaching method (lecture) to the modern teaching methods (demonstration, inquiry, discovery, problem-solving, assignment, project, field trip, laboratory, questioning, game & simulation, discussion etc.). Of all the teaching methods, the questioning method appears to be indispensable. This is because there is no teaching method adopted in the classroom that the teacher does not question the students or entertain questions from the students. One of the essential tools teachers use to promote learning during classroom instruction is questions.

Teachers ask students questions at the beginning, middle or end of a lesson. Borich (1988:195) outlined the importance of teacher questioning during instruction to include the following: (i) To arouse interest and curiosity (ii) To focus attention on an issue (iii) To diagnose specific learning difficulties (iv) To review already learnt content (v) To reinforce recently learnt materials (vi) To manage or remind students of procedure (vii) To redirect or structure the flow of ideas (viii) To allow expression of feeling (ix) To probe deeper after an answer is given (x) To promote thought and understanding of ideas. This makes it imperative that the teacher be equipped with the rudiments and techniques of questioning in order to achieve the aims or objectives of questioning students while carrying out classroom instruction in mathematics. It has been evidenced by researchers that students have hatred for mathematics and the use of the right mode of questioning technique can bring about motivation in the students.

Caram and Davies (2005) opined that one of the effective strategies for classroom questioning is the use of sufficient wait-time by the teacher. Wait time is a crucial factor in questioning technique. Wait-time can be defined as the amount of time a teacher allows to elapse after he or she has posed a question before students start to respond. Fredericks (2005) defined wait time as the period of silence between the time a question is asked by a teacher and the time when one or more students respond to that question. Lake (1973) defined wait-time as the

length of pause that precedes a teachers question before students respond to the question. Napell (nd) opined that wait-time is the amount of time after an initial question has been posed before the teacher answers it, repeats, rephrases, or adds further information to the question; or accepts an answer from a student.

Rowe (1974) defined two types of wait time: the wait time I and wait time II. Wait time I is the time between a teacher question and a student answer, whereas wait time II is the time between a student answer and the following teacher feedback or teacher question. However, this study will refer to the initially defined variables by Rowe and, particularly, to wait time I. This means that it lies in the hands of the teacher to determine the amount of wait-time that will be favourable to the students during classroom instruction. Questioning is an important way to monitor student comprehension during instruction, but managing that process can be difficult for teachers. After a teacher asks a question, a silence known as "wait time" occurs and may be perceived as awkward for both beginning and old teachers (Rowe, 1987). Since this silence can make teachers feel uncomfortable, teachers typically wait less than a second before calling on a student or answer their own question. However, Tobin (1987), asserts that extending the pause to 3-5 seconds results in more voluntary student responses, more correct responses, and increased test scores of students on academic achievement. He also asserts that when teachers wait patiently in silence for 3 or more seconds, positive changes in teacher behaviours also occur. Thus, the teacher questioning strategies tend to be more varied and flexible, teachers decrease the quantity and increase the quality and variety of their questions and they ask additional questions that require more complex information processing and higher-level thinking on the part of students.

Questioning is one of the most powerful tool that teachers use to get on the spot feedback from students during classroom instruction. The response from students during instruction gives direction to the instruction. However, it has been observed that many teachers find it difficult to estimate the amount of time needed for a student to respond to a mathematics question, often due to pressure of time, impatience or fear of silence. Mathematics is a subject that involves concept formation. Therefore, rushing students to provide answers to mathematics questions may result in mistakes and frustration. Sufficient wait-time before nominating and after the initial response encourages longer answers, questions from the learners, self-correction and level of student involvement.

Rowe (1974) opined that wait-time is an important questioning variable which determines the quantity and quality of a child discourse that occurs in science. This may be the reason why Alamina (2008) suggests that teachers should after asking questions in the classroom, give students time to think and process the information in their cognitive domain before a child is called upon to respond. It must not skip the teacher's memory that before most students will volunteer to answer a question in mathematics, they must engage in cognitive tasks such as stop listening to the question, make sense of the question, retrieve the answer, form a coherent answer and these require time. The nature of mathematics demands that sufficient wait-time be practiced by mathematics teachers because it will help in actuality to determine the academic achievement of students during instruction.

Duncan (n.d) stressed that the use of insufficient wait time by teachers neither help teaching nor improve learning, and therefore advises that teachers should increase the wait time from the typical one second to 3-5 seconds. This is because the use of insufficient wait-time by teachers according to Napell (1976) is one of the non-facilitating teachers' questioning behaviour. One of the effective ways a teacher can use to promote thought and inquiry in students during classroom instruction is through questioning. Waiting for students' response allows students to utilize their problem-solving and analytical skills to generate appropriate answers. It also prevents the teacher from giving away all of the answers while the students remain passive and not engaged during classroom instruction which is against the constructivists theory of learning (Vygotsky, 1978).

Questioning enables teachers to check learners' understanding. It also benefits learners as it encourages engagement and focuses their thinking on key concepts and ideas. These questions are often arranged according to their level of complexity; this is called taxonomy. Tobin (1980) asserted that improved learning environment that could lead to increased science academic achievement can be produced when an extended wait-time is used during instruction. Though use of extended wait time is advocated, it must be noted that when the extension is more than what it is suppose to be, it also has effects on the academic achievement of students in mathematics and the periodical time allocation for mathematics instruction. The mathematics teacher should extend the wait time so as to allow the effective and efficient utilisation of other questioning variables to come to play.

The question that arises is whether teachers use sufficient wait-time? Are teachers trained on the effective and efficient questioning behaviours during teacher training programme? Will the use of extended wait-time improve classroom environment and students academic achievement in mathematics? How much wait-time should a teacher employ to enhance improved learning in mathematics? Should the same wait-time be apportioned to low level cognitive questions and high level cognitive questions during mathematics instruction? It is against this background that the researcher sought to investigate into the effect of increased/extended teacher wait- time on students' academic achievement in senior secondary mathematics.

Conceptual Framework

Mathematics is a school subject which has been defined by expert in varied perspective. One thing common to all the definition accorded mathematics is that it deals with quantifiable terms in the environment. Students at the senior secondary school already have their belief about mathematics and themselves. The belief is that mathematics is the most difficult subject and as such they can never excel in it. Evaluation of students' achievement starts during classroom instruction when teachers ask students oral questions based on the topic taught. The amount of teacher wait-time (ITWT or ETWT) employed during classroom instruction have effects on students academic achievement. This effect may be favourable or unfavourable based on the teacher wait-time.

Statement of the problem

It has been observed by the researchers that mathematics teachers find it difficult to estimate the amount of time that should be allowed for students to process question information before responding. Teachers fail to acknowledge the fact that students need to comprehend the question, formulate an answer, process language before verbal response. Teachers wait less than one (1) second for students to process mathematics questions (low or high-order cognitive).This phenomenon of insufficient wait-time during mathematics classroom instruction makes students to keep quiet or rush responses and as a result mistakes/errors are committed by students. When students continuously keep quiet or give wrong answers during instruction, teachers feel that students do not know or have not learnt the concepts and this frustrates the teacher's instruction and on the other hand students' effort in mathematics is frustrated and this affects their academic achievement. Therefore, this study sought to investigate the effect of extended teacher wait-time on students' academic achievement in senior secondary mathematics.

Scope of the study

This study is limited to the investigation of effect of increased/extended teacher wait-time on students' academic achievement in senior secondary one mathematics students in Asa High School in Abia State. The study was a case study of one selected Senior Secondary one class from the school. This class was deeply understudied with respect to the amount of teacher wait-time that was allowed during mathematics instruction. The time frame for the study was four (4) weeks.

Purpose of the study

This study attempts to:

1. Ascertain the average wait-time employed by mathematics teachers during mathematics classroom instruction.
2. Determine if there is any relationship between students' accuracy of responses and teacher wait-time
3. Find out the effect of teacher wait-time on the academic achievement of students in mathematics during classroom instruction.

Significance of the Study

This study will be significant to practising and trainee teachers, because it will guide them on the best way to put into practise the appropriate wait-time that will motivate their students and at the same time improve their performance in mathematics during classroom instruction.

Students will also benefit because if mathematics teachers employ the appropriate wait-time during instruction. They will neither ignore nor give wrong responses due to insufficient wait-time. When students responses are in affirmative to teachers questions, they have believe in themselves that they can do mathematics. This belief arouses a self-driven urge to practise mathematics problems on daily bases thus improve their mathematical skills.

Research Questions

Three research questions guided this study:

1. What is the average teacher wait-time employed by teachers during mathematics instruction?
2. Is there any relationship between students' accuracy of responses and teacher wait-time?
3. What difference exists in the academic achievement of students taught mathematics using insufficient and extended teacher wait-time?

Hypothesis

H_{01}: There is no significant relationship between students' accuracy of responses and teacher wait-time.

H_{02}: No significant difference exist in the academic achievement of students taught mathematics using insufficient teacher wait-time and those taught using extended teacher wait-time.

Research Design

The research design employed for this study was a case study since the study involved an in-depth analysis of a phenomenon (teacher wait- time) on students' academic achievement of a unit (Asa High School) over a long period of time.

Area of the Study

Asa High School is a public co-education secondary school located in Ezebudele (now Ezendioma) village in Ukwa-West Local Government Area of Abia State. Ukwa-West is one of the seventeen Local Government Areas in Abia State. As at the 2006 census it had a population of 87,367 and a density of 332.4 inh/km^2. The local government has an area of 271km and shares a common boundary (Imo River) with Oyigbo Local Government Area in Rivers State

Population/Sample

The population of the study comprise of all one hundred and five (105) Senior Secondary one students in Asa High School. A simple random sampling technique was used to select one intact SSI class. The intact class had a total number of forty (40) students of both gender but the sample used for study was the twenty (20) students that answered the oral questions.

Method

The sampled class was taught two mathematics topics (set theory, Trigonometrical ratio) by their regular mathematics teacher. The teaching session lasted for a period of four weeks during which each teaching session was video recorded with the consent of the school principal. The teaching session was divided into two phases. Phase 1: the regular mathematics teacher taught the mathematics concepts using their normal wait-time and Phase 2: teachers taught the same mathematics concepts using an extended wait-time of between 3-5 seconds. The particular traits/behaviours to be measured were not disclosed to both teacher and students. Teacher was allowed to teach the mathematics concepts for the first two weeks and the normal wait-times recorded. The teacher was then trained for two days on how to extend the wait-time during mathematics instruction. This new approach of extended wait-time to 3-5 seconds was used by teacher to teach the same mathematics concepts for the next two weeks of instruction.

The researcher also made some direct observations from a distance to ensure that the teacher did not deviate from the teaching plan. All teaching sessions for each phase were video-recorded. The recorded videos from each teaching session were then played and analysed by a team of two trained ratters. Each trained ratter watched and rated the video recordings independently. The scores by each ratter for each subscale were further vetted by an expert in measurement and evaluation. The average ratings of the two ratters were finally calculated and used as the working frequency for the study. The rating was based on the number of questions answered by students, the accuracy of students' responses and the verbal test scores of students with respect to amount of teacher wait-time. A stopwatch was used to measure the amount of teacher wait-time. The camera used for recording the teaching sessions and the stop watch used for extended timing were test run before usage to ensure that they are in good working conditions. The same topics taught in the first two weeks were repeated using the same lesson plan, same number and type of questions. The difference is in the amount of teacher wait-time which was extended to between 3-5 seconds.

The lesson plans used for teaching were prepared by the researcher. The questions in the lesson plans were twenty in number. The same questions were asked in both phases of instruction. Students were made to respond to the questions orally and the score for each response recorded. Each question was allocated 1 mark.

Method of Data Analysis

Frequency counts, phi-coefficient and percentage mean were used to answer the research questions while X^2 statistics and t-test were used to test the hypotheses at 0.05 alpha level.

Result

Research Question 1: What is the average teacher wait-time employed by teachers during mathematics instruction?

Table 1: Average teacher wait-time employed by teachers during mathematics instruction

Phase 1 Lessons	Average TWT	Remark
Lesson 1	1.5 secs	Insufficient
Lesson 2	2.0 secs	Insufficient
Lesson 3	1.7 secs	Insufficient
Lesson 4	1.2 secs	Insufficient
Sum of TWT	6.4 secs	
Grand TWT	1.6 Secs	

TWT criterion cut off *Any TWT less than 3 secs is insufficient
Any TWT from 3-5 secs is extended

Table 1 shows that the average teacher wait-time employed during mathematics classroom instruction is insufficient in the four lessons taught in phase 1. All four lessons had a teacher wait-time less than 3 secs. That is lesson 1TWT=1.5 secs, lesson 2 TWT=2.0 secs, lesson 3 TWT=1.7 secs and lesson 4 TWT=1.2 secs. Also, a grand teacher wait-time of the phase 1 instruction (1.6 secs) is insufficient.

Research Question 2: Is there any relationship between students' accuracy of responses and teacher wait-time?

Table 2: Phi-coefficient on the relationship between students' accuracy of responses and teacher wait-time

Teacher Wait-Time(TWT)	Accuracy of responses			Ø	Remark
	Correct	Incorrect	Total		
ITWT	2	7	9	0.50	Moderate relationship
ETWT	8	3	11		
Total	10	10	20		

Note: TWT = Teacher wait-time
ITWT = Insufficient teacher wait-time
ETWT= Extended teacher wait-time

Table 2 shows that there is a moderately positive relationship between students' accuracy of responses and teacher wait-time (Ø=0.50). There was more correct responses (8-correct responses) when ETWT was employed and more incorrect responses (7-incorrect responses) when ITWT was used by the same teacher.

Research Question 3: What difference exists in the academic achievement of students taught mathematics using insufficient and extended teacher wait-time?

Table 3: Mean, Standard Deviation and percentage mean score of students taught using insufficient and extended wait time

Teacher Wait-Time	N	Mean	SD	%Mean score	Evaluative remark
ITWT	9	1.55	3.13	15.56	Poor
ETWT	11	4.64	3.26	46.36	Fair

Table 3 shows that the mean score of students taught mathematics using ETWT was higher than that of their ITWT counterparts. This was further shown in the low percentage mean score of the students which was poor in the ITWT group.

H_{01}: There is no significant relationship between students' accuracy of responses and teacher wait-time.

Table 4: Chi-square statistics on the relationship between students' accuracy of responses and teacher wait-time

Teacher Wait-Time(TWT)	Accuracy of students' responses			X^2_{cal}	X^2_{crit}	Result
	Correct	Incorrect	Total			
ITWT	2	7	9	5.05	3.84	Significant
ETWT	8	3	11			
	10	10	20			

***Decision Rule:* Since X^2_{cal} (5.05)> X^2_{crit} (3.84), reject H_{01}**

Table 4 shows that the X^2_{cal} (5.05)> X^2_{crit} (3.84) at the df of 1 and 0.05 significant level. We therefore, reject H_{01} and conclude that there is a significant relationship between students' accuracy of responses and teacher-wait-time.

H_{02}: No significant difference exist in the academic achievement of students taught mathematics using insufficient teacher wait-time and those taught using extended teacher wait-time.

Table 5: t-test on the academic achievement of students taught mathematics using insufficient and extended teacher wait time

TWT	N	$\bar{X}$	SD	Df	t-cal.	t-crit.	Result
ITWT	9	1.55	3.13	18	-2.139	2.10	NS
ETWT	11	4.64	3.26				

Decision Rule: Since t-cal (2.139) > t-cri (2.10), reject H_{02}.

Table 5 shows that t-cal(2.139) > t-cri(2.10) at the df of 18 and 0.05 significant level. We therefore, reject H_{02} and conclude that significant difference exist between the performance of students' taught mathematics using insufficient and extended teacher wait time. This difference was in favour of ETWT group.

Discussion of findings

The finding that mathematics teachers employ insufficient teacher wait-time during mathematics instruction is an issue that needs to be addressed to help bring back the interest of students to the subject. This is in agreement with Napell (1976) who opined that the use of insufficient wait-time by teachers is one of the non-facilitating teachers' questioning behaviour. This is also consistent with the findings of Rowe (1987) when he asserts that teachers wait less than one second (insufficient TWT) for students to process a question and come up with the solution.

It was also, found that there was a moderately positive relationship between students' accuracy of responses and teacher-wait-time (Ø=0.50). When put to statistical test, the result was that there is a significant relationship between students' accuracy of response and teacher-wait-time(X^2_{cal} (5.05)> X^2_{crit} (3.84), df=1 and α =0.05.). When the teacher wait-time was extended to between 3-5 secs, students accuracy of response improved. This is consistent with the findings of Tobin (1987), who asserts that extending the pause to 3-5 seconds results in more voluntary student responses, more correct responses.

The result also showed that the mean score of students taught using ETWT was higher than that of their ITWT counterparts. When put to statistical test the result was that a difference exist between the performance of students taught mathematics using insufficient and extended teacher wait-times. This difference was in favour of TWT group. This may have been as a result of allowing enough teacher wait-time to permit them solve and answer the questions correctly so as to earn the scores for correct responses. This finding is consistent with the findings of Tobin (1987), who asserts that extending the pause to 3-5 seconds results in increased test scores of students on academic achievement; Rowe (1974) who opined that teacher wait-time is an important questioning variable which determines the quantity and quality of a child discourse that occurs in science and Duncan (nd) when he stressed that the use of insufficient wait time by teachers neither help teaching nor improve learning, and therefore advises that teachers should increase the wait time from the typical one second to 3-5 seconds.

Recommendations

Based on the findings of this study, the following recommendations were made.

1. Trainee mathematics teachers should be trained on the effective use of extended teacher wait-time of between 3-5 seconds during micro-teaching since ETWT improves the performance of students' oral responses during classroom instruction.
2. Mathematics teachers should endeavour to desist from the use of insufficient teacher wait-time because it demoralises students when they continue to give incorrect responses.
3. Inspectors/supervisors of education should lay emphasis on the use of ETWT when they go for classroom instruction supervision.

Conclusion

The Extended Teacher Wait-Time (ETWT) proved to be more efficacious in positively increasing students' performance in oral questions in the mathematics lesson. There was a positive relationship between the TWT and students accuracy of responses in a mathematics lesson. The more the time is extended to between 3-5 secs the more the students could answer more questions correctly. The average TWT in the mathematics class was found to 2.60seconds.

REFERENCES

Alamina, J.I. (2008). *Fundamental principles of science teaching and learning.* Port Harcourt: Feni Nigeria Limited.

Borich, G.D. (1988). *Effective teaching methods*. Columbus: Merill Publishing Company.

Caram and Davis. (2005) *Inviting student engagement with questioning.* Kappa Delta Pi Record.

Duncan, D. (nd). Six ways to discourage learning. Retrieved on 2nd January, 2012 from casa.colorado.edu/

Fredericks, A. D. (2005). *Complete idiot's guide to success as a teacher.* Penguin Town: Alpha Books.

Lake, T. (1973). The effect of extended wait time on science achievement. Retrieved on 18th may, 2011from http://onlinelibrary.wiley.com

Napell, S.M. (1976). *Contemporary education*. Indiana: The School of Education Press.

Napell, S.M. (nd). Peer facilitator training session reading assignment. Retrieved on 30th of October, 2011 from uwpla.rso.wisc.edu/

Population ,map and location of LGA Ukwa West. Retrieved on 11th December, 2011 from www.citypopulation.de/php/nigeria.

Rowe, M. B. (1974). What is the value of wait-time? Retrieved on 12th March, 2012 from www.pgcps.pg.k12.md.us/

Rowe, M. B. (1987). Wait time: Slowing down may be a way of speeding up. *American Educator. (11),* 38-43.

Rowe, M.B. (1974). Wait-time and rewards as instructional variables; their influence on language, logic and fate control. *Journal of Research in Science Teaching*. 11(20, 81-94.

Tobin, K.G. (1980). The effect of an extended teacher wait-time on science achievement. *Journal of Research in ScienceTeaching. 17 (5), 469-475.*

Tobin, K.G. (1987). The role of wait time in higher cognitive level learning. *Review of Educational Research, 57,* 69-95.

Vygotsky, L.S. (1978*). Mind in society: The development of higher mental processes.* Cambridge, MA: Harvard University Press.