USING WEB-BASED COMPUTER DRILL AND PRACTICE TO SIMPLIFY DIFFICULT CONCEPTS IN PHYSICS FOR SENIOR SECONDARY SCHOOL STUDENTS

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Abstract
Momentum and kinetic energy have been identified as two confusable concepts in secondary school Physics. Students' difficulty in understanding these concepts was investigated. This study adopted a pre-test-post-test, control group quasi experimental design. A purposive sampling technique was used to select schools that have computers. 98 Physics students of intact classes were selected from two government owned secondary schools in Owerri Municipal. Students were randomly assigned to treatment group of Web–based computer drill and practice (WCDP) and conventional teaching method (CTM). The treatment lasted for six weeks. The instrument used were; kinetic energy and momentum objective test (KEMOT= 0.75); web-based computer drill software (WCDP=0.72). Two research questions were answered. Three null hypotheses were tested at 0.05 level of significance. Data were analysed using ANCOVA. There was a significant main effect of treatment on students' achievement $F_{(1,93)} = 149.349$, $P < .05$). Partial eta square ($\eta^2 = .616$) which implies that treatments accounted for 61.6% variance observed in students' achievement using WCDP method. WCDP group performed better (x = 56.38, S.D = 13. 62) than the CTM group (x = 24.61, S.D = 10.39). Interaction effect of treatment and gender $F_{(1,93)} = .706$, $P > .0$). is not significant.
Keywords: web-based computer- drill, web-based computer practice, difficult concept in senior secondary school physics

Introduction
E-learning is one of the greatest breakthroughs in education. Every classroom instructor or teacher must harness this mode of instruction for effective teaching and learning in order to remain relevant in today's world and in the contemporary society. Science teaching and learning generally is not an easy task for any teacher or students, especially with the abstract nature of Physics where the teacher have to contend with abstract terms like waves, velocity, energy and many others. Many concepts in Physics are abstract in nature, and hence perceived to be difficult. (Chandralekha, 2004). Research shows that performance in Physics at senior school certificate examination level over the years has persistently decreased. (WAEC/NECO 2012 – 2018)

Investigations in relation to difficulty in learning physics are areas that demands attention. This is because the learner is always faced with many challenges, including cognitive disequilibrium which the teachers or instructors may not be aware of. Physics education review showed that students bring common sense understanding of the world around them in their study of Physics. It further asserts that common sense reasoning plays important role on how students understand physics (Ates & Cataloglu, 2007).

'Teachers should know that every learner brings to the classroom a level of already formed alternative conception." (Chukwunenye, Adegoke & Ihekwaba, 2019, p 2340). Cataloglu et al, 2013 contended that

this alternative conception is a system of belief known as naïve impetus theory or model. Also, that this theory or model has been deep seated in the thought process of the learner as a result of the learner's interaction with the environment. Research has shown that this thought process, referred to as an alternative model according to Kola et al (2017), is very difficult to dislodge. One of the major factors that militates against instructional process is the inability of the teacher to recognize the presence of alternate conception in their various degrees amongst learners. This alternate conception from the learners' environment is already deep-seated and it impedes learning (Chukwunenye et al, 2019). When teachers become aware of these alternate conceptions, it becomes a starting point in an instructional process and could be addressed more specifically. It could become an essential part of formative evaluation; from diagnostic point of view, it could also serve as feedback which assists the teacher to channel their instruction to the need of the individual students as the teacher identifies and tackles these misconceptions (Chandra, Chandra, & Nutchey, 2014).
One of the strategies that needed to be harnessed by Physics teachers over the years and has been found to be effective in teaching Physics is computer drill and practice. This is a self–paced instructional strategy developed using computer information technology and application. According to Mudasiru & Adedeji, 2010, in this type of drill, a learner is presented with a set of questions, one at a time, the learner respond by typing in an answer, and the programme in return provides positive or negative feedback. The programme of drill and practice varies in the kind of feedback it provides; and it responds to students' pattern of thinking which is displayed in their response (Chandralekha, 2004). The more sophisticated form of drill and practice is the branching drill. In the branching drill, the software moves the learner to advance questions after the learner answers the initial question correctly at a predetermined mastery level. This programme is also capable of sending the learner back to lower level of the concept when the answer provided is wrong. Some are programmed to automatically review questions before going to the next level. This facility makes drill and practice sequential. The uniqueness in drill and practice is its repetitiveness. It helps the learner to carry out training activities on what had been learned so that knowledge could be memorized and internalized. Since the study of Physics involves development of critical reasoning ability through the training of analytical skill of learners; drill and practice is therefore a skill training model that could be used to teach Physics in order to elicit critical thinking and analytical skills of learners, while the learner carries out repetitively some already learnt activities in a teaching and learning process.

The drill and practice model adapted for this study is web-based interactive tutorial model. The web-based drill is a tutorial model developed by Chandralekha Singh, a professor in the department of Physics and Astronomy at the University of Pittsburgh in the United States of America. This model is a combination of problem-solving method of teaching and tutorial method of teaching which was developed into online instructional strategy with teaching materials which are self-paced study tools. The model uses the "Physics Classroom" as one of the online teaching tools. It is this problem solving strategy that has been modified into drill and practice by the researcher by introducing repetition until mastery is attained. This model enables the students to carry out cognitive activities such as studying concepts, worked examples and calculations. These activities are usually sequential with immediate feedback on its correctness, and opportunity to repeat the steps until the learner demonstrates understanding of the concept in focus. It is self-paced training programmed to meet the individual need of the learner. It involves teaching Physics, not only as application, but also ensuring the understanding of the principle first; because it is when the learner is grounded in the basic principle that the application will naturally follow. In recent times, it is no longer easy to classify software package by the type of teaching function it performs. This is because computer packages and software available in recent times has defiled easy classification because each could sometimes perform more than one function. For instance, a straight drill application could equally function as problem-solving applications or games. However, in every computer package a particular mode will definitely be predominant (Mudasiru et al, 2010).

Research has shown that learners encounter conceptual difficulties on momentum and kinetic energy during classroom instruction (Bryce et al, 2009). Also, that confusion arises between these difficult and somewhat overlapping concepts of momentum and kinetic energy (Bryce et al, 2015). Chandra et al (2012) clearly state that the concepts of momentum and kinetic energy overlap, making it difficult to understand this concept or carry out mathematical operations related to the concept as far as the learners are concerned. Hence learners perform poorly in questions that require qualitative responses in this regard (Bryce et al, 2005).

Bryce et al, (2009) contend that it is easier for learners to understand that there is a direct relationship between the mass and velocity of a moving object and the damage it can cause when it collides with another object. This implies that the higher the momentum, the greater the impact; however, when you consider the distinction between the momentum and kinetic energy as properties of "mass in motion", it becomes difficult to comprehend. This concept, according to researchers, is usually misconstrued by learners as they are usually interchangeable by most learners when such body is in motion. In order to have a good grasp of the concepts of momentum and kinetic energy, the learner must have to understand a number of inter-connected, complex ideas, which could be confusable or difficult to distinguish. The difference between kinetic energy and momentum is difficult to distinguish for object in constant velocity. However, the difference becomes clearer when the motion of this same object is changed by an applied force. Clearly, Chukwunenye et al (2019) asserted that many Physics textbooks have failed to bring these complex and interconnected ideas into focus. It is therefore very important to investigate if the web-based computer drill and practice could be used to improve the learning of difficult and confusable concepts in Physics.

Statement of Problem

Research had shown that kinetic energy and momentum are topics in Physics that are considered difficult, overlapping and boring to many students. This is because learners lack basic skills required to tackle problems on concepts of kinetic energy as well as momentum. This has made a lot of secondary school students to view these concepts as difficult ones to the extent that most learners find it difficult to differentiate between the concepts of momentum and kinetic energy when the need arises. This made these concept to be identified by many researchers as one of the difficult and confusable concept in Physics. Drill and practice involves a self-paced, repetitive sequential approach. It is a skill training model that elicits the use of both critical thinking and analytical skill of the learner, and at the same time helps the learner to memorize and internalize facts and information in the course of carrying out learning activities repetitively. Also, learning the concepts of momentum and kinetic energy involves a sequential cognitive process which would first require proper articulation of thoughts or thinking process. Could the web-based drill and practice be used to improve students' achievement and understanding of momentum and kinetic energy concepts?

Research Questions

Answers were provided for the following research questions in the cause of the study,

i. What is the mean achievement scores of students taught kinetic energy and momentum using web-based computer drill and practice and those taught the same concept using conventional teaching method?
ii. In which of the concepts did the students perform best?

Hypotheses

These following hypotheses guided the study at 0.05 level of significance:

i. There is no significant main effect of treatment on students' achievement in Physics
ii. There is no significant main effect of gender on students' achievement in Physics
iii. There is no significant interaction effect of treatment and gender on students' achievement in Physics

Methodology

A pretest, post-test, control group, quasi-experimental design was adapted for the study. Web-based computer drill and practice (WCDP) was the experimental group (48) and the conventional teaching method (CTM) was the control group (50). A total of 98 physics students from two secondary schools in Owerri Municipal in Imo State, Nigeria were purposively sampled for the study. WCDP group = 48 and CTM group = 50. A total of 98 students of intact classes of SSS II from the two secondary schools were selected. The participants were randomly assigned to treatment groups. Treatment lasted for six contact sessions of a minimum of one hour each. The instrument used were: (i) Kinetic Energy and Momentum Test (KEMT) (r = 0.75), (ii) Web-based computer drill (WCDP) (r = 0.72). The data was analyzed using t-test at 0.05 level of significance. Mean scores were also used to determine if there were any mean gain.

Administration of Instrument

The experimental group and the control group were exposed to treatment using web-based computer drill and practice for the experimental group and the conventional method of classroom teaching for the control group. The duration was six weeks.

Results

The descriptive statistics (mean and standard deviation) on achievement was presented in table 1.1

Table 1.1: Descriptive Statistics (mean and standard deviation) on Achievement

Gender	Method	Mean	Std. Dev.	N
Male	Treatment	54.20	12.390	25
	Control	23.52	10.991	27
	Total	38.27	19.324	52
Female	Treatment	58.86	14.795	22
	Control	25.83	9.743	24
	Total	41.63	20.711	46
Total	Treatment	56.38	13.622	47
	Control	24.61	10.385	51
	Total	39.85	19.954	98

Research Question One: What is the mean achievement score of students taught kinetic energy and momentum using web-based computer drill and practice and those taught using conventional teaching method?

From table 1.1, the mean achievement score for the treatment group is 56.38, with standard deviation of 13.62. Also the mean achievement score for the control group is 24.61, with standard deviation of 10.38.

Research Question Two: In which of the concepts did the students perform best?

Table 2.1: Descriptive (mean and standard deviation) Statistics on Achievement by Concept

S/N	CONCEPTS	N	Mean	Std. Dev.
1	Force choice question (A)	48	19.15	4.582
2	Straight forward computational problems (B)	48	13.72	6.031
3	Work-energy, bar charts, analysis and conceptual reasoning (C)	48	12.98	6.312
4	Description of physical situation (Using impulse momentum change theorem to analyze and predict impact of collision) (D)	48	10.64	7.417
	Total	188	14.12	6.872

From table 2.1, it was observed that students performed best in force choice questions (Group A) with the mean score of 19.15 followed by straight forward computational problems (Group B) with the mean score of 13.72. The mean achievement score for questions on work – energy, bar charts, analysis and conceptual reasoning (Group C) was third with mean score of 12.98. While the mean score of 10.64 in questions involving description of physical situation using impulse and momentum change theorem to analyze and predict impact of collision (Group D) was fourth

Hypothesis One: There is no significant main effect of treatment on students' achievement in Physics

Table 3.1: Summary of Analysis of Covariance (ANCOVA) of Students' Achievement in Physics by Treatment and Gender

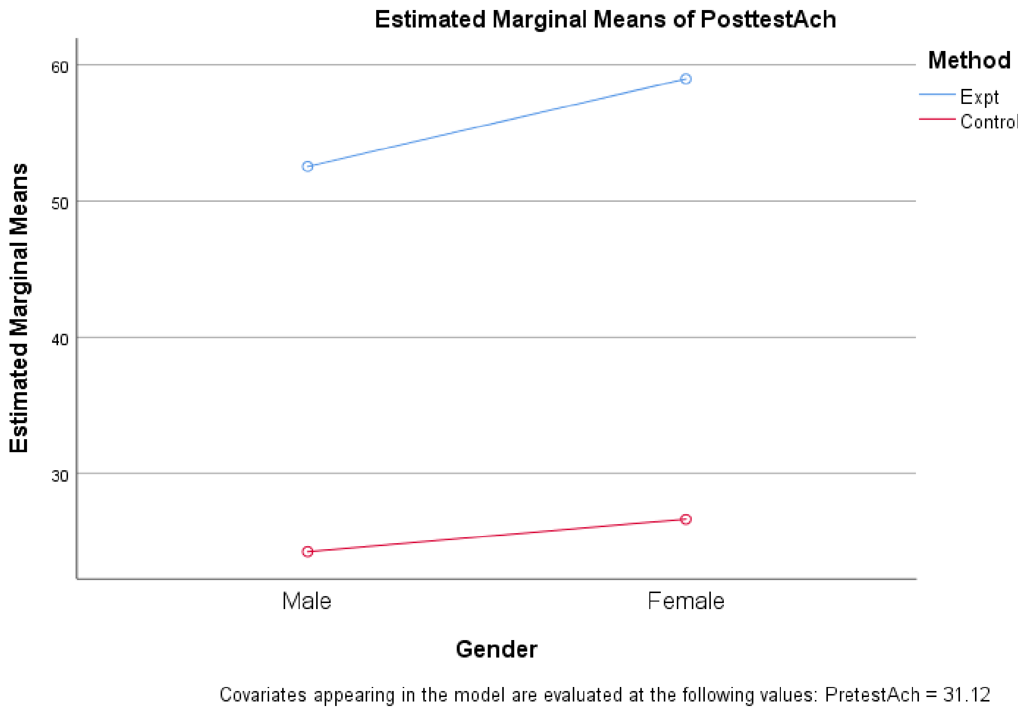
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	25718.266a	4	6429.567	46.337	.000	.666
Intercept	9897.580	1	9897.580	71.330	.000	.434
Pretest-Ach	700.227	1	700.227	5.046	.027	.051
Gender	458.614	1	458.614	3.305	.072	.034
Treatment	20723.222	1	20723.222	149.349	.000	.616
Gender *Treatment	98.006	1	98.006	.706	.403	.008
Error	12904.438	93	138.757			
Total	194225.000	98				
Corrected Total	38622.704	97				

a. R Squared = .666 (Adjusted R Squared = .652)

Table 3.1 shows the summary of analysis of covariance (ANCOVA) of students' post achievement test score in Physics. The result revealed that there is a significance main effect of treatment on students' achievement in Physics $F_{(1,93)} = 149.349$, $P < .05$). Partial eta square ($\eta^2 = .616$). The implication of this is that the treatment accounted for 61.6% of variance observed in students' achievement in Physics.

Hypotheses Two: There is no significant main effect of gender on students' achievement in Physics Table 3.1 above also shows that there is no main significant effect of gender on achievement in Physics $F_{(1,93)} = 3.305$, $P > .05$).

Hypotheses Three: There is no significant interaction effect of treatment and gender on students' achievement in Physics. Table 3:1 also shows that there is no significant interaction effect between gender and treatment used $F_{(1,93)} = 0.706$, $P > 0.05$).



Findings

Finding reveals that for conceptual understanding, the WCDP is best as could be seen from their mean score of 56.38 for treatment group compared to 24.61 for control group. This implies that web-based computer drill and practice made more significant impact in learning physics than the conventional method. The repetitiveness is an advantage to the learner and is based on concept building. This implies that the learner will not move to the next level until the present level is understood. Furthermore, the learner could be redirected to the previous level when significant learning did not occur.

The study also showed that the treatment group has a mean score of 56.38 and standard deviation of 14.80 while the control group has a mean score of 24.61 and a standard deviation of 9.74. It was observed that students performed best in force choice question (Group A) with mean score of 19.15 followed by straight forward computational problem (Group B) with mean score of 13.72. Questions on work-energy, bar charts, analysis and conceptual reasoning (Group C) follow thirdly with mean score of 12.98. The fourth was questions involving description of physical situation using impulse and momentum change theorem (Group D) with the mean score of 10.64. This implies that web – based computer drill and practice is very good, especially in teaching difficult concepts in Physics

Online web-based classroom instructional software referred to as "Physics classroom" which was used as teaching tool in this study is a comprehensive package provided by a group of university educators in Pittburgh based in America in 2014. It is made up of questions that are concept builders required by the learner to build up conceptual understanding on the chosen topic. Repeating every step using problem solving model as proposed by Singh 2008 until understanding is attained is the aspect that modified into drilling. The questioning module which is equally a concept builder presented the learner with carefully grafted questions which target various aspects of the concept the researcher have in focus. The outcomes elicited are also targeted from variety of angles using multiple difficulty levels or varying concept to build up knowledge. The concepts in focus for this research are;

Group A – force choice questions

Group B – Straight forward computational problems

Group C – Work, energy, bar charts, analysis and conceptual reasoning
Group D – Description of physical situation

i. Understanding laws of momentum and kinetic energy
ii. Use momentum analysis of collision and relating it to kinetic energy

All these were used to prepare multiple choice questions aimed at eliciting response on common difficulties faced by students. They are conceptual questions whose answers were provided from different contextual levels.

The mean score for the concepts builders were equally high, beginning from force choice question (Group A) with the mean score of 19.15. The least mean score for concepts involving physical situations using impulse and momentum change theorem (Group D), which is 10.64 is still good. This implies that WCDP is good for conceptual understanding.

On the interaction effects of treatment and gender on students' achievement in Physics, the result showed that there was no significant interaction effect of treatments and genders on students' achievement in Physics. This shows that if a level playing group is provided when using WCDP as teaching strategy, both gender benefit optimally.

Conclusion

Web-based interactive drill and practice is a very good strategy to challenge analytical and critical reasoning amongst learners, especially for very difficult or confusable concepts in Physics, irrespective of the concept in focus in the learning environment.

Recommendation

i. There is the need to develop a comprehensive online self-paced repetitive model as well as instructional tools that should be able to utilize the thought pattern of the learner to bring about conceptual change or confront misconceptions.
ii. Classroom teachers need to discover the entry points to effective teaching.
iii. There is the need to develop scientific and exploratory skills of the learner through analytical and critical thinking by using web-based drill and practice.
iv. There is also the need to develop localized online textual materials, tools and three-dimensional learning environments that will meet the challenge of today's learner.

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