

Effect of Wait-Time on Attitude and Retention of Senior Secondary School Students to Learning Chemistry Concepts

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Abstract

Chemistry is one of the sciences that has significantly influenced society. However, Nigerian secondary students' performance in the subject has long been a source of considerable worry. Nevertheless, adopting appropriate techniques, such as wait time, becomes essential when we recognise the importance of attitude and retention in classroom experiences for improving students' chemistry academic performance. This study investigated effect of wait-time on attitude and retention of senior secondary school students to learning chemistry concepts. Specifically, the study investigated: i. the effect of wait-time on students' attitudes towards chemistry and ii. effect of wait-time on secondary school students' retention ability in chemistry. The study involved one experimental group and one control group and they were both Pretested, Post-tested to determine their retention ability. Chemistry Students' Attitude Questionnaire (CSAQ) was administered on the experimental group only after the treatment to determine their attitude towards the use of wait-time instructional technique. Two research questions were answered in the study. The results of the study indicated that: the interaction has no effect on the attitude of the students towards learning chemistry after adopting a one-way ANOVA since it consists of one independent variable (experimental and the control group), one dependent variable (attitude) and the pre-attitude serves as the covariate. The result from the analysis revealed p-value greater than 0.5 indicating that the mean difference between the attitude of the two groups is not statistically significant and there is statistically significant difference in the academic performance of the students in the experimental group in the post test and post post-test as the p-value is less than 0.05, hence, the experimental group were able to retain their performance. Hence, wait time has an effect on their retention ability. It was, however, recommended that a larger sample and longer experimental period be recommended for future research; this will give the researcher more time to carry out the research appropriately and give a clear causal effect of the treatment on the experimental group. According to the findings, the wait time instructional strategy is particularly helpful for improving students' retention ability in chemistry, hence, it should be encouraged in senior secondary school chemistry instruction.

Introduction

One of the disciplines taught in Nigeria's senior secondary schools is chemistry (Igwe, 2015). According to the definition given by Igwe (2017), chemistry is a natural science that studies the properties of inanimate objects. These properties include the creation of these objects and the modifications they undergo when exposed to extremes in temperature, pressure, cold, and contact. The natural science discipline of chemistry plays a significant role in the secondary school curriculum. It is a very admirable academic field because it makes learning exciting for students. According to Igwe (2017), its presence in secondary school curricula has been defended (for luring young people to occupations with chemical alternatives) and praised as innovative (for generating a wealth of experience for the educated populace).

The chemistry curriculum is created to satisfy requirements for the senior high school program in the National Policy on Education and to demonstrate connections between the subject of chemistry and other science courses, such as biology and physics. Students must grasp their ability to reason in the formal operational stage because they must learn chemistry through comprehension, which necessitates this. Chemistry is one of the sciences that has had a significant influence on society. It helps students get ready for the real world of work by providing them with career options in disciplines including medicine, pharmacy, chemical engineering, food science, and environmental studies (Wahyudiati, 2022). The importance of chemistry in our daily lives, in our country, and in business is unwavering. Our daily actions frequently include chemistry. Chemistry is life, it permeates all things, and it is the crown prince and oracle of modern science (Opara & Waswa, 2013). The goal of chemistry education is to create a society that is literate in science. It introduces students to some fundamental ideas, skills, and attitudes that they will need in order to work in the sciences and closely related fields in the future.

Broadly speaking, chemistry education refers to the transfer of scientific knowledge to those who aren't often considered to be a part of the scientific community. Anand (2021) asserts that modern scientists and technologists are now more important than ever because it seems that the science education currently given to youngsters is out of date and essentially acts as a basis for future scientific training. For a country like Nigeria to be able to keep up with the most recent technological advancements in developed nations, it is necessary to produce highly trained scientists or scientifically literate citizens who have the knowledge and comprehension to follow science and scientific debates with interest. Students' attitudes and teachers' methods of teaching are, therefore, important variables when discussing students' academic achievement and retention in chemistry. Attitudes, according to Perloff (2016), refer to mental and emotional constructs that influence how people behave towards a certain item or issue. According to Karma and Tshering (2020), the idea of attitude is one that results from an endeavour to explain patterns in people's behaviour. In their own view, Nja et al (2022) presented attitudes as a component of psychology and are exhibited through a variety of likes and dislikes in certain activities. Çalik et al (2015) state that attitudes towards chemistry refer to students' propensity to react to chemistry depending on the thoughts and pictures they form as a result of their learning experiences. This implies that attitude has a vital role to play in students' academic performance. It further means that if the attitude of a student could be generated during the teaching and learning process, academic performance and retention concepts will be enhanced.

Retention is the ability to retain, and later recall information or knowledge gained after learning. Kumar (2017) sees retention as the ability of the learner to preserve and later remember information or knowledge gained after learning or as mental memory that processes which are used to acquire, store or retrieve information. Pillado, Futralan and Comighud (2020) posited that retention is a preservative factor of the mind. The mind acquired the materials of knowledge through sensation and perception. These acquired materials in the mind need to be preserved in form of image for knowledge to develop. Additionally, retention as the ability to remember experiences, and things learned. Accordingly, Tehseen and Ul Hadi (2015) define retention as the ability to store information that can be easily recalled from the short- and long-term memory. Students' retention is very important in teaching and learning interactions especially in chemistry (Alzen, et al., 2021).

Furthermore, as important as the students' attitude and retention appear, the methods employed by the teachers have a crucial role in enhancing both. This is because concepts in chemistry need to be properly learned and understood for them to be retained. In response to this, the use of wait time has been suggested by scholars in various studies. Borich (2014) defined wait-time as the period of time a teacher stops after answering a student's question. It typically starts when a teacher pauses and ends when the teacher invites a student to answer and the student speaks. Accordingly, this wait time appears to be a crucial factor in influencing the ability of students and interactions that take place in the classroom. The usage of wait time is a reaction to the necessity of remembering to ask the question first, pause, and then call on the student to respond. All pupils get the chance to reflect and practice responding as a result. Thus, it is a tactic to boost the chances for students to answer. When a question is asked and then a student is called upon or a collective answer is cued, it is referred to as the pause.

Two basic kinds of wait times have been identified (Bibi, 2014). These are teachers' question pause (wait time 1); and student response pause (wait time 2). While waiting after a teacher asks a question (wait time 1) gives students time to consider the question and come up with a response, waiting after a student responds (wait time 2) gives students time to change, add to, or comment on their response. When wait time is used, it's thought that students are more actively thinking, participate more frequently, give better quality responses, and engage in more positive student-to-student interactions. The use of wait time typically leads to fewer student redirects and discipline issues.

According to Bibi (2014), wait time is another dynamic aspect that is related to teachers' questions. Waiting for three seconds or more after asking a question is referred to as wait time. This can be accomplished through silent counting, watching a stopwatch, or keeping track of the second hand of a clock. Although it might seem crucial, teachers rarely wait longer than one minute to respond to their own queries (Powell & Caseau, 2004). Teachers sometimes overlook the fact that introspection, critical and creative thinking require time. Stokhof et al (2017) contend that a teacher's questioning strategy should function in a way that gives students enough time to consider and respond. In other words, there is no denying that teachers have always asked many good questions. The problem, however, lies in the method of asking the question. According to Bibi (2014), for instance, less than one second of time has repeatedly been observed to lapse between the end of the students' answers and the start of the teacher's next question.

Methodology

The present study involved one experimental group and one control group and they were both Pre-tested, Post-tested to determine their academic performance and retention ability. The Chemistry Students' Attitude Questionnaire (CSAQ) was administered to the experimental and control groups before and after teaching them the chemistry concepts to determine the effect of wait time on the students' attitude towards learning chemistry concepts.

Research Design Layout

Group	Pre-test	Treatment	Post-test	Post Post-test
EG	O ₁	X ₁	O ₂	O ₃
CG	O ₁	X ₀	O ₂	

EG = Experimental Group

CG = Control Group, X₁ = Treatment, X₀ = No Treatment, O₁ = Pre-test, O₂ = Post-test, O₃ = Post post-test

The population for this study comprises all the secondary school II students of Niger State, Nigeria. There are three zones in Niger State of which only zone B was purposively sampled. Two equivalent schools that were ready to allow their students to take part in the study were involved in this study. Two intact classes each from each school were involved in the study. The first school served as experimental group while the second one served as the control group. The total sample for the study consisted of 35 Secondary School II Chemistry students. Twenty of the students formed the experimental group while fifteen were found in the control group. The group of students consist of 9 males and 26 females.

For the purpose of this study, the research instruments were designed as stated below:

1. Wait-time Instructional Technique which is the treatment instrument for the experimental group.
2. Chemistry Students' Performance Test (CSPT) consisting of 30 multiple-choice questions was used as Pre-test, Post-test and Retention tests.
3. The Chemistry Students' Attitudes Questionnaire (CSAQ) comprising of 20 items was used as questionnaire to collect data on Attitude and it is a 5-points Likert rating scale. The rating of the 5-points Likert scale is as follows: Strongly Agree (SA) 5, Agree (A) 4, Neutral (N) 3, Disagree (D) 2, and Strongly Disagree (SD) 1. This was administered only to the treatment group.

Results and Findings

Research Question 1: Does wait-time have any effect on secondary school students' attitudes towards chemistry?

Table 1 shows that the mean value of attitude of the respondents in the experimental group is not much different from that of the control group before the intervention. it can be seen that the mean difference is 0.45, which is less than one.

Table 1

Pre-attitude and Post-attitude for the Experimental and Control Group

Treatment	Pre-attitude	Post-attitude
Expt. Mean	61.75	58.55
N	20	20
Std. Deviation	7.297	9.539
Contr. Mean	62.20	56.40
N	15	15
Std. Deviation	6.201	6.843
Total Mean	61.94	57.63
N	35	35
Std. Deviation	6.756	8.444

As it is shown on Table 1 that the attitude of the secondary school students in the experimental group is almost the same as that of the control group. From the table it was discovered that there is mean difference in the post attitude of the respondents after the intervention, that is, after exposing the respondents in the experimental group to wait time and those in control group to traditional method of teaching, there was difference in their mean value. Hence, there is the need to investigate further to determine whether the mean difference is statistically significant or not. This is what called for hypothesis 1: *There is no significant difference between the attitudinal mean scores of students taught chemistry using of wait-time and those taught using conventional method.* This hypothesis is tested using one-way ANCOVA since it consists of one independent variable which is groups that is experimental, and the control group and one dependent variable which is attitude of the respondents to learning of chemistry and the pre-attitude serves as the covariate. This is demonstrated on Table 2

Table 2

*ANCOVA of Effect of Wait Time on Attitude of Secondary School Students to Organic Chemistry***Dependent Variable: Post attitude**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1659.335 ^a	2	829.667	34.712	.000	.684
Intercept	13.770	1	13.770	.576	.453	.018
Pre-attitude	1619.713	1	1619.713	67.767	.000	.679
Group	58.324	1	58.324	2.440	.128	.071
Error	764.837	32	23.901			
Total	118661.000	35				
Corrected Total	62424.171	34				

a. R Squared = .684 (Adjusted R Squared = .665)

It can be deduced from Table 2 that the p-value > 0.05, this shows that the mean difference observed on Table 1 between the attitude of respondents in experimental group and those in the control group is not statistically significant and as a result the null hypothesis 1 is therefore not rejected. That is, there is no significant difference between the attitudinal

mean scores of students taught chemistry using of wait-time and those taught using conventional method. This means that the intervention did not has effect on the attitude of the respondents, it does not change their attitude towards learning of chemistry.

Research Question 2: Are there effects of wait-time on secondary school students' retention ability in chemistry?

The research question 2 result to hypothesis 2: *There is no significant difference between the retention mean scores of students taught chemistry using wait-time.* It was as result of this that paired sample t-test analysis was employed to analyse the data collated for this purpose as seen on Table 3, to see whether there is difference in the performance of the respondents in the experimental group when they were re-tested after two weeks.

Table 3

Paired Sample t-test Analysis of Effect of Wait-Time on Retention Ability of Students

	Mean	N	Std. Deviation	t	df	sig
Pair 1 Post-test 1	18.60	20	3.455	5.547	19	0.001
Post- test 2	21.75	20	3.768			

As it is being revealed on Table 3, the p-value < 0.05, this shows that there is difference in the academic performance of the respondents in the experimental group in the post test and post post-test and the difference is statistically significant because the p-value is less than 0.05. the mean difference can be said to be in favour of the post post-test since the mean value of the post post-test is greater than their post-test. This means that the students in the experimental group were able to retain their performance and the wait-time has effect on the retention ability of the students.

Conclusion

Chemistry being a natural science that studies the properties of inanimate objects which include the creation of the objects and the modifications they go through when exposed to extremes in temperature, pressure, cold, and contact. The inherent content of the subject chemistry requires good instructional strategy for students improved academic performance. It is essential to know that one of these instructional strategies as identified by previous researches Iksan & Daniel (2015); Sabo (2017); Abiam & Odok (2021) is wait-time. The following conclusions were made in accordance with the two research questions answered in the study.

On research question one *“Does wait-time have any effect on secondary school students' attitudes towards chemistry?”* To analyse this, data was collated through the use of a 20-item questionnaire administered to the respondents before and after the intervention to both the experimental group and the control group to ascertain their attitude to learning of organic chemistry before the intervention and to show whether there is change in their attitude as a result of the intervention respectively. However, before the intervention both groups (experimental and control groups) have similar attitude towards chemistry. But after the intervention, there is mean difference in the post attitude of the respondents after the intervention, this implied that after exposing the respondents in the experimental group to wait time and those in control group to traditional method of teaching, there was difference in their mean value. Hence, determining the significant level of the mean difference

statistically, a one-way ANCOVA was adopted since it consists of one independent variable (experimental and the control group), one dependent variable (attitude) and the pre-attitude serves as the covariate. The result from the analysis revealed p-value greater than 0.5 indicating that the mean difference between the attitude of the two groups is not statistically significant, hence, the intervention has no effect on the attitude of the respondents towards learning chemistry.

Research question two "*are there effects of wait-time on secondary school students' retention ability in chemistry?*" a post-post-test reshuffled CSPT was administered to the respondents in the experimental group alone after two weeks of post-testing them. This is to ensure whether wait-time (intervention) for the experimental group has effect on the academic performance of the respondents in chemistry. Using a paired sample t-test analysis, the data collated for this purpose was adopted to determine whether there is difference in the performance of the respondents in the experimental group when they were re-tested after two weeks. The table revealed a p-value < 0.05, which indicated statistically significant difference in the academic performance of the respondents in the experimental group in the post test and post post-test. Hence, the mean difference is in favour of the post post-test since the mean value of the post post-test is greater than their post-test. Also, the experimental group were able to retain their performance, hence, wait-time has effect on their retention ability. In conclusion, students' attitude to and retention in chemistry are important variables when discussing students' academic achievement in chemistry and the methods employed by the teachers have a crucial role in enhancing both. The study has been able to establish that wait time enhances students' attitude and retention in chemistry. Therefore, this study recommends that the ministry of education and school administrators should encourage chemistry teachers to use wait time in delivering their chemistry lessons. Also, to increase their students' performance in chemistry, teachers should employ wait time strategies in an efficient and consistent manner.

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