Effect of the four-step learning cycle model on students' understanding of concepts related to simple harmonic motion

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Abstract

The study explored the efficacy of four-step (4-E) learning cycle approach on students understanding of concepts related to Simple Harmonic Motion (SHM). 124 students (63 for experimental group and 61 for control group) participated in the study. The students' views and ideas in simple Harmonic Achievement test were analyzed qualitatively. The students' views or ideas on the concepts related to SHM are first analyzed by identifying students' existing naïve ideas (alternative conceptions) on the concepts. These naïve ideas were reported in the way the students have written them.

In the second analysis, the students' responses were analyzed by determining the number of students, who possess sound understanding, partial understanding and alternative ideas of the concepts.

From their responses, before the treatment, it was observed that most students held alternative conception of the concepts related to SHM as shown in part one of the results. After the treatment, it was also observed that some students shifted their levels of understanding from alternative conceptions to partial or sound understanding. It was also found that the four-step learning cycle was statistically significant on teaching most of the concepts involving SHM but not on teaching amplitude and frequency. Based on the findings, it was suggested that Physics teachers should be encouraged to provide a classroom environment and an opportunity for students to explore their ideas and being willing to express and discuss these ideas

Keywords: Understanding, Simple Harmonic Motion, Alternative Conceptions, Constructivist, Achievement test, Concepts

Introduction

With increasing technological developments in the late 20th century, there have been fundamental ranges in educational system with respect to factors like teachers, students and learning environment. Each country changed their curricular including new methods and techniques in order to educate their citizens better. In Nigeria, science curriculum was changed and developed under 6, 3, 3, 4 system of education where, 6 represents the duration of primary education, first 3 is for duration of Junior Secondary School, second 3 represents the duration of Senior Secondary School, while 4 is for minimum duration of University education. This system was unconsciously developed under constructivists learning theory.

Constructivist theory maintains that knowledge is constructed by the individuals actively and students can learn only by doing (Chem, 2003). The constructivist view is a very powerful and influential perspective to many science education researchers these days.

In this view, the most important tool in the process of learning is the interaction between the new knowledge and the existing knowledge (Richardson, 1997). But still there have been many discussions about how we can apply constructivist theory in the classroom.

Constructivism is seen as an orientation towards teaching and learning, and a way of viewing how teaching and learning occur or simply a way of thinking about learning (Richardson, 1997). Teachers do not view constructivism as a way of teaching and learning that can be followed to implement a teaching programme (Boddy, Watson & Aubusson 2003).Constructivism regards learning as a dynamic and social process in which learners actively construct meaning from their experiences in connection with their prior knowledge and social setting (Driver, Asoko, Leach, Mortimer, & Scott 1994). The constructivist view of learning argues that students do not come to the science classroom empty but have tenaciously held ideas about how the natural world works. In the view of constructivist, students should no longer be passive receiver of knowledge given by the teachers; and the teachers should no longer be provider of knowledge (Fosnot, 1996).The above views indicate that learning is a process of acquiring new information, which is active and complex. This is as a result of an active interaction of key cognitive process (Glynn, Yeary & Britton, 1999). This is also an active interaction between students and teachers, and students try to make meaning of what is taught by making effort to fit these with their own experience. Constructivist views also emphasize generative learning, questioning or inquiry strategies (Slavin,1994). An emphasis on constructivism and hands-on inquiry-oriented instruction to promote students conceptual knowledge by building on prior knowledge, active engagement with the physics content, and application to real life situations, has been advocated in science lessons. (Stofflett & Stoddart, 1994). Similarly, constructivist views emphasizing discovery, experimentation, and open-ended problems have been successfully applied in science of which physics is one of the sciences. Hence, the use of students' ideas about physics to guide lessons in SHM, providing experiences to test and challenge those ideas to help physics students arrive at more scientifically understanding lend to use of four-step learning cycle (Exploration, Explanation (concept invention), Expansion, and Evaluation (4Es)).

The learning cycle is an approach to teaching and learning that increases the likelihood that students are engaged in the type of thinking that constructivist argues is necessary for productive thinking. This approach has proven effective in helping students construct concepts and conceptual systems as well as develop more effective reasoning skills. Therefore, to achieve this, teachers should have a clear idea of what students have already known and understood so that they can engage students in activities that help them construct new meanings. This provides opportunities for the students to discuss about their ideas concerning concepts in SHM and issues that are prominent in the learning process.

The study investigated the Senior Secondary Three (SS111) students understanding of concepts in simple harmonic motion which have been reported to be difficult to learn by students (Chief Examiners Report, West African Examination Council 2011). There are lot of studies in the literature concerning student's misconceptions about physics concepts and their properties. The roots of these misconceptions; how they affect disciplinary knowledge, and how they can be removed have been investigated by many researchers. (Gill, Perez & Carrascosa, 1990; Heller & Finley, 1992). There have been much constructivist-oriented research on the understanding of a wide range of physics concepts in students (Eylon & Ganiel, 1990) undergraduate and post graduate physics students (Mc Dermott & Shaffer, 1993), and teachers of science and physics (Heller and Finley, 1992).

The Learning Cycle

There are different types of learning cycle, that is, five, four and three phase-learning cycle. In this study, the four-phase learning cycle was used because the phases are built on students' existing knowledge and provide opportunities that will encourage deep approaches to learning. This learning cycle (Abraham, 1997) method is a four phase inquiry approach consisting of exploration, explanation, expansion and evaluation. The key element of the learning cycle method is that laboratory activities that precede lectures. Since its inception in the 1960s, the learning cycle has been the focus of many studies conducted to determine its effectiveness (Staver and Stronger, 2002; Hanuscin & Lee, 2007) It is pertinent to say that the learning cycle has been found very effective at teaching science concepts and improving generalizable reasoning skills in students from junior to

Secondary Schools and even in the Universities. More recently, learning cycle has been found to be effective helping students to acquire scientific conceptions.

While instructional approaches, developed based upon conceptual change approach, have been advocated for helping students to recognize their misconceptions and reject them in favour of a more scientific view (Lawson, Alkhoums, Benford, Falcomer, 2000). None of the previous researches has examined the effects of four-phase learning cycle on understanding of several interrelated concepts and of different aspects involved in simple harmonic motion. This study investigates the efficacy of four-phase learning cycle and lecture method of teaching SSIII students understanding of several interrelated concepts and a number of different aspects involved in SHM.

Purpose

The purpose of this study was to determine the efficacy of four-phase learning cycle method on SSIII students understanding of simple harmonic motion.

The questions investigated by this study were:

- Do students have alternative conceptions of concepts related to SHM?
- What are the students' levels of understanding of SHM when taught using four-step learning cycle model?

The hypothesis tested at P≤.05 in this study was:

- The students' level of understanding of concepts in SHM is significantly independent of methods of instruction used (four-step learning cycle and lecture method).

Design and Procedure

This study was conducted using quasi-experimental research design. Pretest-Post test non-equivalent control group design was applied in this study. The subjects were chosen from SSIII students of two secondary schools randomly selected from a population of six Senior Secondary Schools in Otukpo Urban of Benue state in Nigeria.

This study was applied to 124 SSIII physics students, of which 63 were in the experimental group and 61 were in control group. In the control group, the convectional teaching method (e.g. lecture method) was applied, whereas in the experimental group 4E learning cycle method was applied. The procedures in the experimental group were as follows.

Exploration**:** This involves laboratory activities. In this phase, the students are at the centre of the action as they collect data to solve the problem. *For instance, students were asked to attach a metal bob to one end of the string from a rigid support and pull the mass slightly to one side of its equilibrium position and release it.* The students were asked to observe the to and fro movement of the bob about the rest position and take the time taken for complete oscillation.

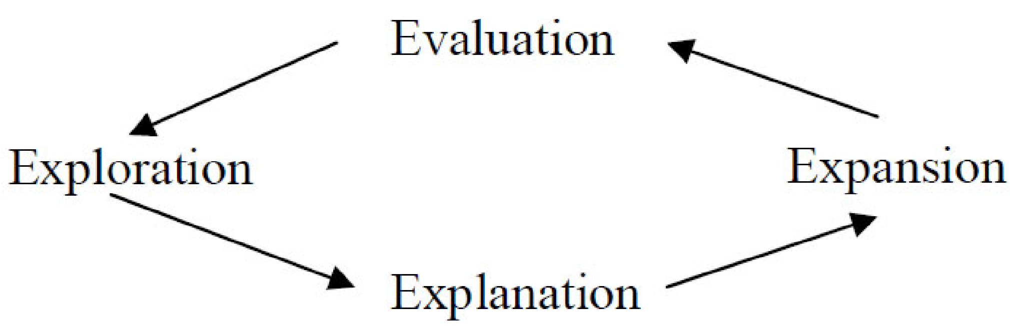
Explanation**:** In this stage, the teacher leads the students to relate the results of the activity and/or topic to other topics already understood. The teacher discusses the activities or the observations of the students with them. That is, the teacher will share his insights, knowledge and experience with the students by asking probing questions that permit the students to move toward scientifically accepted explanations. The teacher also introduces new vocabulary, phrases or sentences to label what the students have already identified.

Expansion**:** This stage requires that the students engage in the application of scientific knowledge gained. The creative ability of the students is important in this stage. The teacher gives the students the new information that will enable them expand what they have learned in the earlier stages of the learning cycle. The teacher poses problems that the students will solve by applying what they have learned. *For instance, the students were asked to put some iron fillings into a test tube until the test tube can stand erect in a liquid contained in a beaker with about half of the length of the test tube submerged in the liquid. They were also asked to depress the test tube a few centimeters into the liquid and observe the up and down motion of the loaded test-tube and note the regularity of the motion.*

Evaluation: This is an important component during which students reflect on the topics studied. It was an ongoing process in every stage of the cycle. Evaluation was formative at the every stage of the cycle and summative at the end of the teaching process.In both groups the lessons were taught by the research assistants

supervised by the researcher.
The four steps are diagrammatically represented in figure 1.

Figure 1. Four-phase Learning Cycle



Instrument

In this study, data were gathered using Simple Harmonic Motion Achievement Test (SHMAT). This test was developed and validated by the researcher to identify students understanding of simple harmonic motion. SHMAT consisted of 10 short essay questions. In developing SHMAT, research findings reported in the literature were utilized and the objectives of the subject matter were considered. The SHMAT was trial tested with 50 students in SSIII of different school and the responses were used to calculate the reliability of SHMAT using Cronbach Alpha since the scoring was not dichotomously done. The reliability was found to be 0.76. Similarly, coefficient of stability was also found to be 0.98 using Pearson product moment correlation coefficient. The reliability indices mentioned above were found to be high to adjudge the instrument reliable. The validity of the test was checked by two experienced physics teachers and two experts in Measurement and Evaluation. They were requested to check if there was any ambiguity in the questions and whether the questions addressed the purpose of the study.

Scoring of the Items

The scoring of the students' responses in SHMAT in both Pretest and Post test was done by assigning each response 2, 1 or 0 point. That is, students' justifications and explanations as they answer the questions on concepts related to SHM will be scored as follows. (ALPS, 2007).

- Sound understanding or complete response (2mks). This response indicates that students seem to have acquired an integrated scientific perspective. They are able to restructure their ideas and give a coherent explanation of the phenomenon. For instance in explaining simple harmonic motion, complete response will be "simple harmonic motion is an oscillatory motion in a straight line whose acceleration is directed towards a fixed-point (equilibrium position) and the acceleration is proportional to the displacement from the fixed point"
- Partial understanding or incomplete response (Imk). The response indicates that students seem to have a partial knowledge of the concept or phenomenon. That is, ideas are not verbalized in an integrated way, but some kind of understanding is evident for instance, simple harmonic motion is an oscillatory motion in a straight line whose acceleration is directed towards a fixed point or the acceleration is proportional to the displacement from the fixed point only.
- Alternative understanding or alternative conception (Omk). In this, students give just one simplistic incorrect view point. That is, students give linear explanation rather than see a number of factors as being responsible for the phenomenon. This response indicates lack of understanding about the concept or phenomenon. On the basis of 2, 1, or 0, the frequency of responses as well as the percentages will be determined in order to determine the level of understanding

Experimental Procedure

Two instructional approaches were employed for this study. The first approach was the use of four-phase learning cycle method while the second was the use of conventional lecture method. The two approaches were the same in terms of content, basic instructional objectives and mode of evaluation. They differ in terms of instructional activities. The four-phase learning cycle method was based on guided inquiry learning derived from constructivist theory. That is, the students were led to elicit ideas and generate explanations and interpretations of concepts in SHM.

The four-phase learning cycle method namely exploration, explanation, expansion and evaluation was applied to experimental group, while the lecture method approach was applied to the control group. Before the actual experiment, two research assistants (regular physics teachers) were coordinated on the use of the experimental treatments and the marking scheme and the lesson notes. This exercise provided the researcher with the opportunity of identifying the background knowledge of research assistants on the research procedures. The exercise also enabled the researcher to determine the research assistants knowledge of the subject matter and also to ensure that they do not deviate from the steps of the instruction.

After this exercise, the research assistants and the researcher administered the pretest to both groups at the end of which the treatment started. The treatment in both groups lasted for four weeks and in each week, two double periods of 80 minutes were used making a total of eight double periods for four weeks. At the end of the treatment, the research assistants administered the posttest to the groups after two days of revision. During the revision exercise, the students were requested to go through the activities and their notes and seek any clarification where necessary from the research assistants. Data, obtained from the pretest and posttest, were used to answer the research questions using frequency and percentage and test the hypothesis using chi squared statistic. The Chi-squared statistics was adopted because the measurement was on nominal scale.

Results

To answer the first research question students' alternative conceptions of concepts related to simple harmonic motion are described in the part one of the results. In part one the most **unedited occurring alternative conceptions of the students' responses on the concepts** related to SHM is highlighted. The emphasis here is not on the number of the students who made the responses but on the most occurring response of the students regarded as alternative conception with reference to scientifically accepted conception. In part two the data for answering the second research question and testing the hypothesis are presented.

Part One

Q1. What is Simple Harmonic Motion?

Students' Responses (SR)

Experimental group.

- Simple harmonic motion is the motion that takes place between two points in a fixed position which is directly proportional to the oscillating body
- It is to and fro movement of a body where by the rate of change of acceleration is proportional to the displacement of the body and the move in the direction of the force.

Control group.

- Simple harmonic motion is the movement of a body to and from about a fixed point
- SHM is the time of motion in which the object or person moves to and fro or it is to and fro motion
- SHM is a motion in which a body moves to and fro from a constricted point so that at any point of its movement, it maintains a constant velocity.

Q2. What is Amplitude of Simple Harmonic Motion?

SR: *Experimental group.*

- Amplitude is the maximum forward or back word movement of a body in simple harmonic motion
- Amplitude is the maximum velocity of displacement per one second.
- It is the amount of the speed of its frequency

Control group

- Amplitude of SHM is the displacement of a body per second
- The amplitude of a SHM is the displacement of a body from its equilibrium position.

Q3. Explain the term period of Oscillation.

SR: *Experimental group.*

- Period of oscillation is the number of civil or revolution mode in me second

- Period of oscillation it is the time taken to go and from per second

Control group.

- Period of oscillation is the movement of the vibrating oscillatory body in a second
- Period is the time interval
- Period at oscillation is the time equals to the length at pendulum and acceleration due to gravity

Q4. What is frequency of a Simple Harmonic Motion?
SR: *Experimental group.*

- Frequency is the speed that is used during the function of SHM
- Frequency of a simple pendulum is the no of the to and from movement of the pendulum built or it is the member of oscillation of the pendulum hulb.

Control group.

- Frequency is the number of times or period it takes a body to compete in one second
- Frequency is defined the number of per second of vibration body.
- The frequency of a simple pendulum is the period in which the pendulum moves front and back.

Q5. What happens to frequency and period when the speed of an object in SHM increases.
SR: *Experimental group.*

- The frequency is increased and the period is increased
- When the speed of an object performing SHM increases the frequency will.
- When the speed of an object performing simple harmonic is decreased to its frequency and period, the frequency of that object is reduced.

Control group.

- When the speed of an object performing simple harmonic motion is increased its frequency and period also

- When the speed of an object performing simple harmonic is increased the frequency will decrease while the period will increase.

Q6 On what does period of Simple Pendulum Depend?

SR: *Experimental group*

- The period of a simple pendulum depends on the direct of wind and the angle it is been set through (the must be set through a small angel)
- Period depends on how and when you leave it to scoring

Control group.

- The period of a simple pendulum is dependent on the constant to and fro movement along the fixed point
- The period depends on the frequency
- The period of a simple pendulum depends on the number of oscillations and frequency

Q7. Describe the changes in K.E of a swinging pendulum body with respect to its position.

SR: *Experimental group.*

- When the pendulum is at nt it is possessing an energy called potential energy but when a little external force is applied, the potential energy changes to kinetic energy (K.E), ie. The external force that is during acted upon the pendulum gave right kinetic energy.
- Kinetic energy is the energy of a body in motion and when a pendulum hob swings to and fro it make one oscillation and the position of the pendulum bulb changes
- The changes in the K.E of a swing pendulum bob with respect to its position is that as long as the bob keeps moving it reduces the speed until it finally gets to a stop after a long period of time

Control group.

- When a simple pendulum bob is in position it is said to possess a potential energy them moment of starts swinging there is a change in motion potential energy to kinetic energy which means the pendulum bob is in motion

- The swing of pendulum bob is the changes of the K.E the pendulum is displaced through a large angle.

Q8. Explain the balancing of velocity and acceleration at the equilibrium position of an object performing SHM.

SR: *Experimental group.*

- The velocity is = 0 is fixed
- The velocity → O, the acceleration → max
- The velocity and acceleration equal to zero

Control group.

- The acceleration and velocity are equal and opposite
- Its velocity and acceleration decreased as the motion continued.
- Velocity and acceleration → constant in position
- There is displacement in its velocity and acceleration

Q9. What are the effects of wind on a swinging pendulum bob?

SR: *Experimental group.*

- It effect the period
- It given wrong oscillation for second
- It frequency varies

Control group.

- It will increase the wind
- It causes the displacement
- That a gravitational force acts upon it but not two strong in stopping the oscillation

Q10. What are the effects of a large displacement on a swinging pendulum bob?

SR: *Experiment group.*

- It moves faster and not oscillates but only move on a straight line.
- The swinging bob will move to a different direction and when it return it dash with the retort stand

Control group.

- It will be curve when it suppose to be arc
- It does not accelerate properly i.e. it does not come back to its fixed point
- It will not make the pendulum bob not to complete oscillation.

Part Two

The results obtained from the study when the students' responses were grouped into the levels of understanding (Sound understanding, Partial understanding and Alternative conception) are presented in tables 1, 2 & 3.

Table1. *Number and percentage of students of the* ***control group*** *in each level of understanding of concepts in SHM before and after the treatment*

N=61	**Pretest**(Before treatment)						**Posttest**(After treatment)					
S/N	**SU***		**PU****		**AC*****		**SU**		**PU**		**AC**	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
1	13	21.0	14	23.0	34	56.0	29	48.0	21	34.0	11	18.0
2	14	23.0	6	10.0	41	67.0	35	57.0	11	18.0	15	25.0
3	13	21.0	17	28.0	31	51.0	32	52.0	13	21.0	16	26.0
4	25	41.0	1	2.0	35	57.0	38	62.0	2	3.0	21	34.0
5	13	21.0	11	18.0	37	61.0	24	39.0	11	18.0	26	43.0
6	5	8.0	9	15.0	47	77.0	10	16.0	14	23.0	37	61.0
7	0	0.0	0	0.0	61	100.00	4	7.0	4	7.0	53	86.0
8	6	10.0	6	10.0	49	80.0	12	20.0	6	10.0	43	70.0
9	5	8.0	1	2.0	55	90.0	8	13.0	5	8.0	48	79.0
10	1	2.0	1	2.0	59	96.0	5	8.0	5	8.0s	51	84.0

*Sound understanding.**Partial understanding ***Alternative conception

Information in table 1 shows that students in control group fairly shifted their level of understanding from alternative conception to sound and partial understanding of the concepts. For instance, 26 students shifted from alternative conception of the meaning of SHM (item 1) to sound understanding while 7 of the students moved from the same idea to partial understanding. There was not much shifting in item 7 as shown in table 1.

Table 2. *Number and percentage of students of the* ***experimental group*** *in each level of understanding of concepts in SHM before and after the treatment with 4-Es*

N=63	**Pretest**(Before treatment)						**Posttest**(After treatment)					
S/N	**SU***		**PU****		**AC*****		**SU**		**PU**		**AC**	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
1	19	30.0	9	14.0	35	53.0	47	74.0	10	16.0	6	10.0
2	10	16.0	12	19.0	41	65.0	40	63.0	12	19.0	1	17.0
3	6	10.0	25	40.0	32	50.0	30	48.0	27	43.0	6	10.0
4	7	11.0	4	6.0	52	83.0	46	73.0	1	2.0	1	25.0
5	6	10.0	20	32.0	37	58.0	38	60.0	14	22.0	1	17.0
6	8	13.0	7	11.0	48	76.0	19	30.0	21	33.0	23	37.0
7	2	3.0	01	2.0	60	95.0	24	38.0	5	8.0	34	54.0
8	2	3.0	3	5.0	58	92.0	33	52.0	10	16.0	20	32.0
9	2	3.0	3	5.0	58	92.0	20	32.0	27	43.0	16	25.0
10	0	0.0	1	2.0	62	98.0	19	30.0	15	24.0	29	46.0

*Sound understanding.**Partial understanding ***Alternative conception

Table 2 shows that 90% of the students either maintained their level of understanding or shifted their level of understanding from alternative conception to partial or sound understanding after treatment. It was also observed that before the treatment 53% of the students had alternative/no conception of concept of SHM (item 1) and after the treatment only 10% of the students remained at the alternative conception level.

Table 3 above indicates that there is significant difference in the level of understanding of concepts related to SHM in items 1, 3, 4, 5, 6, 7, 8, 9&10 between the students of the experimental group and control group. There is no significant difference in items 2 and 4 between the experimental and control groups. The calculation of the χ^2 statistical value was done using manual calculator since the numbers were very few.

Table 3. *χ^2 Statistics on the level of understanding of concepts related to simple harmonic motion by treatment*

S/No	Group	2 SU*	1 PU**	0 AC***	df	χ^2	
1	Experimental	47	10	6	2	9.24	5.991**
	Control	29	21	11			
2	Experimental	40	12	11	2	3.91	5.991
	Control	35	11	15			
3	Experimental	30	27	6	2	9.49	5.991**
	Control	32	13	16			
4	Experimental	46	1	16	2	1.74	5.991**
	Control	38	2	21			
5	Experimental	38	14	11	2	9.58	5.991**
	Control	24	11	26			
6	Experimental	19	21	23	2	7.44	5.991**
	Control	10	14	37			
7	Experimental	24	5	34	2	18.50	5.991**
	Control	4	4	53			
8	Experimental	33	10	20	2	19.17	5.991**
	Control	12	6	43			
9	Experimental	20	27	16	2	36.25	5.991**
	Control	8	5	48			
10	Experimental	19	15	29	2	38.82	5.991**
	Control	5	5	51			

**$P \leq .05$

*Sound understanding.**Partial understanding ***Alternative conception

Discussion

The purpose of this study was to explore the effectiveness of the four-phase learning cycle method on the SSIII students' understanding of concepts related to simple harmonic motion. Results from this study showed that the application of the leaning cycle approach, such as four phase learning cycle enhances students' understanding of key aspects and concepts related to SHM. Possible reason for observed difference may include value associated with alternative ways of acquiring knowledge in science and confirmation value of hands-on-activities which are key characteristics of learning cycle (Lawson, 2001).

During learning cycle, students learned through their own actions and reactions by involving in hands on activities (Oludipe & Oludipe 2010). The hands-on activities are those activities involved in an experiment for practical experiences in Simple

Pendulum. They explored new materials and phenomena that raise questions and encourage them to seek answers. Such question as, "what makes pendulum bob to come to rest?" Students' exploration involved them in activities that enable them to examine the adequacy of their prior conceptions and force them to argue about and test those conceptions identified in this study. For instance, some of the students who fail to associate the concepts of acceleration, fixed point and displacement with SHM are likely to be in a state of disequilibrium. This disequilibrium sets in especially when predictions based on their prior beliefs are contradicted. This situation provides the students with the opportunity to construct or reconstruct more appropriate scientific conceptions (Madu, 2004; Narli, 2011). Hence, learning cycle approach requires a teaching environment in which students had more opportunity to identify and express their conceptions, examine the utility of them and apply the new concepts and ideas in a context familiar to them. However, in the traditional group, a concept or a group of related concepts was verbally introduced and explained in the lecture approach. Students in traditional group mainly focused on concepts related to the subject that require less conceptual restructuring.

The finding of this study regarding better performance of students in learning cycle group is consistent with the view claiming that correct use of the leaning cycle accomplishes effective learning of science concepts (Lawson, 2001:166). According to Lawson

> Learning new concepts is not purely abstractive process. Rather, concept acquisition depends upon one's ability to generate and test ideas or hypotheses and respect those that lead to contradictions. Thus, concept learning can be characterized as constructive; while new conceptual knowledge depends upon skill in generating and testing ideas. As one gains skill in generating and teaching hypotheses concepts construction becomes easier.

The above assertion indicates that for students to acquire the knowledge of SHM, the students should be able to understand the essential characteristics of such oscillatory motion like regularity and repetition of motion.

As seen in tables 1 and 2, there is statistically significant difference regarding pretest results between the experimental and control groups after the treatment in terms of their level of understanding of concepts in SMH. The results of the pretest and the post-test indicate that the students taught by using four-phase learning cycle method were more successful in shifting their levels of understanding from alternative conception to sound understanding and partial understanding respectively, than the students taught by the traditional approach.

In order to identify students misconceptions about SHM, students' writings were used in this study. The students' writings have shown that students bring their own intuitive ideas about the concepts related to simple harmonic motion. These ideas may have been deduced from personal experience or even from what they have read or seen in the physical world. Whenever these ideas are misconceptions, teachers should try to ensure that they are challenged and discussed immediately. Otherwise, student will find it very difficult to understand completely the processes and modeling in the physical world"

Successful learning of simple harmonic motion depends on being able to understand the principles involved. That is, being able to understand the following two rules

- Deceleration is always in the opposite direction to the displacement from the equilibrium position.
- Acceleration is proportional to the displacement from the equilibrium position.

It has been demonstrated from the results that they have not really understood the principles involved. The principles that a body in motion has an equilibrium position to which it always tends to return when displaced because it is acted by a restoring force. This restoring force causes the body to go to and fro past the equilibrium position.

Some research studies conducted by Barry and Graham (1992) revealed that there are misconceptions, in the students understanding of mechanical concepts, in particular, velocity, speed, acceleration and force. These concepts are so much involved in the study of simple harmonic motion and the failure to have a thorough understanding of these concepts affect the understanding of simple harmonic motion. While dealing with the concept of SHM, some students used a position criterion "the acceleration and velocity equal to zero", or "velocity and acceleration are constant in motion"

Others either associated direction of acceleration with the direction of motion or thought that increasing velocity also meant increasing acceleration. This type of association is also found in their responses concerning frequency, period and speed. For example "when the speed of an object performing SHM is increased the frequency will increase while the period will increase". "The frequency is increased and the period is increased". Regarding the concepts of S.H.M, some students postulated a SHM as to and for movement of a body with the change of acceleration proportional to the displacement. Others thought that SHM is the time of motion in which the object or person moves to and fro rather than associating it with direction of acceleration towards fixed point and the acceleration being proportional to the displacement from the fixed point. The implication of the above findings is that the physics teachers may have to confront some of the students' alternative ideas in SHM which are not easy to change. Another implication of this study is that students need to be aware of these conceptions and confront them through the use of 4Es that would allow students active participation. When teaching about concepts in SHM is very important to provide students with enough time and opportunity to construct or reconstruct ideas at their own pace, a meaningful conceptual model of properties of SHM that will be in accordance with scientific conceptions is required.

Conclusion

Over the last two decades, science education research has revealed that students already have ideas about how physical systems have been even before they start to study physics. In many cases, these ideas called alternative conceptions differ from accepted scientific ideas. There have been consistent calls for constructivist teaching based on the constructivist views of learning during the past decade. There are two arguments to support constructivist educational practices (Perkin, 1999). First, philosophically, the student has to construct or reconstruct what things mean because the stimuli he/she encounters are not logically sufficient to convey the message. Secondly, research shows that active engagement in teaching and learning may lead to better understanding, conceptual change and subsequent retention and utilization of knowledge (Brooks and Brooks, 1993; Fosnot, 1996). Therefore, a better way of teaching and learning physics is to adopt a radical approach that will enhance students' understanding and eliminate passive approaches to learning across the schools. (Gardener, 1991).

Recommendations

Previous research has shown that it is difficult for students to change their initial ideas in physics. Similarly, the findings of this indicate that some students still held tenaciously to their naïve ideas.

In view of the above findings, it is recommended that:

- Teachers should plan their lessons by taking students' prior knowledge into consideration and try to find out and remove students' misconceptions and learning difficulties.
- Teachers need to follow developments and innovations in education and technology, and implement contemporary instructional approaches in their classrooms
- Teachers should be informed of constructivist theory and its applications in practice through in-service training and workshops.

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References

Abraham, M.R. (1997). The learning cycle Approach to science instruction; Research Matters to the science Teachers no 970 website:http://www.edu.sfu.ca/narsite/publications. Retrieved April, 2012.

Action Learning Practice for School (ALPS) (2004). *What is Understanding?* Website: http://www.learnweb.larred.edu/ALPs/IFU/infro. Retrieved April, 2010.

Barry, J. and Graham, T. (1992). Sixth form students' intuitive understanding or mechanics concepts: Part 2. *Teaching Mathematics and its applications,11*(3), 106 – 111.

Broddy, N. Watson, K, and Aubusson, P.J. (2003). A trail of Five Es: model for constructivist teaching and learning. *Research in Science Education 3*(3) 1 – 16.

Chen, C (2003). A Constructivist Approach to Teaching: Implication in Teaching computer Network. *Information Technology, learning and Performance Journal 21*(2), 17-27.

Driver, R., Asoko, H., Leach, J., Mortimer, E., & Scott, P. (1994). Constructing scientific knowledge in the classroom. *Educational research, 23*(7), 5 – 12.

Eylon, B.S. & Ganiel, S. (1990). Macro-micro relationship: The missing link between electrostatics and electrodynamics in students reasoning.*International Journal of science education* 12(1), 79 – 94.

Fosnot, C.T. (1996). Constructivist: A psychological theory of learning. In C.T. Fosnot (Ed.), *Constructivism: Theory, perspective and Practice.* New York. Teacher College Press.

Gardner, H. (1991). *The unschooled mind: How children think and how school should teach.* New York: Basic Books.

Gill Perez D and Carrascosa, J. (1990). What to do about Science "Misconceptions". *Science Education 74*(5), 531 – 540.

Glynn, S.M., Yeany, R.H., & Britton, B.K. (1991). A constructive view of learning science. In S.M. Glynn, R.H. Yeany, & B.K. Brittons (Eds.), *The psychology of learning science.* Hilldane, New Jersey: Lawrence Erlbaum Associates.

Hanuscin, D.L. and Lee, M.H. (2007). Using Learning Cycle Approach to Teaching and Learning to Prospective Elementary Teachers. Website:http://www.missimri.edu/zhanuscin/aste. Retrieved April, 2010

Heller, P.M and Finley, F. N. (1992). Variable Uses of Alternative Conceptions: A Case Study of Current Electricity. *Journal of Research in Science Teaching, 29*(3), 259-275.

Lawson, A.E. (2001). Using the learning cycle to teach Biology concepts and reasoning patterns. *Journal of Biological Education 35*(4), 165-168.

Lawson, A.E. Alkhoury, S, Bedford, R. & Falconer, K.A. (2000). What kinds of scientific concepts exist? Concept construction and intellectual development in college biology. *Journal of Research in Science Teaching*, *37*, 996-1018.

Madu, B.C. (2004). Effect of constructivist-based instructional approach on students' conceptual change and retention in current electricity. *Unpublished Ph.D thesis,* University of Nigeria, Nsukka.

McDermott and Shaffer, P.S. (1992). Research as a guide for curriculum development: An example from introductory electricity Part 1. Investigation of students' understanding. *American Journal of Physics, 60*(11), 994.

Narli, S. (2011). Is Constructivist Learning Environment Really Effective on Learning and long term Knowledge Retention in mathematics. *Journal of Educational Research and Reviews, 6*(1), 36-49.

Oludipe, B., & Oludipe, I.D. (2010). Effect of constructivist based teaching strategy on academic performance of students in integrated science at the junior secondary schools level. *Educational Research and Review, 5*(7), 347-353.

Perkins, D. (1999). *The many faces Educational leadership*, *57*(3), 6 – 11.

Richardson, V. (1997). *Constructivist Teaching and teacher education; Theory and practice.* In V. Richardson (Ed.), Constructivist teacher education building a world of new understandings (Pp 3 -19). Washington D.C.: Falmer press.

Semb, G.B., & Ellis, J.A. (1994). Knowledge taught in schools: What is remember? *Educational Research, 64,* 253 – 286.

Slavin, R.E. (1994). *Educational psychology: theory and practice* (4th ed). U.S.A: Allyn and Bacon.

Staver, J.R. & Stronger, M.S. (2000). Teaching Elementary teachers how to use learning cycle for guided inquiry instruction in science website:http://www.biosined/nit.org/partialfile. Retrieved April, 2010.

Stofflet, R.T. & Staddart, T. (1994). The ability to understand and conceptual change pedagogy as a function of prior content learning experience. *Journal of Research in Science Teaching, 31,* 31-51.

West African Examination Council (WAEC). (2011). *Chief Examiners' Report in Physics*.