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The effectiveness of advance organiser model on students' academic achievement in learning work and energy

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ABSTRACT

The purpose of this study was to investigate the effectiveness of the advance organiser model (AOM) on students' academic achievement in learning work and energy. The design of the study was quasi-experimental pretest–posttest nonequivalent control groups. The total population of the study was 139 students of three sections in Endabaguna preparatory school in Tigray Region, Ethiopia. Two sections with equivalent means on the pretest were taken to participate in the study purposely and one section assigned as the experimental group and the other section assigned as the control group randomly. The experimental group was taught using the lesson plan based on the AOM, and the control group was taught using the lesson plan based on the conventional teaching method. Pretest and posttest were administered before and after the treatment, respectively. Independent sample *t*-test was used to analyse the data at the probability level of 0.05. The findings of the study showed that the AOM was more effective than the conventional teaching method with effect size of 0.49. This model was also effective to teach male and female students and objectives namely understanding and application. However, both methods were equally important to teach work and energy under the objective knowledge level.

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Advance organiser model; quasi-experimental; learning outcome; physics education

Introduction

Education is a process in which teacher, student, and curriculum are the three factors that can make teaching and learning meaningful (Eggen & Kauchak, 2011). Teaching is a process which is planned and organised by the teacher for the purpose of better learning of students by selecting appropriate teaching method that fits the contents of the lesson (Ahmed, 2004). Science and Technology has great contribution for the development of the country. Thereby, Best and James (2003) argued that improving science teaching and learning is a national priority in the educational system of the country. Since science contains many abstract concepts, students may learn them in different ways so that science teacher should use an appropriate method of teaching for effective teaching to take place (Driver, Asoko, Leach, Scott, & Mortimer, 1994). As result, according to

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Linn and Eylon (2006), science education emerged to solve this particular problem which focuses on studies, how to teach science? Why to teach science? Whom to teach science? Obviously, the main function of science education at secondary and senior secondary school levels is to make the students able to acquire scientific knowledge, skills, and thinking ability in a systematic way, which could further enable them to use that knowledge in their lives for making maximum benefits from the science and scientific advancements.

The essence of science in general is the observation and exploration of the world around us with a view to identifying some underlying order or pattern in what we find. And physics is that part of science which deals primarily with the inanimate world (Whitehead, 2011), and which furthermore is concerned with trying to identify the most fundamental principles. Physics has many abstract concepts which students cannot understand easily. Hence, teachers use suitable teaching approach that fits the learner. Shulman (1986) argued that teachers' ability to understand and use subject matter knowledge affects student academic achievement. Moreover, Hill, Rowan, and Ball (2005) claimed that teachers' mathematics achievement significantly related to students' academic achievement.

Over the last decades, physics education has emerged as a growing subfield of physics. Physics education research aims to develop and utilise theories and techniques that characterise, influence, and measure the learning of physics by students. These theories, concepts, and techniques are better understood when lectures are accompanied with demonstration, hands-on experiments through self-discovery, and questions that require students to ponder what will happen in an experiment and why. Usually, teachers do not directly use the knowledge created by the researcher, but, rather, an intermediate knowledge which has already been reformulated (Solomon, 1985).The purpose of physics teaching in secondary school is to enable students to grasp systematically the basic knowledge of physics needed for further study of modern science and technology and to understand its applications. Physics teaching–learning process provides more possibilities of involving children in activities liked by the students (Linn & Eylon, 2006).

Model of teaching is an exciting and rapidly developing field that holds much promise both as scientific enterprise and means of improving cognitive abilities of the learners. Models of teaching are designed to shape and implement these strategies to help learners develop their capacity to think clearly and wisely and build social skills and commitment (Githua & Angela, 2008). Models of teaching support their teaching in the creation of proper environment, and various components of teaching are interrelated. According to Joyce and Weil (2004), a teaching model can be considered as a type of blueprint for teaching and it provides structure and direction for teaching.

Advance organiser model (AOM) is an appropriate instructional strategy for teaching science concepts that are used before direct instruction, or before a new topic; this is sometimes called a hook, set induction, or anticipatory set (Curzon, 1990). According to Willerman and Harg (1991), advance organisers help teachers to organise and convey large amounts of information as meaningfully and efficiently as possible. This model is designed to strengthen students' cognitive structures and is taken from verbal learning principle, in which the main aim is to give the most possible to students. AOM provides support for effective teaching and learning process and is presented prior to providing a new concept. In this way, AOM provides a framework to enable students to learn new ideas or information by meaningfully linking these ideas to the existing knowledge. The ultimate end of this model is deep understanding and meaningful learning. Githua and Angela (2008) argued that any subject is a chain of concepts, and when we accept these concepts they are also settled as a chain in our mind; if a new concept is presented, it is related with the old one. In this model, a teacher first recalls the previous knowledge, and then gives the new knowledge on the basis of previous one. Moreover, this model is beneficial to encourage students to directly participate in their learning and to be self-reflective throughout the lesson.

In this study, the topic work and energy is selected because it is one of the most important topics in physics. However, most students have difficulties in understanding work and energy from the point of view of physics and their daily life activities. Warren (1982) insists that energy is an abstract mathematical concept, and argues that teaching must start from its scientific definition or else all that is taught is confused and largely meaningless. Moreover, Warren (1991) claimed that energy is the name of an important bit of mathematics that you will learn about if you ever study science or engineering at an advanced level. According to the researchers' teaching experiences, most of the teachers at Endabaguna preparatory school used only conventional teaching method such as lecture and demonstration, in which the students are passive receivers and teachers are sources of knowledge. As a result, all students, in general, and female students, in particular, in that school complain that physics is difficult and physics classrooms are boring, which lead them to poor academic performance. This may be attributed to the fact that, as Wachanga (2002) has argued, teachers treat boys and girls differently and in ways that often are not beneficial to girls' motivation and achievement. This poor student achievement has prompted educational researchers worldwide to continuously identify factors that can account for academic outcomes in the classroom (Goldring & Osborne, 1994).

Different researchers in Ethiopia claim that academic achievements are affected by different factors. For instance, Fekadu (2008) argued that students' achievement in physics is affected by a variety of schools, need of students, preparation of curriculum, skill of teacher in class room situation, teaching methods, and administration. Ahmed (2004) also argued that active teaching methods had an influence on students' academic achievement. Furthermore, Aklilu (2010) argued that teaching physics through computer simulation enhances students' academic achievement. Among these, the teaching method has to be given priority due to its frequent impact and direct consequence upon the learners' achievements. In our school, there is no culture of doing research on physics pedagogical methods. Therefore, there is need for teachers to use teaching methods or strategy that can enhance students' academic achievement in Physics in secondary and senior secondary schools. In addition, other studies (Kowshik, 2015; Owoeye & Olatunji, 2016) have shown that Advance Organiser teaching strategy significantly influenced students' academic performance in Biology in secondary and senior secondary schools.

The results of the studies regarding the effectiveness of teaching models vary from situation to situation; that is, in most research findings, AOM is effective but it is ineffective in some findings. Recent outdoor studies have been conducted to evaluate the different dimensions of the AOM. Two investigators, namely Shihusa and Keraro (2009), conducted the effect of AOM on students' motivation in learning biology and they found that students taught using advance organisers had a higher level of motivation than those taught using conventional teaching methods (CTM). The effect of advance organiser strategy during instruction on secondary school students' mathematics achievement was studied by Githua and Angela (2008) and they found that students who were taught by the AOM were superior to the students who were taught by the traditional teaching method. Weil and Murphy (1982) asserted that use of an advance organiser is a highly effective instructional strategy for all subject areas, where the objective is to achieve meaningful assimilation of concepts. However, no attempt has been made in Ethiopia, in general, and in our school, in particular, so far, to analyse the effectiveness of AOM on students' academic achievement in learning physics, in general, and work and energy, in particular. The researchers' experience and awareness regarding the methodology of teaching exists in the present school system convinced them that there is a felt need to change the method of physics instruction. Any meaningful attempt to evolve a new strategy of teaching will be a great help and remedy to the present repetitive system of instruction (Lee & Liu, 2010). Obviously, there are various types of teaching methods in the educational system. Each of the methods is used under a suitable situation. Although there is no best method of teaching/learning (Carin, 1997) in the education system, there is a choice of one method over the other due to nature of the learner, nature of the content, and the desired outcomes. As far as comparing the effectiveness of methods is concerned, some educators advocate the self-centered indirect instructions of constructivist approaches such as the guided discovery method (Akinbobola & Afolabi, 2010).

Conceptual framework

Models of teaching

Models of teaching are like plans, patterns, or blueprints, which present the steps necessary to bring about a desired outcome (Joyce & Weil, 2004). Models create the necessary environment, which facilitates the teaching–learning process. It consists of guidelines for designing educational activities and environments. It is designed to achieve a particular set of objectives. There are many powerful models of teaching designed to bring about particular kinds of learning and to help students to learn more effectively. According to Joyce, Weil, and Calhoun (1986), teaching models are prescriptive teaching strategies designed to accomplish particular teaching goals. There are many models of teaching that are built around the mental process as ranging from systems for teaching general problem-solving ability to procedure for teaching process. According to Joyce and Weil (2004), the components of a teaching model are Syntax, Social system, Principles of reaction, Support system and Instructional and nurturing effects. Model of teaching has many purposes. Functions of models of teaching are designing curriculum or course of study, development, and selection of instructional materials and guiding teacher's activities (Eggen & Kauchak, 2011). There are many models of teaching that are built around the mental process as ranging from systems for teaching general problem-solving ability to procedures for teaching process. Joyce and Weil (2004) developed more than 20 models of teaching, which are grouped on the basis of their chief emphasis. They organised these models into the following four basic families: (1) Information processing models, (2) Personal models, (3) Social interaction models, and (4) Behaviour modification models.

Advance organiser model

An AOM is the member of information processing family. This model is a kind of cognitive bridge, which teachers use to help learners make a link between what they know and what are to be learnt (Novak & Gowin, 1984). Githua and Angela (2008) argued that advance organisers can refer to a relatively short arrangement of material introduced to the learner before the lesson. It is designed to cue the relevant prior knowledge of a learner and it is usually presented at a higher level of abstraction, generality, and inclusiveness than that of the planned lesson (Curzon, 1990). Therefore, before beginning a lesson, teachers should ask questions, present a simple outline, or give students a few key words to help them focus on the major concepts (Willerman & Harg, 1991). Such strategies are called the advance organisers. Shihusa and Keraro (2009) argued that as long as advance organisers do their job of introducing new learning concepts and linking or developing new schema to relate the material, they can take many shapes, including a simple oral introduction by the teacher, student discussion, outlines, advance organisers timelines, charts, diagrams, and concept maps.

According to Joyce and Weil (2004), there are two categories of advance organisers: expository and comparative. Expository organisers function to provide the learner a conceptual framework for unfamiliar material, and comparative organisers are used when the knowledge to be acquired is relatively familiar to the learner. Willerman and Harg (1991) classified the components of AOM into five categories. These are: Syntax, Social system, Principles of reaction, Support system and Instructional and Nurtural effects. According to Joyce, Weil, and Calhoun (1986), teachers offer a three phase of AOM of teaching that includes 'the presentation of the advance organiser, the presentation of the learning task or material, and the strengthening of cognitive organization' (p. 255). The three phases and their corresponding activities of this model have been presented as follows.

(1) Presentation of the advance organiser – In this phase, the teacher goes over the goals of the lesson and gets students ready to learn, introduces the topic, connects to previous learning, and refers to materials needed. Moreover, teacher presents the advance organiser, making sure that it provides a framework for later learning the content and is connected to student's prior knowledge. The types of organisers can be charts, photos, films, graphics, concept maps, and handouts and the teacher explains what the organiser is, but give detailed content in the next Phase.
(2) Presentations of the learning task or material – In this phase, the teacher presents learning concepts and content, paying special attention to the logical ordering and meaningfulness to students and explain the content using the advance organiser as a framework connection. Students were required to explain the message presented by the advance organiser presented to the students. During the instructional process, students were actively engaged in a discussion in an effort to interpret the advance organiser.
(3) Strengthening of cognitive organisation – In this phase, the teacher asks questions and elicits student responses to the presentation to extend student thinking and encourage precise critical thinking either in large group, small group or individual activity.

Application of AOM

This model is especially useful to structure extended curriculum sequences or courses and to guide students systematically in the key ideas. Following are the main application of this model:

(1) Abstract subjects which cannot be seen or presented can be easily taught by this model.
(2) Cognitive aims can be achieved by this model. Selection, organisation, presentation, and expression can be achieved.
(3) The concept of socialisation can be drawn in the study of socialisation patterns in different cultures. This advance organiser thus aids in expanding students' knowledge about cultures.
(4) It can also be shaped to teach the skill of effective reception learning. Critical thinking and cognitive reorganisation can be explained to the learners, who receive direct instruction in orderly thinking and in the notion of knowledge hierarchies.
(5) This model is considered good and used widely in school. When the teacher presents the subject in an organised way, students get all matter in systematic order. In less time, more knowledge can be given.
(6) The instructional effect of this model is that the ability to learn from reading, lectures, and other media is used. Presentation is another effect, as an interest in inquiry and precise habits of thing.

Conventional teaching method

This is a highly structured and teacher-directed approach. The major goal of direct instruction is maximisation of student learning time. In the conventional (traditional) teaching method, the teacher is the authority and the students are passive learners (Novak & Gowin, 1984). This type of structure has an elitist approach towards students. While some students are able to perform and solve complex problems in physics, they fail to apply basic knowledge in novel situations (Driver et al., 1994). The conventional teaching method is reminiscent of the popular perception of school. Students are instructed by the teacher to study the textbook. The teacher provides information to the students, including concepts, facts, terms, and diagrams (Aluko, 2008). Class periods are lecture based and involve note taking, usually through the use of a chalk board or white board. In this teaching style, it is expected that students will answer questions generated by their teachers. Furthermore, Carin (1997) emphasised 'no best method to guide learning in all situations'. A method not only differs from the other by its elements and procedures but also in the ratio of teacher dominance to amount of student participation.

Concept of work and energy

Research concerning energy teaching focused mainly on the importance given to the conservation principle when compared with other aspects of the energy concept, in particular energy degradation (Driver et al., 1994). For physicists, conservation, which implies that energy is a quantifiable concept, is the basic characteristic of energy (Solomon, 1985). Researchers have presented ways of characterising the different approaches to teaching about energy. Work and energy are already part of students' everyday language and experience (Lijnse, 2004), the development of energy understanding in the direction of energy conservation is challenging (Driver, 1985).

The development of energy understanding involves understanding many aspects of energy such as energy source, transfer, transformation, and conservation. To be scientifically complete and sophisticated, understanding should be based on energy as a conserved quantity. Students' overall understanding can progress toward energy conservation by identifying energy sources in a system and connecting various forms of energy and energy transfer processes to changes occurring in the system. In addition, students should be able to recognise and use energy concepts across mechanical, thermodynamic, biological, chemical, and technological applications (Lee & Liu, 2010). Findings indicated that when students asked to generate their own ideas, they often consider energy as human-related, depository, activity-related, or as an ingredient, product, function, or fluid-like substance (Reinertsen, 2013).

Purpose of the study

This study was designed to investigate the effectiveness of AOM on students' academic achievement in learning work and energy, in Endabaguna preparatory school. The study was designed to achieve the following specific objectives:

(1) To compare the effectiveness of AOM with the CTM on students' academic achievement in learning work and energy.
(2) To compare the effectiveness of AOM with the CTM under the category of objectives: knowledge, understanding, and application.
(3) To compare the effectiveness of AOM in teaching male and female students.

Research hypotheses

The following alternative hypotheses were formulated and tested at 0.05 level of significance.

(1) There is a significance difference between the means of the posttest of the experimental and control groups.
(2) There is a significance difference between the means of the posttest of experimental and control groups under category of objectives: knowledge, understanding, and application.
(3) There is a significant effect of gender (male and female) on students' physics academic achievement after being taught work and energy with AOM.

Methodology

Research design

The design of the study was quasi-experimental: pretest–posttest nonequivalent groups. Best and James (2003) suggested that quasi-experimental designs are used when randomisation is impossible. In quasi-experimental designs, the participants are not randomly assigned to groups, and the experimental and control groups are not equivalent on variables that may affect the dependent variable (Best & James, 2003). According to Cohen, Manion, and Morrison (2007), one of the most commonly used quasi-experimental designs in educational research can be represented as:

Experimental O1 × O2

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Control O3 O4

The dashed line separating the parallel rows in the diagram of the nonequivalent control group indicates that the experimental and control groups have not been equated by randomisation. The researchers used the quasi-experimental (pretest and posttest nonequivalent groups) since in educational research there were many factors that hindered to perform true experimental design.

This study was conducted on total population of 139 (61 female and 78 males) grade-11 natural science students in Endabaguna preparatory school, which is found in Northern-West zone of Tigray, Ethiopia. Purposive and random sampling techniques were used to determine the sample size; that is, in that school there were three grade-11 natural science classes and all of them were given pretest from work and energy and the two classes with equivalent means were selected to participate in the study purposely. The researcher used the purposeful sampling technique to control previous students' academic achievement that may affect the posttest result of students. From the two selected classes with equivalent means, one class was assigned as an experimental group and the other assigned as control group randomly. That is, the experimental group received the pretest, the treatment X and the posttest and the control group received a pretest followed by the control condition and a posttest.

Instrumentation

Lesson plans

The lesson plan for the experimental group was prepared using the AOM. In this model, there are three phases of teaching: phase (1) – the presentation of the advance organizer, phase (2) – the presentation of the learning task or material, and phase (3) – the strengthening of cognitive organisation. Since the time for single period in that school was 40 minutes, it was very difficult to apply all the phases of these models in single period. Thus, the different phases of this model were selected by the researcher according to the contents of the topic and the grade levels of the students to facilitate the teaching–learning process in class room instructions. This lesson was prepared in such a way that those students actively participated with guidance of the teacher in the starter activity, main activity, and concluding activity of the lesson. The lesson for the control group was prepared using the conventional teaching method, which was commonly practised in that school. This lesson has four phases of teaching: (1) Introduction, (2) presentation, (3) stabilisation, and (4) evaluation. This type of lesson plan is practiced by the teachers in that school in which the teacher dominants, whereas the learners remain passive.

Achievement test (pretest and posttest) from work and energy

An achievement testing pretest was conducted to know the previous knowledge of students about work and energy and to take two classes with similar means to participate in the study and the posttest was also administered to investigate the effectiveness of AOM on students' academic achievement in learning work and energy. Each of the tests (pre and post) contained 20 multiple choice questions. One score was assigned for each correct answer. Items were prepared keeping in mind the objectives of learning and the content of the topics. Adequate directions were provided in the question paper and answer sheet was also provided at the last page of the questions. It should be noted that out of the 20 questions, five were knowledge level; seven were understanding level; and eight were an application level. The maximum marks for the test were 20, that is, one mark for one question. Table 1 presents the load given and the item for each of the three objectives in constructing the pretest and posttest.

Table 2 below depicts the number of questions and periods for the contents of the lesson under study (i.e. work and energy) for each of the three objectives (knowledge, understanding, and application) in both the pretest and posttest.

Statistical techniques employed

Since the research was quantitative, it has its own appropriate statistical data analysis tools (Best & James, 2003). The pretest and the posttest score of the experimental and the control groups were analysed using independent samples *t*-test and Levene's test using SPSS (v.20) Statistical Software and Excel. The hypotheses were analysed at $p = .05$ to see the statistical significance difference between the experimental and control groups.

To compute the item difficulty (*p* value) of the pretest and posttest, the following formula given by Abiy, Alemayehu, Daniel, Melese, and Yilma (2009) was used:

$$P = \left(\frac{A}{N}\right)100\%,$$

where A and N are the number of students who answered the item correctly and the total number of students who attempted, respectively.

To determine the quality of the items of the pretest and posttest, discrimination index (D) of the items was calculated using the following formula given by Ebel and Frisbie (1991):

$$D = \frac{A - B}{N/2},$$

Table 1. Load given to objectives of the pretest and posttest.

Objectives	No of questions	Mark	Percentage	Items	
				Pretest	Posttest
Knowledge	5	5	25	1,6,7,13,17	1,6,8,13,17
Understanding	7	7	35	2,3,8,9,10,12,20	2,3,5,7,9,10,12
Application	8	8	40	4,5,11,14,15,16,18,19	4,11,14,15,16,18,19,20
Total	20	20	100	20	20

Table 2. Blueprint (table of specifications).

Contents	No of periods	No questions for each objectives			
		Knowledge	Understanding	Application	Total
Work as a scalar product and work done by constant and variable forces	3	2	3	2	7
Kinetic energy, work energy theorem and Potential energy	5	2	1	3	6
Conservation of energy, conservative and dissipative forces	4	1	3	3	7
Total	12	5	7	8	20

where A, B, and N are the number of correct scores from the high scoring group, the number of correct scores from the low scoring group, and the total number of students in the two groups, respectively.

The reliability of the pretest and posttest were calculated using the Spearman–Brown formula:

$$\text{Reliability} = \frac{2r}{1+r},$$

where 'r' is the actual correlation between the halves of the instrument. That means 'r' is either a Spearman rank order correlation or a Pearson product moment correlation.

In calculating the effect size (ES; Eta squared) for independent samples in a t-test, the following formula is used:

$$\text{Effect size (ES)} = \frac{t^2}{t^2 + N_1 + N_2 - 2},$$

where t, N_1, and N_2 are the t-value calculated by SPSS, the number in the sample of group one, and the number in the sample of group two, respectively.

Moreover, taking the variances into consideration, Cohen's effect size (ES) can also be calculated using the following formula:

$$\text{ES} = \frac{M_1 - M_2}{\sqrt{(S_1^2 + S_2^2)/2}}$$

Validity and reliability of the instruments

The achievement tests for pretest and posttest include 20 multiple choice questions each from work and energy. Obviously, these questions and the lesson plans were checked by two physics teachers from Addis Ababa University and one teacher from Endabaguna preparatory school, using reviewing checklist to check the internal validity. In addition, the questions and the lesson plans were modified using the comments from the experts. Moreover, the questions were constructed with the help of Blue print to check the content validity and also the researcher take care the difficulty level of the two tests – that is, the pretest and posttest questions had the same content and difficulty level but different forms in the construction of the test since the score of the students in the pretest and posttest may vary due to difference in their difficulty than the difference in the treatment. In administering the tests, the teacher seriously controls the students in order not to cheat each other, as cheating decrease the validity of the tests. The researcher also returned the answer sheet to few students and the score were accepted by the students. Thus, the respondent validity was checked and also both type-I and type-II errors were minimised.

The internal consistency of the tests was checked by asking a similar question in different items of the tests and the reliability of the tests was checked by using the split half method – that is, 20 grade-11 students were selected randomly from a governmental school which was found on different area of the study as pilot test and the questions were administered to the 20 students and the students' marks were split into two halves and the researcher took care to make the two halves had an equivalent level of difficulty. First, the correlation of the two halves was calculated and it was found that the correlations of the pretest and posttest were 0.54 and 0.64, respectively. In addition, Cronbach-alpha reliabilities of the pretest and the posttest were 0.70 and 0.78, respectively, which were within the range of good reliability.

The item discrimination (*D*) of the 20 items of the pretest was between 0.33 and 0.66. Out of the 20 items, 7 of them were very good items and the remaining 13 were good items. In addition, the item discrimination of the 20 items of the posttest was also between 0.33 and 0.66. This means that 12 items were good items and 8 items were very good items. Generally, all the items were good and accepted. This means that no item was rejected. The item difficulty (*P*) of the 20 items of pretest was between 0.2 and 0.55 and that of the posttest was between 0.2 and 0.7, which were accepted. This means that the questions were neither easy nor difficult.

Pretest

The aim of the pretest was to know the previous students' academic achievement about work and energy and to select two sections with equivalent means to assign as experimental and control groups. The Achievement test (pretest) was administered at the same time to all of the three classes of grade-11 natural science students before they learnt work and energy and the test was administered and collected with the help of physics teachers in that school and also the researcher controlled any form of cheating among the students. This means that the pretest results of the three classes are given in Table 3. Thereby, Table 3 summarises the means of the pretest result of the three sections of grade-11 natural science students, which enables the researchers to take two sections with equivalent means.

As can be seen from Table 3, section B and C have equivalent means, whereas section A has a mean far from the means of the rest of two sections. Hence the two sections with equivalent means were selected to participate in this study purposively to minimise the effect of previous students' academic achievement. Thus, the two sections B and C were assigned randomly as control group and experimental group, respectively.

Table 3. Means of the pretest of the three sections.

Sections	*N*	Mean	Standard deviation
A	47	5.42	1.456
B	46	6.26	1.757
C	46	6.61	2.016

The experimental and control groups

Primarily, one grade-11 physics teacher was trained by the researcher for five days about AOM and how this model was applied in teaching physics. This teacher was also teaching the experimental group with the help of the lesson plans based on AOM and 12 lesson plans were prepared for three weeks to teach the topics from work and energy. In the experimental class room, the teacher presented the different type of advance organisers in front of the students and asked students to observe them and to reflect what they understand from the organisers either at the starter activity, main activity or concluding activity of the lesson in every 12 lessons. The advance organisers used in this study were: (1) Expository – simply describes the new content, (2) Narrative – presents new information in a story format, (3) Skimming – skimming material before reading, and (4) Graphical organisers – effective with all types of organisers: pictographs, descriptive patterns, concept patterns. The control group also learned the same topic for equal duration of time by the same teacher as that of the experimental group using the 12 lesson plans based on the conventional teaching method. This means that the teacher used the actual lesson plans commonly practised in that school in class room instruction without advance organisers.

Posttest

After the two groups were thought by the same teacher for three weeks with their own lesson plans about work and energy, the posttest was administered to the two groups simultaneously at the same time to investigate the effectiveness of AOM in teaching work and energy. Thereby, the test was administered and collected with the help of physics teachers in that school and the researchers controlled seriously in order to minimise any form of cheating among the students.

Results

Pretest and posttest results of the experimental and control groups

The result of the pretest and posttest of both the experimental and control group students were analysed using independent samples t-test at a significant level of $\alpha = 0.05$. Since the data in this study were parametric and ratio scales. Obviously, in order to use this t-test, the data distribution needs to satisfy the assumption of normality (Schucany & Tony Ng, 2006). Thereby, the scores of the pretest and posttest of both the experimental and control groups in the population satisfied the normal curve distribution or the bell-shaped symmetry of the Gaussian curve of distribution.

Table 4 summarises the mean difference and statistical significance difference by analysing the pretest–posttest result of the experimental and control groups and the posttest result of the experimental and control group students under category of knowledge, understanding, and application of both the experimental and control group students using independent samples t-test.

As can be seen from Table 4, the probability value (p) of the pretest result is greater than the significant level (i.e. p value > .05). This shows that there is no statistically significant difference between the means of the pretest of the experimental and the control groups. This shows that the two groups do not differ significantly in the initial academic ability of students, because the two groups were taught using the conventional teaching

Table 4. Independent samples *t*-test for pretest and posttest result and posttest result under the category of objectives: knowledge, understanding and application of experimental and control groups.

Type of test	Group	*N*	Mean	Std. deviation	Std. error mean	df	*T*	Sig. (2-tailed)
Pretest	Experimental	46	6.61	2.016	0.297	90	0.882	0.380
	Control	46	6.26	1.757	0.259			
Posttest	Experimental	46	14.72	1.695	0.250	90	9.475	0.000
	Control	46	11.04	2.011	0.296			
Objectives in the posttest								
Knowledge	Experimental	46	3.54	0.936	0.138	90	.754	0.453
	Control	46	3.39	1.000	0.147			
Understanding	Experimental	46	5.04	0.918	0.135	90	7.358	0.000
	Control	46	3.72	0.807	0.119			
Application	Experimental	46	6.15	1.135	0.167	90	9.587	0.000
	Control	46	3.93	1.083	0.160			

method before the treatment. On the other hand, the probability value (p) of the posttest result is less than the significant level (i.e. p value < .05). Hence it is possible to say that the alternative hypothesis is supported. This means that there is a statistically significant difference between the means of posttest result of the experimental and control groups. So it can be concluded that AOM is more effective than the conventional teaching method in teaching work and energy.

The results in Table 4 above show that there is no a statistically significant difference between the two means (p value > .05) of the posttest result of the experimental and the control groups respect to the category of knowledge level. Hence it is possible to say that the alternative hypothesis is not supported. On the other hand, the mean score of the posttest result of the experimental group under category of understanding on the variable 'the effectiveness of advance organizer model' ($M = 5.04$, SD = 0.918) is statistically and significantly higher {$t = 7.358$, df = 90, two tailed = 0.000} than the mean of the control group under the category of understanding ($M = 3.72$, SD = 0.807). Moreover, the mean score of the posttest result of the experimental group under category of application on the variable 'the effectiveness of advance organizer model' ($M = 6.15$, SD = 1.135) is statistically and significantly higher {$t = 9.587$, df = 90, two tailed = 0.000} than the mean of the control group under the category of application ($M = 3.93$, SD = 1.083). Hence it is possible to say that the alternative hypothesis is supported with respect to the category of understanding and application levels. From these results, we concluded that the treatment (AOM) is equally effective as the CTM in teaching work and energy under category of objective knowledge, whereas AOM is more effective than CTM in teaching work and energy under the category of objectives' understanding and application.

Table 5 shows the independent samples t-test for posttest result of male and female students in the experimental group.

Finally, as can be seen from the Table 5, there was no statistically significant difference between the two means of male and female students ($p = .647$, i.e. p value > .05). Hence, it

Table 5. Independent samples *t*-test for posttest result of male and female students in the experimental group.

Type of test	Gender	*N*	Mean	Std. deviation	Std. error mean	df	*T*	Sig. (2-tailed)
Posttest	Male	26	14.62	1.745	0.342	44	−0.461	0.647
	Female	20	14.85	1.663	0.372			

is possible to say that the alternative hypothesis is not supported and no statistically significant difference is found between the means of males and females.

Discussion

The first finding of this study revealed that the performance of students in both experimental and control groups in pretest were low and do not differ statistically. This finding established the homogeneity of the two groups involved in the study prior to the experiment. Another major finding of this study was that the academic performance means scores of students in experimental and control groups were statistically different after the treatment. By implication, therefore, AOM is more effective than the conventional teaching method in teaching work and energy. This result agrees with Githua and Angela's (2008) findings on secondary school students' mathematics achievement. Shihusa and Keraro (2009) used advance organisers in their study, so as to enhance students' motivation in learning biology, and their results indicated that a significant difference was identified between group means of students who were taught using advance organisers and those taught using CTM. They concluded that teaching using advance organisers enhances student's motivation in learning biology. It is obvious that the ES is just the standardised mean difference between two groups. Thereby, to see how the ES was big between the two groups of experimental and control, a modest ES of 0.49 was calculated in this finding, according to Cohen et al. (2007). This ES was almost similar to the ES of 0.54 which was obtained by Shihusa and Keraro (2009).

On the other hand, the results presented in Table 4 showed that the mean score of the posttest result of the experimental group under category of objectives namely: understanding and application on the variable the effectiveness of AOM is statistically and significantly higher than the mean of the control group. From this, it can be concluded that AOM is more effective than CTM under the category of objectives, namely understanding and application. Since ES is an important tool in reporting and interpreting effectiveness of a particular intervention, relative to some comparison, a moderate ES of 0.38 and 0.5 for understanding and application, respectively was calculated using Cohen et al.'s (2007) procedure. Chung (1996) studied the effects of using advance organisers and captions to introduce video in the foreign language classroom and he suggested that the advance organiser strategy was more meaningful.

Moreover, both AOM and the CTM are equally applicable to teach facts, terminologies, and principles of work and energy on the category of the objectives of knowledge. This finding coincides with the finding of Bajpai (1986). However, this result contradicts with the finding of Shamnad (2005), even though his study focused on the concept attainment model on achievement in Arabic grammar of standard ix students.

Furthermore, the findings of this study indicate that there was no statistically significant difference between male and female students on their academic achievement in work and energy in each of the experimental and control groups before and after the treatment. In other words, AOM is equally effective to teach work and energy for male and female students. The implication of this result is that gender was not a significant predictor of students' academic performance in work and energy. The implication of this result is that gender was not a significant predictor of students' academic performance in work and energy. This finding agrees with the findings of other studies

(DaRos & Onwuegbuzie, 1999; Igboke, 2004; Kolawole & Popoola, 2011; Owoeye & Olatunji, 2016). This finding seems to contradict earlier studies which show that there was a significant gender difference in their motivation after being taught using AOM (Dawson, 2000; Shihusa & Keraro, 2009).

Conclusion

In conclusion, the AOM is more effective than conventional teaching method in teaching work and energy for grade-11 natural science students to develop their academic achievement. The findings of the study show that the AOM is more effective than the conventional teaching method with ES of 0.49. Both the AOM and CTM are effective in teaching work and energy under the category of knowledge. The AOM is more effective than the conventional teaching method in teaching work and energy under the category of understanding and application to enhance students' academic achievement. This model is also equally effective to improve the academic achievement of male and female students in teaching work and energy.

Recommendation

Based on our findings, the AOM is definitely better than the conventional teaching method to enhance students' academic achievement in teaching work and energy under the category of understanding and application. Since the application of models of teaching in the classroom will facilitate better learning activities, the AOM shall be introduced in Endabaguna preparatory School.

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