© Kamla-Raj 2010
Int J Edu Sci, 2(1): 21-28 (2010)
PRINT: ISSN 0975-1122 ONLINE: 2456-6322
DOI: 10.31901/24566322.2010/02.01.03

The Effect of Analogical Reasoning and Extended Wait Time on Achievement in Biology

Janet Omolayo Olajide* and Femi Adetunji Adeoye**

**Samaru College of Agriculture, Division of Agricultural Colleges, Ahmadu Bello University, Zaria, Kaduna State, Nigeria.*
E-mail omolajide@gmail.com
***School of Education, National Open University of Nigeria, Lagos, Lagos State, Nigeria.*
E-mail feminoun2005@yahoo.com

KEYWORDS Reasoning. Analogy. Wait Time. Biology. Traffic Light Device

ABSTRACT This study investigated the effect of using analogical reasoning and extended wait time on science achievement. 95 students were used in a pretest, posttest experimental and control group design experiment. Analysis of variance (ANOVA) was used to analyse the result with Scheffe's test to identify which group(s) showed significant difference. The result showed that achievement improved where analogy and extended wait time and analogy only groups were used. The result showed that teaching with analogy and extended wait time enhances achievement, and teachers should be trained, and retrained to use this strategy in teaching.

INTRODUCTION

Science educators world over are usually faced with the challenge of improving science teaching so that learners can achieve high and develop a positive attitude to science. Needless to say advancement in science for a nation is the bedrock of technological development. Thus, the government of any nation is not just interested in teaching its populace how to read and write but is interested in their scientific development which can lead to higher technological advancement.

Developed nations like the United States of America, Japan, China etc. pump a lot of money into scientific innovations, which today has turned them into a nation of manufacturers rather than consumer nations to which many third world countries belong.

Since science learning is so important it is necessary that science educators introduce appropriate behaviours in their classroom to enhance effective science learning and therefore better performance in science. Evidence from the result of the senior secondary school certificate examination (SSCE) show that between 1994 and 1998 not up 40% of the registered candidates passed (see Table 1). The purpose of this paper therefore is to tryout a strategy which will enable students to achieve better in science and therefore be able to face the challenges of the scientific world better.

Research findings already show that there is poor performance in science among African students. The reason for this according to the proponent of the African World view thesis is that students who have high level of belief in African values and tradition perform poorly in science. This is because certain cultural factors have negative effect towards science (Ogunniyi 1988; Jegede et al. 1989). Dzama and Osborne (1999) said poor performance in science in developing countries is not just due to the world views of students in these countries, but due to absence of supportive environment for serious science learning where science features significantly in the popular culture. Thus, if the classroom environment is to be made conducive for learning science, the teacher has to introduce a strategy which would develop students' scientific understanding, thinking and problem solving abilities.

Over the years the inquiry method has been introduced in the teaching of science at both primary and secondary school levels in Nigeria. Inquiry which is an art of questioning, exploring and experimenting. It involves development of skills such as acquisition skills, manipulative skill, creative skills and such like (Sund and Trowbridge 1967). However this method cannot be properly practiced even at the primary level let alone at the secondary schools. This is so because of lack of equipment and even lack of proper encouragement of teachers. Recently in April 2009, teachers in south-west Nigeria went on strike due to lack of proper remuneration by that government. In

Table 1: SSCE Results in Science Subjects Between 1994-1998

Year	*Subject*	*Number that registered*	*Number that passed*	*Percentage pass with credit*
1994	Chemistry	161262	38212	23.7
	Biology	508384	57955	11.4
	Physics	146000	21462	14.7
1995	Chemistry	133188	48514	36.7
	Biology	453353	80734	18.9
	Physics	120768	16738	18.7
1996	Chemistry	144990	48514	33.46
	Biology	506628	80734	15.9
	Physics	132768	16738	12.6
1997	Chemistry	172382	40652	23.58
	Biology	609026	96202	15.79
	Physics	157700	14745	9.35
1998	Chemistry	182659	39085	21.39
	Biology	626894	215946	34.4
	Physics	10063	1002	9.95

Source: WAEC, Lagos 1999 (Nigeria).

the light of this situation educators have to think of other methods that can develop scientific under-standing of students, their thinking and problem solving abilities. Such a method would help to solve conceptual problems and result in higher achievement in science.

There are over 400 national reports in the United States of America expressing growing dissatisfaction with the quality of science teaching and learning and have called for changes in the practice of teachers and learners and policy makers (AAAS 1989). There is overwhelming consistency in these reports, recognizing that students should build understanding about what they are endeavoring to learn and an advocacy for changes in the traditional roles of teachers. One popular phrase that has been included in most of these reports is that "less is more". This means that fewer concepts need to be studied in greater depth to enable students build deeper understanding (Palmer 1973). Thus, teaching Biology using the strategy of Analogical reasoning and extended wait time which is the main focus of this paper is going to help students achieve better in science.

What is Analogy?

Analogy is a comparison of structures between domains (Clement 1978). It is a relation between parts of structures of two domains and may be viewed as a comparison statement on the grounds of structures of two domains pointing to some resemblances. The two domains are the analog and the target. The analog is the domain used as basis for structural comparison and the target is the domain to be explained. Over the years analogy has been used as a concept building tools. It consists of objects, events or situations that share features in common. That is to say they are in one or more ways similar. Those shared features have a significantly neural impact by causing increased cell activity which results in fast learning. The brain is an analogy processor i.e. it works by analogy and metaphors. It relates whole concept to another and looks for similarities, differences or relationships between them. It does not assemble thoughts and feelings from bits of data (Silvester et al. 1999). Thus, the use of analogy helps students to concretize their ideas by enriching their representation of problem situation with previously observed or observable (but imaginable) structures or mechanisms. Through analogies an understanding of novel situations may be constructed by comparison to more familiar domain of knowledge. Many recent cognitive approaches to instruction emphasize the importance of understanding the science. Learning begins with the learners' science (Wittrock 1985). Thus, through the use of analogy one goes from known to the unknown, and the unfamiliar becomes familiar.

What is Wait Time?

Wait time is the time the teacher waits after a question is asked, before accepting an answer, repeating the question, rephrasing it or supplying the answer (Rowe 1969, 1974). Lake (1973) summarizes the wait time phenomenon by defining it as "the length of pause preceding any teacher utterance. By defining wait time in this way teachers are provided with direct control over relevant pauses within the course of a lesson. Wait time has been found to be a variable which could be used to determine the quality and quantity of learners discourse that occur in a science lesson.

There are two types of wait time, wait time 1and ll. Wait time l is the time the teacher waits after a question. It normally begins when the teacher stops speaking and terminates when a student responds or the teacher speaks again. The sequence is as follows: Teacher asks a question and pauses. He/she calls on a student to answer the question, pauses again. The two pauses are summed up together and they constitute an instance of the first wait time (Rowe

1969, 1974). Wait time ll is defined as the time a teacher wait after a pupil's response to the question asked him/her by the teacher. It is calculated by taking the sum of all the students' pause and terminates when the teacher speaks. The variable of wait time in learning science has been found to be very important in teaching. This means that if it is not properly used, effective learning cannot take place in the science classroom (Rowe 1974, 1986; Tobin 1985). This is because according to Moriber (1971), students need a period of "private thought" which help them to put ideas together during inquiry lessons.

Research work by Rowe (1974), Tobin (1980) showed that when extended wait time of 5seconds for wait time l and 3seconds for wait time ll were used for students in inquiry class certain positive behaviours were observed in both students and teachers. Such as:

a) Students increase their length of response

b) They offer more alternative responses

c) They asked more questions and interact more with other students.

The above outcome showed students understand the lesson better and are therefore likely to achieve better and have positive attitude to science. On the part of the teacher, the effect the extended wait time had on them include:

a) Teachers' response exhibit greater flexibility as indicated by the occurrence of fewer discourse errors.

b) The number and kind of questions for the performance of certain children seem to change. The above outcomes tend to show that the teacher's behaviour can be positively affected. This will put them in a better position to encourage the students to achieve better in science. Thus, if wait time is properly used it will lead to those outcomes that will enhance higher achievement in science.

Statement of the Problem

This study aims at investigating the effect of the use of extended wait time and analogical reasoning on students' academic achievement in Biology.

Research Hypotheses

The hypothesis to be tested states that: There is no significant difference in the mean academic achievements of students taught using the following methods:

a) A combination of analogical reasoning and extended wait time.
b) Analogical reasoning only.
c) A combination of traditional lecture method and extended wait time.
d) Traditional lecture method only.

METHODOLOGY

Research Design

For this study a pretest and posttest experimental control group design was adopted to determine any possible treatment effects. There were four groups, three experimental and one control groups. The subjects were members of two intact classes of Samaru and Kaduna Colleges of Agriculture randomly assigned to the three experimental and one control groups. The three experimental groups were labeled E_1, E_2, E_3 respectively and the control group was labeled C. Experimental group1 (E_1) had treatment that involved combination of analogical reasoning plus extended wait time, experimental group ll (E_2) had treatment that involved the use of analogical reasoning only. Experimental group 111 (E_3) had extended wait time plus traditional lecture method of instruction. Control group (C) had traditional lecture method only.

A pretest was administered to both the experimental and control groups. Treatments were administered to the experimental groups, but were withheld from the control group who were taught using the conventional lecture method. Thereafter a post test was administered to all four groups. The first experimental and second experimental groups had 24 subjects each while the third had 25; the control group had 22 subjects. Altogether 95 students were assigned to the different groups.

A Flow chart of the design is illustrated below:

R_1'! O_1'!X_1'!P_2

R1= Experimental group1 (E_1)

R_2 '!O_1'!X_2'!P_2

R2 = Experimental groupll (E_2)

R_3'! O_1'!X_3'!P_2

R3 = Experimental grouplll(E_3)

R_4'! O_1'!X_3'! P_2 R4 =

Control group (C)

X_1 = Extended wait-time and analogical reasoning

X_2 = Analogical reasoning

X_3 = Extended wait-time and lecture method

X_4 = Lecture method alone
O_1 = Pretest
P_2 = Posttest

Illustration of the Quasi-experimental Research Design

Population and Sample

Population: The target population for this study was all Pre- National Diploma students of the three Colleges of Agriculture in the Division of Agricultural Colleges of Ahmadu Bello University, Zaria, Kaduna and Kabba. The three towns are located in Northern Nigeria. Zaria and Kaduna are in the present Kaduna state, while Kabba is situated in Kogi State. The total number is distributed as follows : Kabba is 23, Kaduna 22 and Zaria 73.

Sampling: The Pre-National Diploma (Pre-ND) students of the Colleges of Agriculture in Zaria and Kaduna formed the subjects of this study. These two Colleges were chosen for the following reasons: First, their syllabus is similar to that of the senior secondary school (SSS) in Nigeria and since the results of the study had implication for teaching in the secondary school, this category of students was found to be suitable.

Secondly, at the time of conducting the study, secondary schools were about going on long vacation, and it was no longer possible to use the secondary schools at the time. The Pre-ND students were found to be a suitable alternative, since the content of their syllabus was significantly similar to that of the secondary school. The proximity of the two colleges to the researcher made it less problematic for the researcher to conduct an experimental research in the colleges. The Kabba college was not included because of its distance from the researcher.

The average chronological age of the Pre-National Diploma students is 20years. Candidates are admitted from the different States of Nigeria, giving the admission a wide geographical spread. The total number of students was 95, and this comprised 73 from Samaru college of Agriculture, Zaria and 22 from kaduna College of Agriculture, Kaduna. All the students had the same entry points. The researcher used the student list to distribute the 73 students of Samaru college of Agriculture into three experimental groups of 24, 24,and 25, while the 22 students in Kaduna college constituted the control group. Thus, two intact classes were used for the study.

Instrumentation

The instruments used for this study comprised:
1. Selected Biology Topics.
2. Research Items.
3. Multiple choice Assessment Test (MCAT).

Selected Biology Topics

The topics to be taught during the research were selected by the researchers with consultation with two secondary school Biology teachers and two Pre-ND Biology teachers. After looking through the syllabuses the following topics were selected for teaching:
1. Nutrition in plants with particular reference to photosynthesis
2. Respiration in flowering plants.
3. Transportation in plants
4. Transpiration in plants.

These topics were chosen because they are present in both Pre-ND and the senior secondary school Biology syllabuses. Further more, they are regarded as difficult topics in Biology of which analogy and extended wait time can help students to achieve better understanding of.

Eight lessons were prepared altogether. Four were prepared with analogy and four without analogy. Questions were also included in between the lessons for the purpose of wait time manipulations. The lessons with analogy were taught to the experimental groups 1 and ll (E_1 and E_2).While in addition to analogical reasoning extended wait time l and ll were used for group 1 and there was no wait time manipulation for experimental group ll. The lessons without analogy were taught to experimental group lll (E_3) and the control group. No variation of wait time for the control group. The optimum extended wait time's l and ll used were 5seconds and 3seconds respectively. This is in accordance with the suggestions by Tobin (1980).

Research Items

Research items include:
1. Audiotape recorder and audio cassettes to tape the lessons.
2. The timing light device used as signals during wait time manipulations.
3. Teaching format – lessons prepared with and without analogical linkages.

Multiple Choice Assessment Test (MCAT)

The MCAT was constructed by the researchers. This consisted of 25 items and each had five options in the multiple choice format in order to test the knowledge of the concept taught. The questions covered all four topics. The subjects were expected to answer all the questions.

The pretest and posttest was one and the same test, that means a test and retest method was used. This is quite in order because according to Tuckman (1978) from James (2000), a pretest may increase the likelihood that an individual will do better on the subsequent posttest, particularly when it is identical to the pretest. The test gave a reliability coefficient of 0.79 using Kuder-Richardson coefficient of reliability.

Data Collection Procedure

Analogical Teaching Format

For the procedure of teaching using analogy the Glynn et al. (1991), model of Teaching with analogy(TWA) was adapted. It has six steps:

i. Introduction of target concept
ii. Recall analog concept
iii. identify similar features
iv. Map similar features
v. Draw conclusion about concept
vi. Indicate where analogy breaks down.

However, for this research study this model will be compressed into four steps instead of six, by merging together steps iii and iv as it is unnecessary for this teaching. Thus, the new steps will now be:-

i. Introduction of target concept.
ii. Recall analog concept.
iii. Identification and mapping out similar features
iv. Conclusion.

The operations can be explained as follows:-

i. Introduction of target concept involves giving a brief description of certain basic facts about the concepts presented to the subjects in the process of learning target concepts.
ii. Recall of analog concept: This stage involves the selection of objects by the researcher of which is familiar to the learner. The analog concept is supposed to help the learner relate together concepts they previously viewed as unrelated.
iii. Identification and mapping of similar features of both analog and target concepts are presented to the learner. The teacher uses what is familiar to the student in the analog to the target, i.e. what the student does not know and it enhances the students understanding.
iv. Drawing Conclusion: Drawing conclusion about the target concepts and indicating where analogy breaks down, i.e. pointing out the limits of the structural resemblances or similarities between target and analog concepts.

Extended Wait Time Device and Wait Time Measurement

A wait time of 5seconds and 3seconds were adopted from Tobin(1985). The traffic light device used by Swift and Gooding(1983) was adapted for use in this study. Whereas the device was a voice activated relay system which operated "red and green traffic light" to signal when an appropriate period of silence had elapsed; the one used for the research was manually operated by trained research assistant. The light device had two switches, the first one switches off after 5 and 3 seconds depending on how it was manipulated.

The four topics used for this research were taught by the researcher to remove teacher bias. The researcher adhered as much as possible to the teaching guidelines.

The 4 groups designed used in this study consisted of three experimental (E_1,E_2 and E_3)and a control group ©. The three experimental groups received treatment as follows:

The Experimental Group 1(E_1): The pretest was administered to them with the (MCAT). They were subsequently taught all four lessons containing analogy with extended wait time l and ll of 5seconds and 3 seconds, respectively. The wait time manipulation was done by a trained research assistant. Each lesson lasted for 60 minutes.

The Experimental Group ll (E_2): This group was also pre tested and were taught using lessons with analogy without wait time manipulation.

The Experimental Group lll (E_3): After pretest this group was taught using the lesson without analogy but with extended wait times l and ll.

Control Group (C): This group was pre tested. Teaching of the four lessons without analogy was done the conventional way with no wait time manipulation.

Data Analysis

The data collected from this study were ana-

lyzed using the analysis of variance (ANOVA).This statistical method was used because more than two means were evaluated for significant difference, and the researcher was interested in determining whether or not one group differed significantly from the other. Where the difference was significant, the Scheffe's procedure was used to determine which of the teaching methods was significantly different. Only the scores of students who completed the treatment and who sat for the pre and posttest were included in the analysis.

RESULTS

The data analysed were obtained from the pre and post achievement tests. Analysis of variance (ANOVA) was used for the statistical analysis. Where the hypothesis found to be significant, Scheffe's procedure was used to verify which one of the methods produce the main effect.

To test this hypothesis the data for this hypothesis were first subjected to an analysis of variance and the result showed that there was a significant difference as shown in table 1a.

The F value of 0.0001 is less than the critical value of 0.05. Thus, the difference observed in the achievement scores was seen to be significant at 0.05 level of significance. The result was then subjected to the Scheffe's test to find out which of the method is responsible for the difference (see Table 1b).

The result of the Scheffe's test showed that only the analogy plus extended wait time group and the analogy only group result showed significant difference, when compared with the traditional lecture method. Also, the traditional lecture plus extended wait time versus analogy plus extended wait time groups showed significant difference. But the mean difference between the traditional lecture and the traditional lecture plus extended wait time was not significant. All these point to the fact that analogical reasoning has a great impact on achievement in science and it really helps students' understanding and the effect is immediate. However, since the mean score for those taught using analogy plus extended wait time method was higher than that of those using analogy only, it means that extended wait time 1 and ll of 5 and 3 seconds respectively used during questioning and answering process has a positive effect on students' learning. The means and the standard deviation of the achievement (see Table 1c).

It can also be seen that the mean score of students taught using the traditional lecture method plus extended wait time was higher than those taught using the traditional lecture method

Table 1a: ANOVA of the achievement of the experimental and control groups scores

Source	*DF*	*Sum of Square*	*Mean Square*	*F Value*	*P. Value*
Between Group	3	368.77	122.92	7.61*	0.0001
Within Group	84	1357.18	16.16		
Total	87	1725.95			

*Significant at P e" 0.05 level

Table 1b: Scheffe's test of achievement of experimental and control groups.

Methods	*F value*	*Remarks*
Traditional lecture vs Traditonal lecture+Extime	7.61	Not significant
Traditional lecture vs Analogy only	7.61	Significant
Traditional lecture vs Analogy + Extime	7.61	Significant
Traditional lecture +Extime vs Analogy	7.61	Not significant
Traditional +Extime vs Analogy +Extime	7.61	Significant
Analogy vs Analogy + Extime	7.61	Not significant

Table 1c: Mean score and standard deviation of the experimental and control groups in the achievement tests.

Methods	*Mean score*	*Standard Deviation*
Analogy + Extended wait-time	15.28	4.08
Analogy only	13.27	4.67
Traditional lecture + Extended wait time	11.77	3.54
Traditional lecture only	9.63	3.68

only. This means that the extended wait time 1and ll of 5 and 3 seconds used during the questioning and answering has great positive effect on students' learning.

DISCUSSION

The main aim of this study is to find out if combining extended wait time with analogical reasoning can positively affect achievement in Biology. The result showed statistical difference between the experimental and control groups and the hypothesis of no significant difference were rejected. The mean scores of the experimental and control groups showed that the achievement results of those in the combination of analogical reasoning with extended wait time and those in analogy group was significant. This shows that using analogical reasoning in teaching is very important. Lagoke (1993) showed that when analogical reasoning alone was used to teach students their performance improved as they retained concept better.

Tobin (1980) said extended wait time during inquiry science teaching led to improved science achievement. According to Tobin and Caple (1982), the use of wait time of between 3-5 seconds was associated with high student achievement in science. It is therefore not surprising that a combination of these two variables in teaching science resulted in better achievement. The fact that the result of the analogy group was found to be significant is in line with other previous research findings (Gilbert 1989; Clement 1987; Lagoke 1993) which is why the method was recommended for teaching science. Analogical reasoning helps students to use familiar situation to explain those that are not familiar and try to make sense of it so it is important that the analogy comes from the students' environment.

It may be summarized from this study, which is on the effect of analogical reasoning and extended wait time on achievement in Biology. The instructional strategies used were a combi-nation of analogical reasoning plus extended wait time, analogy only, a combination of traditional lecture method plus extended wait time, and lecture method alone .The subjects were Pre-national diploma students of colleges of Agriculture in Samaru and Kaduna. One hypothesis was tested. The result showed a significant difference in the achievements of the subjects.

CONCLUSION

In this study lessons were prepared with analogical linkages with which the learners are familiar and extended wait time1 of 5seconds and wait time ll of 3seconds were also prepared and administered to students. The following conclusions were drawn:

1. The use of analogical reasoning and extended wait time helped to improve the quality of instructions such that students understanding of the subject matter improved and thereby improving performance.
2. The good effect of extended wait time was seen more when used with analogical reasoning than with the traditional lecture method. The implication of this study is that the use of a combination of analogical reasoning plus extended wait time has greatly enhanced achievement in science.

RECOMMENDATION

Based on the above findings the following recommendations are made:

i. it is highly recommended that teachers should teach for more meaningful learning with the use of analogical reasoning and extended wait time, as this led to higher students' achievement.
ii. since extended wait time provides for the student a period of "private thought" which will allow the new knowledge to be incorporated into the existing one, science teachers should cultivate the habit of extending wait time l of 5seconds and wait time ll of 3seconds, irrespective of what ever method is being used to teach as this will help students to grasp knowledge better.
iii. science educators should incorporate the use of analogy and extended wait time into the teaching methods of teachers in training, so that they can adopt it in teaching their students.

REFERENCES

American Association for the Advancement of Science1989. Science For All Americans: *Summary Project 2061*. Washington D.C: Author.

Abdullahi A 1982. *Science Teaching in Nigeria*. Ilorin: Atoto Press Limited.

Ausubel DP 1968. *Educational Psychology. A Cognitive View.* New York: Holt Rinehart and Winston.

Brown DE, Clement JJ 1989. Overcoming misconception via analogical reasoning: Abstract transfer versus explanatory model construction. *Instructional Science*, 18: 237-261.

Black D, Solomon J 1987. Can pupils use taught analogies for electric current? *School Science Review,* 3: 249-254.

Bajah ST 1975. Preparation of the secondary school teacher of the physical science for African environment. *West African Journal of Education,* 19(10): 85-96.

Brooks MN 1975. A study of locus of control and science achievement. *Journal of Research in Science Teaching,* 12(2): 175-181.

Black M.1962. *Models and Metaphors*. Itaca, N.Y: Cornell University Press.

Clement J 1987. Overcoming Students' misconception in physics: The role of anchoring Intuitions and Analogical Validity; *Proceedings of the Second International Seminar on Misconceptions and Education Strategies in Science and Mathematics*. 3 Ithaca.

Chewprecha T, Gardner M, Sapianchai M 1980. Comparison of training methods in modifying question and wait time behaviours of Thai high school chemistry teachers. *Journal of Research in Science Teaching,* 17(5): 191-200.

Clement J 1978. The Role of Analogy in Scientific Thinking. Examples from a *Problem Solving Interview.* Massachusetts:University of Massachusetts, Department of Physics and Astronomy. *Available on Microfiche.*

Dzama ENN, Osborne JF 1999 Poor performance in Science among African students: An alternative explanation to the African world view Thesis. *Journal of Research in Science Teaching,* 36(3): 387- 403.

Glynn SM, Yaearny RH, Britton BK (Eds.) 1991. *A Teaching with Analogies Model. The Psychology of Learning Science.* Hillsdale N.J: Eribaum, pp. 219 – 240.

Gilbert W 1989. An evaluation of the use of analogy, simile and metaphor in science texts. *Journal of Research in Science Teaching,* 26(4): 315-327.

Gooding TC, Swift JN, Swift PR 1987. Using wait- time feedback and supportive intervention to improve classroom discussion. *The Tower Review,* 4(11): 3-9.

James T 2000. *Effect of Combining Reflective Writing with Concept Mapping and Lecture method on preservice NCE Teachers Attitude and Achievement in biology.* Ph. D. Thesis, Unpublished. Zaria: Ahmadu Bello University.

Jegede OJ, Olajide JO 1995. Wait time, classroom discourse and the influence of Sociocultural Factors in Science Teaching *Science Education,* 79(3): 233-295.

Jegede OJ 1989.Toward a Philosophical basis for education of the 1990s: An African View-Point. In: DE Aerget (Ed.): *The History and Philosophy of Science in Science Teaching.* Tallahasse FL: Florida State University, pp. 185-198.

Lagoke BA 1993. *Analogical linkages Between Sociocultural Environment and Biology Concept Attainment by Secondary School Students Using a Constructivist Framework.* Ph.D. Thesis, Unpublished. Zaria: Ahmadu Bello University.

Lake JH 1973. *The Influence of Wait Time on the Verbal Dimension of Students' Inquiry Behaviour.* PhD Thesis, Rutgers University, 34, 6476-A.

Moriber G 1971. Wait time in College Student. *Science Education,* 55: 321-333.

Olajide JO, Jegede OJ 1989. An Investigation into the Average Wait times of Nigerian Integrated Science Classroom in Inquiry Based Lessons. *Nigerian Educational Forum,* 11: 295-298.

Ogunniyi MB 1988. Adapting western science to traditional African culture. *International Journal of Science Education,* 10: 1-9.

Olajide JO 1987. *Sociocultural Factors Affecting Wait time in Inquiry Based Integrated Science Classroom.* M.Ed. Thesis, Unpublished. Zaria: Ahmadu Bello University.

Osborne J, Freyberg P 1985. *Learning in Science: The Implication of Children's Science.* Auckland: Heinmann.

Palmer EL 1973. *A Determination of the Relative Consistency and Concordance of Student Science Interest Responsible for Utilizing Panel and Final.* Ph.D. Thesis, Unpublished, Wisconsin: University of Wisconsin.

Rowe MB 1986. Wait time, slowing down may be a way of speeding up. *Journal of Teacher Education,* 37: 43-50.

Rowe MB 1974 Wait time and rewards as instructional variables, their influences in language, logic and fate control: Part One Wait time. *Journal of Research in Science Teaching,* 11(2): 81-94.

Rowe MB 1969. Science, soul and sanctions. *Science and Children,* 6(6): 11-13.

Sund RB, Trowbridge LW 1967. *Teaching Science by Inquiry in the Secondary Schools.* Columbus, Ohio: Charles E. Merril Books Inc.

Silvester D, Howard E, Kay D, Wathen A 1999. Efficient preconditioning of the linearized navier-strokes equations for incompressible flow. *Technical Report UMIACS-TR-99-66,* Institute for Advanced Computer Studies University of Maryland.

Tobin K 1987. The role of wait-time in higher cognitive level learning. *Review of Educational Research,* 57(1): 69- 95.

Tobin KG, Capie W 1982. Relationships between classroom process variables and middle science achievement. *Journal of Educational Psychology,* 11: 441-454.

Tobin K 1980. The Effect of Extended Wait time on Science Achievement. *Journal of Research in Science Teaching,* 17(5): 469-475.

Wittrock MC 1985. Learning science by generating new conceptions from old ideas. In: West Pives (Ed.): *Cognitive Structure and Conceptual Change*. Orlando: Academic Press.

Zook KB 2005 Effect of analogical processes on learning and misrepresentation. *Journal of Educational Psychology Review*. 3(1): 41- 72.