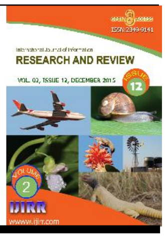
IJIRR

International Journal of Information Research and Review
Vol. 02, Issue, 12, pp. 1560-1571 December, 2015



Research Article

ENHANCING PHYSICS STUDENTS' MOTIVATION IN CONCEPT LEARNING THROUGH CONTEXT-RICH ANALOGIES

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ARTICLE INFO

Article History:

Received 09th, September 2015
Received in revised form
19th, October 2015
Accepted 26h, November 2015
Published online 30th, December 2015

Keywords:

Concept learning,
Motivation,
Physical heat concepts,
Socio-cultural knowledge,
Traditional dance analogy.

ABSTRACT

An important component of science learning in general and physics learning in particular is mastery of concepts. The physics curriculum incorporates many abstract concepts which, if not effectively grasped by students form a barrier to their further learning. Research in concept learning reveals that analogy is an efficacious instructional strategy in facilitating conceptual change within a constructivist paradigm. However, in most non-Western contexts, most of the analogies used by educators have merely replicated analogical models fashioned for teaching science within Western classrooms. Motivation is an important psychological dimension in achievement of expected learning outcomes in science. The aim of this research was to investigate the effect of analogies derived from learners' socio-cultural context in facilitating their motivation to learn physics concepts. In particular, the study employed a traditional dance analogy to teach aspects of physical heat concepts. Learners' motivation was compared to that of another set of learners taught using the usual conventional methods. Using the Solomon Four Non-equivalent Control Group design, data were collected from Form One (Grade 9) students in four secondary schools in Nyandarua County, Kenya. The instrument comprised a students' motivation questionnaire (SMQ) in two forms, one for use as pretest and the other as posttest. The two were systematically assessed for validity and reliability by involving experts in Science Education in Laikipia University and through pilot study. The hypothesis was tested using student's t-test and analysis of variance (ANOVA) at an alpha level of .05. Results showed that students taught using the dance analogy developed significantly higher motivation compared to those taught using conventional methods. Based on the finding, the researchers conclude that analogies based on learners' socio-cultural contexts are an effective way of enhancing learners' motivation during instruction. Therefore, teachers should often consider socio-cultural knowledge as the basis for selecting and designing analogies to enhance learners' motivation in concept learning in physics.

INTRODUCTION

Physics as a discipline has been defined as the branch of the natural sciences that seeks to understand the principles and laws that govern the universe (Zhaoyao, 2002). This aspect is captured in one of the aims of teaching physics in secondary schools in Kenya, that is, to promote learners' scientific knowledge about the physical world (Okere, 1996). Therefore, an important component of physics learning and indeed science learning in schools is mastery of concepts. According to Njuguna (2012), understanding scientific concepts is paramount for accurate interpretation and explanation of observable physical and natural phenomena. An important issue to consider in concept learning and achievement in physics is the psychological dimensions of the curriculum. In recent years, of all the personal and psychological variables that have attracted researchers' attention and focus in science education, motivation leads other variables (Tella, 2007). Academic motivation is defined as the psychological process that determines the direction, intensity and persistence of behavior related to learning (Husen and Postelthwaite, 1991). Motivation has been described as an essential ingredient in learning (Shihusa and Keraro, 2009). According to Mwangi and Githua (2003), if learners are not attracted to a concept, learning will almost certainly be limited. They further explain that it is the learner who decides whether or not to engage in learning a concept and that this choice is to a large extent based on the learner's interest and motivation to participate in the learning process. During instruction, it is therefore a teacher's main role to discover, initiate and sustain learners' motivation to learn. According to Wachanga (2002), a well-designed set of instructional activities that involve learners is instrumental to motivating learners and achieving improved learning outcomes. Consequently, in concept learning in physics and indeed science, teachers have the responsibility to select and /or design

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teaching strategies that encourage learners to participate in the learning activities thereby arousing and sustaining their interest and motivation. Research in concept learning in science reveals that analogy is an efficacious instructional strategy in facilitating conceptual change within a constructivist paradigm (Lakoge, Jegede and Oyebanji, 2007). Research results indicate that analogy teaching is useful in providing visualization of abstract concepts (Tsai, 1999), overcoming misconceptions (Dilber and Duzgun, 2008), motivating learners (Shihusa and Keraro, 2009) and addressing the gender gap in science learning (Lakoge, Jegede and Oyebanji, 2007). In use of analogies, it is important to consider learners' background so that the selected analogy is familiar to as many learners as possible. Review of literature established that most of the studies on analogies within non-Western contexts merely replicated analogical models fashioned for teaching science in Western classrooms. The analogy used in this study was designed based on the assumption that a traditional dance is a familiar social phenomenon within the learners' socio-cultural knowledge.

The secondary school physics curriculum in Kenya and equivalent grades worldwide incorporates many abstract concepts which are central for explaining observed physical and natural phenomena. The abstract nature of physics along with other content learning difficulties, for example, the mathematical nature of physics, means that physics classes require a high-level skills set (Taber, 2002).Many topics in physics are related to or are based on the structure of matter. Matter is composed of sub-microscopic particles whose behavior explains the observed macroscopic properties of matter (Feynman, 1995). A good example of such a topic is 'heat' which forms an important part of the science curriculum in primary schools and physics curriculum in secondary schools in Kenya (KIE, 2012). An essential characteristic of the topic is the interplay between the macroscopic properties of matter and the microscopic behavior of particles of matter (Sirhan, 2007). Explanation of physical phenomena associated with heating and cooling, for example, temperature, thermal expansion, heat energy transfer and change of state is based on kinetic theory of matter (Berkheimer, Anderson and Spees, 2010). The theory explains the composition and the structure of matter, the behavior of particles of matter and the processes that arise when different matter interacts. This abstract nature of the theory makes its teaching and learning in schools challenging (Bar and Galili, 1994; Hewson and Hamlyn, 1984).

A needs assessment survey conducted by the Centre for Mathematics, Science and Technology Education in Africa(CEMASTEA) in Nyandarua County, Kenya in 2009 identified 'heat' as one of the topics that presented difficulties in physics education (CEMASTEA, 2010). Teachers explained that due to the abstract nature of kinetic theory of matter, there were no readily available practical activities to facilitate students' conceptualization. Therefore most of them resorted to teaching using theoretical approaches. This situation has led to development of a negative attitude and misconceptions on physical heat concepts among learners in the county. Computer simulation was limited due to the fact that, being largely a rural county, most schools in Nyandarua are not connected to electricity grid and therefore integration of information communication and technology in classroom teaching and learning is limited (Waithanji, 2014). The survey recommended that there was need to build the capacity of physics teachers to design and employ teaching and learning strategies capable of capturing and sustaining learners' interest to learn the topic. This study was partly in response to that concern.

Statement of the Problem

In Nyandarua County, Kenya, teaching of physical heat concepts is mostly theoretical, which has led to development of negative attitude by learners. Although analogy teaching has been found beneficial in enhancing learners' motivation to learn science concepts, the factor of social climate as the basis for selecting and designing the analogies has largely been ignored. This study investigated the effect of a traditional dance analogy on physics students' motivation to learn physical heat concepts.

Purpose of the Study

The purpose of the study was to investigate the effect of teaching using a traditional dance analogy on physics students' motivation to learn aspects of physical heat concepts. The effect was assessed by comparing analogy teaching with conventional teaching methods. Conventional teaching methods were identified as those employing the usual minds-on approaches that teachers regularly employ in science lessons. These include but not limited to explanations, discussions and question and answer techniques.

Objective of the Study

The objective of the study was to compare the effect of teaching using a traditional dance analogy on physics students' motivation to learn aspects of physical heat concepts with that of the students taught using conventional methods.

Research Hypothesis

$H_0$1: There is no statistically significant difference in motivation to learn aspects of physical heat concepts between students taught using traditional dance analogy and those taught using conventional methods.

Limitations of the Study

The study focused on students drawn from public co-educational sub-county schools in Nyandarua County. Generalization of results should therefore be limited to students enrolled in such schools within the county. The findings can only be applied with caution to students in private schools because these schools have different admission criteriato students with regard to academic requirements. The findings should also be generalized with caution to county and national public schools in Nyandarua County because these schools admit students from outside the county and are therefore likely to have different prior knowledge concerning heat as a result of being brought up in areas with different social environment.

Literature Review

Effective Concept Learning in Science Education

Students' ideas in physics and indeed in science and the way they change as a result of teaching can be identified as part of the broader picture concerning human learning. Learners' scientific understanding of various concepts has been addressed by a number of studies. Results of these studies suggest that there is a general trend in the way conceptions are constructed which has provided useful insight for science instruction and curriculum development. It is now well established that students construct their understanding of natural phenomena from all of their experiences, in and out of school (Dekkers and Thijs, 1998; Griffins and Preston, 1992). Studies have shown that students come to the learning situation with existing conceptions about the physical world around them. These preconceptions are relevant to the subsequent learning of the concepts (Anderson and Smith, 1992; Driver and Easley, 1978; Duit and Treagust, 1998).

The issue of how conceptual change can be promoted is a matter of great interest and a subject of contemporary research. The constructivist approach assumes that students' prior conceptions are a necessary starting point of instruction and that teaching should be designed to enable the learner change and develop the prior conceptions (Driver, 1995). In order to adopt the approach, a decision has to be made about the appropriate learning activities. An important principle in arriving at this decision is to start with the assumption that meaning is more effectively derived from experience or 'episodes' (Jung, 1985). This is because, according to cognitive psychology, it is the specifics of a situation that have a greater impact on learning than the content or structure of the content. This means that science educators need to give greater consideration to the experiences and activities that learners will be exposed to in the teaching-learning process in order that the learners are provided opportunity to construct the desired conceptions in a meaningful way. It points to instructional approaches that are structured around the domains of experience and that are context-dependent. The learning activities should be interesting and intrinsically satisfying while the experiences to be related to the scientific concepts should be familiar to the learners (Guidoni, 1986). Teaching using analogies provides one such approach.

Effect of Analogies in Concept Learning in Science

Researchers and educators agree that conceptual change is a sophisticated process and is less likely to be accomplished with conventional instruction (Tasker and Dalton, 2006). According to Millar (1990), the main reason why students find it difficult to employ kinetic theory of matter to explain macroscopic behaviour of heated or cooled matter is the way the concept is taught in schools. Millar explained that aspects of the theory should be taught obliquely through specific experiences rather than teaching it directly and expecting learners to assimilate it. Harrison and Treagust (2002) suggested that teaching the kinetic theory of matter should dispense with the 'quick-tell' but should guide learners through well planned and designed instructional activities to negotiate an understanding that is compatible with science.

Teaching using analogies provides an interesting and engaging way to explain science concepts. Simply stated, an analogy is a process of identifying similarities between two concepts, a familiar one and an unfamiliar one. The familiar concept is called the base or analog while the unfamiliar concept is called the target (Dilber and Duzgun, 2008). An analogy makes difficult and abstract concepts clearer by comparing them with everyday objects or processes (Harrison and Coll, 2005). When students see the link or analogy between the familiar process and the abstract or unobservable phenomenon, they are then able to visualize the aspects of the phenomenon. Gentner (1983) used a mathematical notation to represent the working of an analogy where a mapping M between elements b_i in the base domain and elements t_i in the target domain are linked as follows:

$$M: b_i \rightarrow t_i$$

Use of analogies has been found useful in concept learning in science, not only in providing visualization of abstract concepts, but also in overcoming misconceptions and motivating students. In physics education, for example, Kigo (2006) used a water flow analogy to teach aspects of electric current flow. His findings were that students taught using the analogy gained more conceptual understanding than those taught using conventional methods. Reiner (2000) used substance based concepts to teach a variety of physics concepts, for example, particulate nature of light. Clement and Brown (1989) successfully used compressed springs to facilitate students' conceptualization of force and its reaction. Tsai (1999) used dominoes to address four of students' alternative conceptions concerning aspects of kinetic theory of matter namely the size, arrangement, motion and distance between particles in the three states of matter. Lakoge, Jegede and Oyebanji (2007) found teaching using analogies effective in addressing gender differences in conceptualization of selected biological concepts. Dilber and Duzgun (2008) used analogies to eliminate students' misconceptions of electric current flow. Shihusa and Keraro (2009) found that use of graphic advance organizers to provide linkage of aspects of pollution resulted in better students' conceptualization compared to conventional teaching methods.

Within non-Western contexts, most of the studies on analogies have merely replicated the use of models fashioned for teaching science in Western classrooms. Review of literature did not identify any study that attempts to use students' socio-cultural knowledge as the basis for selecting analogies to be used for concept learning in science. In use of analogies, there is also the need to consider the students' background so that the selected analogy is familiar to as many students as possible (Lakoge, Jegede and Oyebanji, 2007). This study employed a traditional African dance analogy to enhance students' motivation to learn aspects of physical heat concepts.

Effect of Analogies in Enhancing Students' Motivation to Learn Science Concepts

In concept learning in science, motivation and interest are essential ingredients (Shihusa andKeraro, 2009). Factors that influence a learner's engagement in a concept include interest in the task, perceived value and utility of knowledge, self-efficacy and social climate (Harrison andColl, 2005). Keller (1979) identified four learner motivation categories to enhance learning. His famous ARCS model has been articulated by Mondoh (2005). The four categories include attention (A), relevance (R), confidence (C) and satisfaction (S). Attention refers to the extent to which students' curiosity to learn and attend to subject matter is achieved. Relevance of the subject matter refers to the extent students perceive content of the subject matter to be significant and valuable to them. Confidence is the students' perceived probability of success due to personal control of their behaviour while satisfaction refers to the students' psychological equilibrium between experience of intrinsic growth needs and external rewards. The four dimensions of the ARCS model formed the basis of objective statements in the instrument to assess students' motivation to learn aspects of physical heat concepts.

Use of analogies has been found effective in cultivating students' motivation to learn science concepts. Shihusa and Keraro (2009) established positive gains in motivation to learn aspects of land and water pollution for students exposed to graphic advance organizers. Clement and Brown (1989) found that students taught the concept of force and its reaction using the analogy of compressed springs had better motivation compared to students not exposed to the analogy. Lakoge, Jegede and Oyebanji (2007) found that, on top of bridging the gap between boys and girls in conceptualization of selected biology concepts, use of environmental analogies resulted in better students' motivation compared to teaching using conventional methods.

The analogies in the studies enumerated above were based on physical objects and processes. The factor of social climate to provide motivation in concept learning in science has been largely ignored when selecting and using analogies. Review of literature did not identify any study that uses social interactions within classroom set-ups to generate analogies. Analogies that are based on social knowledge and experience are likely to arouse interest and motivation because they are drawn from the learner's real world. Humor is also likely to add to the appeal of the analogy. This study used a 'dance' analogy enacted by the learners. Aspects of the dance were related to those of kinetic theory of matter and hence applied to explain physical phenomena associated with heat. It was the considered view of the researchers that a dance, preferably a traditional dance, would be one that students could easily associate with, given the enthusiasm shown by secondary school students in Kenya towards the annual national music and drama festivals.

Effects of Teaching Scientific Concepts using Dance Formations and Movement

Throughout history, educational philosophers and educators have advocated movement as away of promoting learning. Teaching and learning through creative movement provides the learner with rich experiences that form a firm foundation of conceptual change and development (Skoning, 2008). Literature has documented benefits of using creative movement as a teaching tool. These include increased conceptualization, improved classroom behaviour with respect to interaction and relationship among learners, development of creativity and enhanced interest to learn (Jackson, 2013). Dance is a type of art that generally involves movement of the body often rhythmic to music and musical instruments (Yost 2013). Dances are performed by many cultures as a form of emotional expression, social interaction or physical exercise (Griss, 1994). According to Yost, there are many styles and genres of dance which stem from the social, cultural, moral and aesthetical values of a society. Most African traditional dances are characterized by functional movement with symbolic meaning (Kinyua, 2013). According to Jackson,science is about movement. The concrete and fundamental movement could be connected to abstract scientific ideas leading to their conceptualization. However formal research into use of dance to teach core content in science remains sparse. This study employed the idea of using the 'ndumo' and 'mwomboko' dance formations and movement to simulate the movement of particles of matter under different conditions as a means of explaining kinetic theory of matter. 'Ndumo' and 'mwomboko' are popular traditional dances among the Kikuyu ethnic community predominantly living in the central part of Kenya. Traditional dance was preferred by this research to other contemporary dances because of moral considerations.

The Kikuyu community is endowed with a rich cultural heritage in which music and dance are highly valued. 'Ndumo' is a popular dance performed by elderly women. It was traditionally performed to celebrate bumper harvest. It is characterized by a formation where the dancers dance in fixed positions. The body movements involve clapping and swinging the body posture with the feet firmly on the ground. This movement resembles vibration of particles of solid matter in their fixed states. 'Mwomboko' is performed by both men and women who dance in pairs. The dance is accompanied by sound from accordion and iron cymbals and its rhythm and tempo is controlled by the intensity of the sound from the instruments. It is usually performed by all age groups. There is variation in the vigor of the dance depending on the age group (Gethoi, 2010). Kinyua (2013) has analyzed the rhythmic, melodic and structural attributes of the dance in the context of Kikuyu traditions. In 'Mwomboko' dance the dancers move as they count two steps and then bend down rhythmically with the heads bowing and hands held together and stretched sideways. They move back and forth within the dancing arena. At times the female dancers turn round as male dancers pause and grip the hands of the next female partners.

This movement and formation was found by the researchers to be comparable to the behaviour of particles of liquids and gases in different temperature conditions. It was envisaged that if the intensity of sound of the instruments represented heat energy and consequently the temperature, then the dancers and their movement would resemble the particles of matter as explained in the kinetic theory. These ideas were used to develop the teaching analogy as summarized in figure 1.

Traditional Dance (Base) Concept	Physical Heat (Target) Concepts
a)Individual dancers	a') Atoms of solid matter
b)Pairs of dancers	b') Molecules of liquids and gases
c)Sound from instruments	c') Heating
d)Dancing space/rings	d') Volume of matter
e)Dancing troupe	e') Matter
f)Increased sound from instruments	f') Increased heating/temperature
g)Decreased sound from instruments	g') Decreased heating (cooling)
h)Intensity of dancing	h') Rate of random motion/vibration of molecules/atoms of matter
i)Expansion of dancing space	i') Thermal expansion of matter
j)Collision among dancers	j') Random collision of gas molecules
k)Change of dancing rings	k') Change of state

Source: Authors

Figure 1. Traditional dance analogy with physical heat concepts

Theoretical Framework

The study was situated grounded on the ARCS theory of motivation developed by Keller (1979) and articulated by Mondoh (2005). Keller's model of motivation was organized in terms of personal inputs, environmental influences and expected outputs. According to the model, motives and expectancy as well as systematic effort to influence motivation determine the level of effort expended and the level of expected output. When applied in the teaching-learning process, effort together with the application of individual abilities, skills and knowledge, plus the effort to design or manage the learning experience, determine performance. The acronym ARCS stand for attention, relevance, confidence and satisfaction.

Attention is an element of motivation and a pre-requisite for learning. For learning to occur, attention must be aroused, directed and sustained. Relevance emphasizes the importance of learners' understanding why they should expend effort on a given task. In general, a learner will be more motivated to learn if he/she perceives that the new knowledge or skill will help to achieve a goal in the present or future. At the same time, a learner will "tend to be most interested in content that has some connections to their prior experiences or interests" (Keller 1979, p.50). Confidence highlights the importance of learners feeling confident in their ability to succeed. Satisfaction emphasizes the contribution of feeling satisfied after a learning experience in order for motivation to be sustained. The sense of satisfaction comes in the form of incentives or rewards in terms of learning gains the learner experiences.

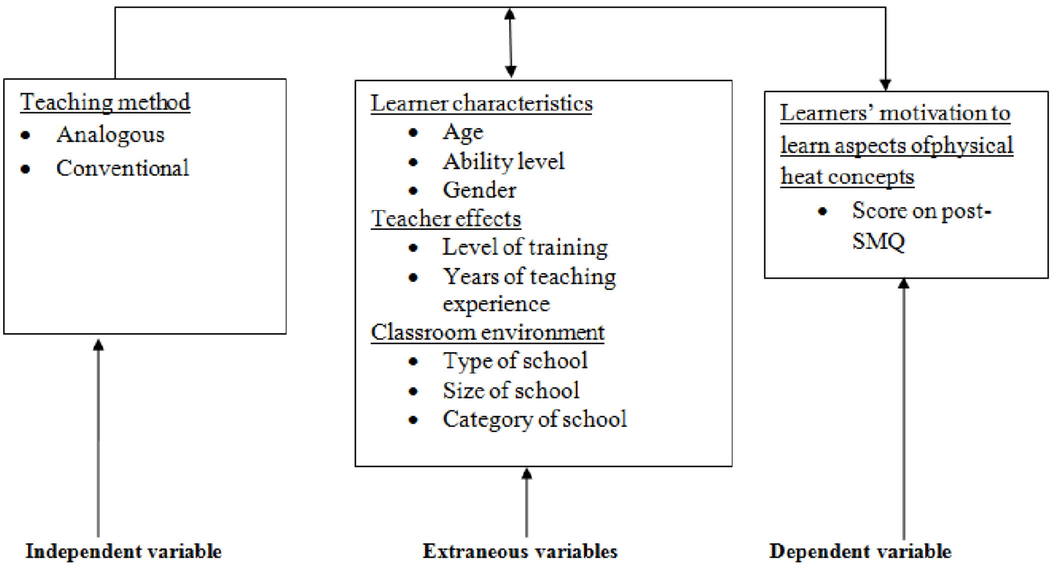
The ARCS theory of motivation was deemed significant in the study because it provides directly on strategies for making instruction more effective. The basic assumption was that the traditional dance analogy would provide learners with a rich experience on which to base learning of physical heat concepts and hence enhance their interest and motivation.The main question addressed by the study was whether students taught using the traditional dance analogy would have significantly higher motivation to learn physical heat concepts compared to those taught using the conventional teaching methods. Figure 2 shows the relationship among variables subsumed in the study.

controlled by involving learners of the same grade and through random assignment of classes to the design groups. To take care of gender, classes taking part in the study had almost the same number of boys as girls. Teacher effects refer to characteristics of the teacher that are likely to influence learning outcomes in the classroom. These include the teachers' professional experience and academic qualification (Lavy, 2008; Kruger, 1999; Vosniadou, 2003). These studies showed that teacher effectiveness peaks and levels out after three years of continuous teaching. Moreover, teachers with a minimum Bachelors degree had the highest output with respect to learning outcomes compared to Diploma graduates (Park and Hannum, 2001). In this respect, the classes that took part in the study were those that were being taught by graduate teachers with at least three years physics teaching experience. According to Wright, Sandra and Sanders (1997),teachers' age, gender and socio-economic background have no significant effect on learning outcomes. The extent to which school related factors may influence learning outcomes has been investigated (Coon, Carey andFulker, 2003; Stevenson and Lee 2009). These factors include the size of the school determined by the number of streams, type of school depending on whether it is day or boarding and whether the school is public or private and the category of school determined by whether it is national, county or sub-county. To control the extraneous factor of classroom environment, the study focused on public, co-educational schools of sub-county category only.

MATERIALS AND METHODS

Research Design

Quasi-experimental research involving the Solomon Four Non-equivalent Control Group design was used.



Source: Authors

Figure 2. Relationship among variables of the study

Figure 2 shows interaction of variables for achieving the objective of the study. Learner characteristics, teacher effects and classroom environment were identified as factors that could influence the relationship between the independent and the dependent variables. These extraneous variables were considered potential in forming rival hypotheses to the study and hence needed to be controlled. Age and ability level were

Secondary schools in Kenya are taught as intact groups and authorities do not normally allow classes to be dismantled and reconstituted for research purposes. Solomon Four Non-equivalent Control Group design is superior to other experimental designs in terms of controlling the major threats to internal validity, except those associated with interaction and history, maturation and instrumentation (Fraenkel and Wallen, 2000). In this study, no extraordinary event was observed in the sample schools to introduce threat to history and interaction. The conditions under which the instruments were administered were kept as similar as possible across the sample schools in order to control instrumentation and selection. The schools were randomly assigned to the control and treatment groups to control for selection, maturation and interaction. The summary of the design is summarized in figure 3.

Group	Pretest	Treatment	Posttest
E_1	O_1	X	O_2
C_1	O_3		O_4
E_2		X	O_5
C_2			O_6

Source: Cohen and Manion (2012, p.398)

Figure 3. The Solomon Four Non-equivalent Control Group design

According to Ary, Jacobs and Razavieh (1979), an experimental comparison is designed such that the control group is subjected to the usual set of conditions while the experimental group is subjected to the novel treatments. In this regard group $E_1$was the true experimental group which received pretest O_1 the treatment X and posttest O_2. Group C_1 was the true control group which received pretest O_3 followed by the control condition and then the posttest O_4. Groups E_2 and C_2 received similar conditions as E_1 and C_1 respectively but did not receive pretests. The treatment groups E_1 and E_2 were taught using the dance analogy while the control groups C_1 and C_2 were taught using the conventional methods.

Sampling Procedures

The target population comprised all Form I (Grade 9) students in secondary school in Nyandarua County, Kenya.According to the secondary school physics syllabus, students are introduced to aspects of kinetic theory of matter at this level.Gender balance was achieved by conducting the study in mixed secondary schools.In research it is not necessary to capture data from all subjects in the target population in order to understand the phenomenon being studied. Observations can be made on a small portion of the population and the findings generalized to the population as long as the sample is representative of the population (Mbeche, 2004).

This is the rationale of sampling. It was necessary to ensure that the Form I classes selected had at least 30 students per class and approximately equal number of boys as girls. In addition, it was important that the selected schools had a physics laboratory and that the classes were being taught physics bygraduate teachers with at least three years teaching experience. The first step was to identify all schools in the county that possessed these characteristics.

To minimize contamination among the design groups, it was found appropriate to have the four schools (each in the respective design group) located in different sub-counties within the county. The first phase of sampling involved random selection of four among the seven sub-counties in Nyandarua County. Simple random sampling was then used to select one school in each of these sub counties. The four schools were randomly assigned into the four groups in the research design. This process generated the results in Table 1.

Table 1. Sub-counties Selected and Sample Size in Identified Schools

Design group	Sub-county	Number of students (n)
E_1	Nyandarua central	44
C_1	Nyandarua North	48
E_2	Nyandarua West	46
C_2	Kipipiri	37
Total (N)		175

Instrumentation

Students' motivation to learn aspects of physical heat concepts was measured using the Students' Motivation Questionnaires (SMQ). The SMQ pretest and posttest each comprised 32 items derived from the four dimensions of motivation articulated by Mondoh (2005). These dimensions are attention, relevance confidence and satisfaction. The SMQ pretest was used to assess students' motivation to attend to physics lessons in general (appendix A) while the posttest was used to assess students' motivation to attend to the lessons on physical heat concepts (appendix B). The statements of the items were constructed on a five-point Likert scale. Half of the items were positive while the other half comprised negative motivation statements. Table 8 shows the distribution and orientation of the items.

Table 2. Distribution and Orientation of Items in SMQ Pretest and Posttest

Dimension of motivation	Pretest		Posttest	
	Positive	Negative	Positive	Negative
Attention	1,3,11,27	2,5,7,18	1,4,8,31	2,3,7,12
Relevance	9,10,13,25	12,15,16,20	9,13,14,16	10,17,27,29
Confidence	8,17,21,23	6,14,22,24	6,19,23,24	11,15,20,22
Satisfaction	4,19,26,30	28,29,31,32	5,21,25,30	18,26,28,32

Students' score on SMQ was used as a measure of their motivation. The score chart in table 3 was used to assign scores to students' responses. The maximum score on SMQ was therefore 160 while the minimum was 32

Table 3. Score Chart for Positive and Negative Motivation Statements in SMQ

	Score	
Response	Positive statements	Negative statements
Strongly disagree	1	5
Disagree	2	4
Not sure	3	3
Agree	4	2
Strongly agree	5	1

The reliability of the SMQ was systematically assessed using data from the pilot study in two public co-educational schools in Nyandarua County that were not part of the study sample. To compute the reliability index, the split-half method was applied. This method is considered suitable for instruments with many items which can be split into two similar halves (Peil, 1995). The pretest and posttest of SMQ items were divided into two sets, A and B, each comprising two items from each of the four dimensions of motivation, that is, attention, relevance, confidence and satisfaction. One of the two items was positive while the other was negative. Random assignment of items into the sets was done. Table 4 shows the distribution of the items of the pretest and posttest of SMQ in the two sets.

Table 4. Distribution of Items of SMQ Pretest and Posttest into Sets A and B

	Set	
SMQ	A	B
	Item Numbers	Item Numbers
Pretest	2,5,6,11,13,14,16,20,21, 23,25,27,28,30,19,32	1,3,4,8,7,9,10,12,17,15,1 8,31,22,24,26,29
	Item Numbers	Item Numbers
Posttest	1,3,5,6,9,12,13,15,18,19, 22,25,26,27,29,31	2,4,7,8,10,11,16,17,20,2 1,23,24,28,14,30,32

Students' total scores on the two sets of the pretest and posttest of SMQ were recorded and respectively compared using Pearson's product-moment correlation. The correlation coefficients for the pretest and posttest of SMQ obtained were .81 and .74 respectively.Ary, Jacobs and Razavieh (1979) point out that the split-half method underestimates the reliability because it amounts to reducing the entire test to half its former length. Therefore to transform the split-half correlation into an appropriate reliability estimate for the entire test, the Spearman-Brown Prophesy formula was employed. The formula is given by:

$$\gamma_2 = \frac{2\gamma_1}{1+\gamma_1}$$

Where γ_2 = estimated reliability of the entire test

γ_1= reliability of half of a test found by the split-half technique The estimates for the reliabilities of the SMQ pretest and posttest were found to be .90 and .85 respectively. The coefficients were both above the threshold value of 0.70 recommended for social sciences research (Mugenda and Mugenda, 2003). They were therefore found suitable for use in the main study.

Data Collection

Teachers in the experimental groups E_1 and E_2 were trained by one of the researchers on how to use the dance activity to explain physical phenomena associated with heating and cooling. Pre-SMQ was administered to groups E_1 and C_1 followed by teaching of physical heat concepts in four instructional periods. In the experimental groups E_1 and E_2, links were drawn between aspects of the traditional dance and those of the behavior of particles of different phases of matter under different temperature conditions. Conventional methods were used to explain the behavior of heated or cooled matter for the control groups C_1 and C_2. At the end of the teaching period, post-SMQ was administered to all the groups.

Data Analysis

Students' responses in the SMQ were scored using the score chart in table 3.The total score for each student was computed which could range from 32 to 160. The mean score of students ineach group was computed and the means compared. To test the significance of the difference between pre-SMQ means for groups E_1 and C_1, student's t-test was used while ANOVA was used to test the significance of the difference among all group means on post-SMQ. Tukey-Kramer post hoc tests were run to establish the significance of the difference between all possible pairs of group means. According to Hall (1998), Tukey-Kramer tests are superior to other post hoc tests in maintaining the alpha levels and are suitable where the sample means are not equal. The hypothesis was tested at an alpha level of .05.

RESULTS

The study sought to determine the effect of teaching using traditional dance analogy on students' motivation to learn aspects of physical heat concepts. This was to be achieved by comparing students' scores on SMQ between those taught using the analogy and those taught using the conventional methods. The Solomon Four Group design enabled the researchers to compare students of the experimental and control groups E_1 and C_1 respectively with respect to their motivation using pre-SMQ prior to administration of treatment. Results of the mean scores for the groups and the t-test analysis of the significance of the difference between means are displayed in table 5.

Table 5. t-Test Analysis of the Significance of the Difference between Means for Groups E_1 and C_1 on Pre-SMQ Scores

Group	N	Mean	SD	df	t-Value	P-Value
E_1	38	92.84	11.63	78		0.814
C_1	42	90.90	9.62			0.418

Not significant t (78) = 0.814, P>0.05

Examination of the results displayed in table 5 shows that the mean score for the control group C_1 (mean = 90.90, standard deviation = 9.62) was lower than that of the experimental group E_1 (mean=92.84, standard deviation = 11.63). However, results of the t-test analysis indicated that the difference between the means was not significant (t (78) = 0.814, P>0.05). Hence the two groups were similar with respect to their motivation to attend to physicslessons prior to administration of experimental treatments. The next step was to compare students' scores on motivation to learn aspects of physical heat concepts for all the groups E_1, C_1, E_2 and C_2 using post-SMQ. Table 6 shows the means and standard deviations for the scores.

Table 6. Means and Standard Deviations of Students' Scores on Post-SMQfor Groups E_1, C_1, E_2 and C_2

Group	N	Mean	SD
E_1	38	134.21	9.74
C_1	42	99.43	8.66
E_2	44	139.34	10.95
C_2	35	101.54	8.81

It is evident from the results in table 6 that the means of the experimental groups E_1 and E_2 (Mean = 134.21, SD =9.74 and mean = 139.34, SD = 10.95 respectively) were both higher than those of the control groups C_1 and C_2 (mean = 99.43, SD = 8.66 and mean = 101.54, SD = 8.81 respectively). The significance of the difference among the group means was tested using ANOVA. Table 7 shows the results of the analysis.

Table 7. ANOVA Test of Significance of the Difference among Group Means on the Motivation to Learn Aspects of Physical Heat Concepts using Post-SMQ for Groups E_1, C_1, E_2 and C_2

Source of variance	Sum of squares	df	Mean square	F-value	P-value
Between groups	53740.76	3	17913.59	193.10*	0.00
Within groups	14379.17	155	92.77		
Total	68119.93	158			

*\Significant F (3,155) = 193.10, P< 0.05

The test indicated that the group means were significantly different at α =.05. In order to identify the specific pairs whose means differences were statistically significant, Tukey-Kramer post hoc tests were carried out. The results of the tests are displayed in table 8.

Table 8. Tukey-Kramer Post Hoc Comparisons of Students' Motivation to Learn Aspects of Physical Heat Concepts for Groups E_1, C_1, E_2 and C_2

I Group	J Group	Mean Difference (I-J)	P-value
E_1	C_1	34.78*	0.00
	E_2	-5.13	0.08
	C_2	32.67*	0.00
C_1	E_1	-34.78*	0.00
	E_2	-39.91*	0.00
	C_2	-2.11	0.77
E_2	E_1	5.13	0.08
	C_1	39.91*	0.00
	C_2	37.80*	0.00
C_2	E_1	-32.67*	0.00
	C_1	2.11	0.77
	E_2	-37.80*	0.00

*Represents statistically significant difference

The results show significant differences between the means of experimental and those of the control groups. However the means of the two experimental groups are not significantly different, neither are those of two control groups. These results indicate that teaching using the traditional dance analogy enhanced more of students' motivation to learn aspects of physical heat concepts compared to teaching using conventional methods. Consequently the hypothesis Ho1 was rejected. The results also suggest that use of the analogy had comparable effects on students' motivation for both the pretested and un-pretested groups.

DISCUSSION

The study found significantly better motivation to learn aspects of physical heat concepts for students taught using the dance analogy compared to those taught using conventional methods.Learners' engagement and active participation in the learning process is an effective technique of motivating them. The nature of the learning tasks and the underlying context affects the degree to which learners invest in the learning process (Spenzzini, 2010). This means that the dance analogy provided an inherently interesting and captivating way of learning compared to the conventional methods. Humor may also have had the effect of adding appeal to the use of the analogy. The fact that the analogy was drawn from the learners' social knowledge and experience may also have contributed to their arousal and curiosity to attend to the lessons on physical heat concepts. Rasnick (1987) concluded that students will engage more readily with learning tasks that are embedded in their real-world contexts compared to those that are detached from their social environment.

Another aspect that contributes to motivation in a learning task is the relevance that a learner attaches to the task. In this context, according to Mondoh (2005), relevance is the extent to which learners view the task as meaningful or significant to them. In this study, relevance was interpreted as the extent to which the learning tasks would help the learner to answer syllabus questions on physical phenomena associated with heat and also solve daily-life problems related to physical heat concepts. According to Grolnick and Ryan (2012), learners who are more intrinsically motivated in learning tasks develop better conceptual understanding of the subject matter compared to these with less intrinsic motivation. As such, they are likely to find the learnt content more relevant and significant to their needs. This could be interpreted to imply that students taught using the dance analogy perceived the learnt concepts on physical heat concepts to be more relevant and significant to them compared to those taught using conventional methods.

According to Bandura (1986) confidence or self-efficacy in a task refers to one's perceived expectancy of success in the task. It is one of the four dimensions that contribute to an individual's overall motivation on the task. Motivation on the other hand, influences one's attitude towards the task.The results of the study suggest that students subjected to analogical teaching approach developed higher confidence or expectancy of success in concept learning in physics compared to those taught using conventional teaching approaches. This finding is consistent with the assertion by Bandura that students' success in learning tasks raises their level of expectancy of future success.

The fourth dimension of motivation as articulated by Mondoh (2005) is satisfaction which refers to one's psychological equilibrium between experience of intrinsic growth needs and external rewards. According to Deci (1992), an individual experiences more enjoyment in a task when working because of an internal or intrinsic interest than when working for external or extrinsic rewards. Learners' satisfaction in the learning tasks in this study was measured by the extent to which they found the activities in the lessons stimulating and intrinsically rewarding. It is likely that the social interactions generated within the classroom by use of the dance analogy produced greater enjoyment and psychological satisfaction among the students and hence produced greater motivation compared to that of students taught using conventional methods.

Conclusions, implications and recommendations

The study set itself the task to investigate whether use of analogical linkages drawn from the learners' socio-cultural environment would significantly produce better motivation to learn physical heat concepts compared to teaching using conventional methods. Based on the findings of the study and with respect to the hypothesis posited for testing, it can be concluded that the dance analogywas more efficacious in enhancing students' attention, perception of relevance, confidence and satisfaction with regard to the lessons and content on physical heat concepts compared to conventional methods. The dance analogy used in this regard utilized social interactions within the classroom setting to provide a teaching-learning discourse to facilitate effective concept learning. As expressed by Vigotsky (1986) learners' social environment is an important factor to consider in effective science learning and should be utilized in designing effective learning strategies. Unfortunately, in the teaching of science, especially in sub-Saharan Africa, educators and researchers hardly pay particular attention to the important aspect of trying to see if the learners could utilize their socio-cultural knowledge for scientific knowledge construction (Lakoye, Jegede and Oyebanji, 2007).

An educational implication arising from the findings points to the case of learners' motivation in learning scientific concepts.

Kithaka (2004) working for SMASSE project in Kenya noted that learners' negative attitude towards science brought about by un-motivating and un-inspiring teaching inhibits their performance in science. The findings strengthen the case for considering instructional techniques where learners are actively engaged in interesting instructional activities. As noted by Changeiywo (2002), learners' interest and active participation should be an integral part of classroom science learning. It can be explained that as learners in the present study participated in the dance activities in their groups, they actively took the responsibility over their own learning thereby producing greater attention, relevance, confidence and intrinsic sense of psychological satisfaction.

Based on the results of the study, the researchersrecommend that, in an effort to improve the effectiveness of concept learning in science, curriculum developers should encourage teachers to identify and select analogies drawn from learners' own experiences and grounded in their socio-cultural environment. It is interesting to note that, as demonstrated in the study, certain practices grounded in the learners' socio-cultural environment, can be usefully integrated in learning scientific concepts within a constructivist's model. The inherent psychological motivation of teaching using analogies could be used to draw more learners towards science in general and physics in particular. Many professional courses in the Kenyan universities and other tertiary institutions have physics as an entry requirement, yet because of learners' negative attitude towards the subject, their enrolment in the subject at KCSE in Kenyan secondary schools is low (Siringi, 2005). Teachers should therefore adopt analogical teaching strategy whenever necessary in order to encourage learners to do physics and in so doing, consider learners' socio-cultural knowledge as the basis for selecting and designing the teaching analogies.

REFERENCES

Ary, D., Jacobs, L. andRazarieh, A. 2010. *Introduction to Research in Education.*New York, NY: Holt, Rinehart and Winston Inc.

Bandura, A. 1986. *Social Foundations of Thought and Action*.Engelwood Cliffs: Prentice-Hall

Bar, V. andGalili, I. 1994. Stages of children's views about evaporation.*International Journal of science Education*, 16, 157-169.

Berkheimer, D., Anderson, C. andSpees, T. 2010.Using conceptual change research to reason about curriculum.*Education,* 4(2), 235-252.

CEMASTEA. 2010. *The Extent of Practice of ASEI-PDSI Approach to Teaching Mathematics and Science at Secondary School Level in Kenya.* Nairobi: CEMASTEA.

Changeiywo, J. 2002. Gender perspective in science and technology education in Kenya.*Journal of Education and Human Resources.*1(1), 14-31.

Clement, J. and Brown, D. 1989. Overcoming misconceptions via analogical reasoning: Factors influencing understanding in a teaching experiment. *Instructional science*, 18, 237-261.

Deci, R. 1992. Attitude toward science achievement and motivation: Profiles of male and female students in grades 6 through 10. *Science Education*, 69 (4), 511-526.

Dekkers, P. andThijs, G. 1998. Making productive use of students' initial conceptions in developing the concept of force.*Science Education*, 82(1), 31-52.

Dilber, R. and Duzgun, B. 2008. Effectiveness of analogy on students' success in eliminating misconceptions.*Journal of Physics Education*, 2(3), 174-181.

Driver, R. and Easley, J. 1978. Pupils and paradigms: A review of literature related to concept development in adolescent science students. *Studies in Science Education*, 5, 61-84.

Driver, R. 1995. Constructivist approaches to science teaching. In Steffe L. and Gale J. (Eds.).*Constructivism in Education* (pp.385-400). Hillsdale, NJ: Lawrence Erllbaum Associates.

Duit, R. andTreagust, F. 1998. *Students' Conceptions and Constructivist Teaching Approaches: Improving Science Education*. Chicago: Chicago University Press.

Feynman, R. (1995). The concept of energy.*Physics Education*, 9, 490-498.

Fraenkel, R. andWallen, E. 1991. *Educational Research: A Guide to the Process*. New York: McGraw-Hill Inc.

Gentner, D. (1983). Structure mapping: A theoretical framework for analogy. *Cognitive Science,* 7, 155-170.

Gethoi, M. 2010. History of mwomboko dance. Online https://groups.yahoo.com/neo/groups/africa -oped (conversations/topics/42565Retrieval date: 6/2/2015

Githua, B. andMwangi, G. 2003. Students' mathematics self-concept and motivation to learn mathematics: relationship and gender differences among Kenya's secondary school students in Nairobi and Rift Valley Provinces. *International Journal of Educational Development,* 23, 487-499.

Griffins, A. and Preston, K. 1992. Students' misconceptions relating to fundamental characteristics of atoms and molecules.*Journal of Research in Science Teaching*, 29, 611-628.

Griss, S. 1994. Creative movement of language for learning. (Educational Leadership 51(5), 78-80.

Grolnicks, D. and Ryan, T. 2012. Motivation or cognition? What leads to performance differences in science? On-line, http://www.educ.ualberta.ca/educ/psych/crame. Retrieval date 06.02.2013.

Guidoni, P. 1986. A phenomenological approach to the development and differentiation of energy ideas. In R. P. Driver and E. R. Millar (Eds.), *Energy Matters* (pp. 432-464). New York: Centre for Studies in Science and Mathematics Education, University of Leeds.

Hall, R. 1998. *The Psychology World: Virtual Statistician*. New York: RAWA Inc.

Harrison, A. andColl, R. 2005.*Using Analogies in Middle and Secondary Science Classrooms: An Interesting Way to Teach.* New York: Plenum Ltd.

Harrison, G. andTreagust, F. 2002. Teaching with analogies: A case study in grade 10 optics. *Journal of Research in Science Teaching*, 30 (4), 1291-1307.

Hewson, M. andHewson, P. 1984. Students' misconceptions relating to fundamental characteristics of atoms and molecules.*Journal of Research in Science Teaching*, 20 (8), 611-628.

Husen, T. andPostlethwaite, T. 1991. *International Encyclopedia.*New York: Pergamum Press.

Jackson, L. 2013. Dancer teaches science through movement. Online http://m:trib.com/news/local/jackson/article-7d5071fl-7eb Retrieval date 8/10/2014

Jung, W. 1985.Use of cognitive science to science education. Paper Presented at the Symposium on the Implications of

Cognitive Science for the Education of Science Teachers, Kiel, August, 1985.

Keller, J. 1979. ARCS design process. Online http://arcsmodel.com/mof%sgn20of2prcss.htm

K.I.E., 2012. *Science Syllabus for Kenya Certificate of Secondary Education*. Nairobi: Kenya Literature Bureau.

Kigo, J. 2006. Effects of Water Flow Analogy on Students' Conceptualization of Electric Current Flow. An unpublished M. Ed. Thesis: Egerton University Njoro (Kenya).

Kinyua, H. 2013. Performance of mwomboko poetry.Arrangement and dance movements in mwomboko.Online http://ir/libraryku.ac.ke/handle/123456 789/7484. Retrieval date20/06/2014.

Kithaka, J. 2004. Attitude towards mathematics and science. Paper Presented During SMASSE Project Cycle One. Nairobi, April, 2004.

Kruger, I. 1999. Experimental estimates of education production functions, *Quarterly Journal of Economics* 8(3), 18-33.

Lakoge, B., Jegede, O. and Oyebanji, P. 2007. Towards eliminating the gender gulf in science concepts attainment through the use of environmental analogs.*Eurasia Journal of Mathematics, Science and Technology Education*, 63(7), 117-131.

Lavy, V. 2008. Evaluating the effect of teacher performance incentives on students' achievements.*Journal of Political Economy* 1(2) 160-189.

Mbeche, I. 2004. Sampling methods.In P. Ngauand A. Kumssa.*Research Design, Data Collection and Analysis. A Training Manual*(pp.108-139). United Nations Centre for Regional Development, Africa Office.

Millar, R. 1990. Making sense: What use are particle ideas to children? In Litch P. (Eds.): *Relating Macroscopic Phenomena to Microscopic Particles* (pp.1201-1269). Netherlands: Murray Inc.

Mondoh, H. 2005. *Methods of Teaching Mathematics: A Handbook for Teachers and Students*. Njoro, Kenya: Egerton University Press.

Mugenda, M. andMugenda, A. 2003. *Research Methods: Qualitative Approaches*. Nairobi: Act Press.

Njuguna, G. 2012. *Science Activities for Early Childhood Development Education*. Nairobi: Longhorn Publishers (Kenya) Ltd.

Okere, M. 1996. *Physics Education*. Egerton University, Njoro: Egerton University educational Materials Center and Lectern Publication Limited.

Park, A. and Hannum, E. 2001. Do teachers affect learning in developing countries? Evidence from matched student-teacher data from China: *Working European Journal of Education* 8(3) 1141-1173.

Peil, M. 1995. *Social Science Research Methods: A Handbook for Africa*. Nairobi: East African Educational Publishers.

Rasnick, L. 1987. Learning in school and out.*Educational Researcher*, 16, 13-20.

Reiner, M. (2000). Naive physics reasoning: A commitment to substance-based conceptions. *Cognition and Instruction*, 18, 1-34.

Shihusa, H. andKeraro, F. 2009. Using advance organizers to enhance students' motivation in learning biology.*Eurasia Journal of Mathematics, Science and Technology Education*, 5 (4), 413-420.

Sirhan, G. 2007. A study of the effects of pre-learning with first year university chemistry students.Unpublished PHD Thesis, University of Glasgon, London (UK).

Siringi, S. (2005, March 1). Students are avoiding physics, says Saitoti. The Daily Nation, Nairobi: Kenya: Nation Media Group Ltd. (p.11).

Skoning, S. 2008. Teaching exceptional children plus. *European Journal of Science* Education 8(3), 148-188.

Spenzzini, S. 2010. Effects of visual analogies on learner outcomes: Bridging from the known to unknown. *International Journal for the Scholarship of Teaching and Learning,* 4(2) 1-11.

Stevenson, H. and Lee, S. 2009. Impact of school resources on students' achievement.In W. H Sewel, R. M. Hussesand D.L. Featherman (Eds).*Schooling and Children in American Society*, (pp.123-183). New York: Random House.

Tasker, R. and Dalton, R. 2006. Research into practice: Visualization of the molecular world using animations. *Chemistry Education: Research and Practice,* 7 (2), 241-260.

Tasker, R. and Dalton, R. 2006. Research into practice: Visualization of the molecular world using animations. *Chemistry Education: Research and Practice,* 7 (2), 241-260.

Tella, A. 2007. The impact of motivation on students' academic achievement and learning outcomes in mathematics among secondary school students in Nigeria.*Eurasia Journal of Mathematics, Science and Technology Education*, 3 (2), 149-156.

Tsai, C. 1999. Overcoming junior high school students' misconceptions about microscopic views of phase change: A study of an analogy activity.*Journal of Science Education*, 8 (10, 834-891.

Vosniadou, S. 2003. Exploring the relationship between conceptual change and international learning.In G.M. Sinatra and P.R. Pintrich (Eds.). *Intentional Conceptual Change* (pp. 377-406). Mahwah NJ: Erbaum.

Vygotsky, L. 1986. *Mind in Society: The Development of Higher Psychological Processes*. Cambridge Ma: Harvard university Press.

Wachanga, S. 2002. Effects of cooperative class experiment teaching method on secondary school students' motivation and achievement in chemistry. An Unpublished PHD Thesis, Egerton University, Kenya.

Waithanji, J. 2014. Extent of integration of information communication technology in the teaching-learning process in secondary schools in Nyandarua County, Kenya.Unpublished M.Ed Thesis, Laikipia University, Kenya.

Wright, S., Sandra, P. and Sanders, W. 1997. Teacher and classroom context effects on students' achievement: Implications for teacher evaluation. *Journal of Research in Science Teaching* 12(1), 165-188.

Yost, R. 2013. Dance as a means of creating awareness. Online http://ae89-01a4bcf8879.html Retrieval date 20/06/2015.

Zhaoyao, M. 2002. Physics education for the 21st century: Avoiding a crisis. *Physics Education*, 37 (1), 18-24.

Appendix A: Students' motivation questionnaire (pretest)

S/No	Statement	1	2	3	4	5
1.	I am always alert throughout all physics lessons					
2.	I at times lose concentration during physics lessons					
3.	I find physics lessons quite interesting and exciting					
4.	It is always fun going through physics lessons					
5.	Physics lessons are boring to a large extent					
6.	I am not always convinced about the concepts I learn during physics lessons					
7.	I am not always eager to attend physics lessons					
8.	I find learning of physics concepts like force, heat, etc. quite convincing and assuring.					
9.	I find the information I learn during physics lessons quite useful in answering questions during examinations					
10.	The knowledge I acquire during physics lessons helps me understand other topics					
11.	The progress of physics lessons is always captivating					
12.	The knowledge I get during physics lessons does not help me understand the world around me					
13.	The knowledge I get during physics lessons always helps me solve day to day life problems					
14.	I find learning of many concepts in physics like force, heat, etc difficult					
15.	On the whole I can confidently say that physics lessons are not always useful to me					
16.	There are times when I do not find learning of physics informative					
17.	The progress of physics lessons enhances my ability to answer teacher's question during Physic lessons.					
18.	I enthusiastically participate actively during physics lessons					
19.	Learning physics concepts like force, heat, etc positively influences my desire to learn physics					
20.	Most times I am unable to apply the knowledge I gain from learning physics concepts in learning other subjects					
21.	I am quite confident that I will succeed in physics					
22.	I am not sure of my ability to do well in physics					
23.	The physics lessons I have attended so far have made learning of physics concepts easy and understandable					
24.	Going by the physics lessons I have attended so far, I hold that physics is a hard subject to learn					
25.	In most cases I find the activities during physics lessons meaningful					
26.	I am always satisfied with the way physics lessons are conducted					
27.	I eagerly look forward to participate in activities during physics lessons					
28.	I find most activities during physics lessons a waste of time					
29.	Most physics lessons are not stimulating					
30.	I find most physics lessons internally rewarding					
31.	The activities I go through during physics lessons do not make me appreciate physics					
32.	Most activities during physics lessons make me unhappy and frustrated					

Appendix B: Students' motivation questionnaire (posttest)

S/No	Statement	1	2	3	4	5
1	I was more alert during the course of the lessons compared to lessons in other topics in physics					
2	I kept getting lost during the course of the lessons					
3	The lessons were boring to a large extent					
4	I found the lessons quite interesting and exciting.					
5	It was more fun going through the lessons in comparison to lessons in other topics in physics.					
6	I was quite convinced about the heat concepts I learnt during the physics Lessons.					
7	It was not really exciting to learn about the 'heat' concepts during the course of the lessons					
8	I was more eager to attend the lessons in comparison to lessons in other topics in physics					
9	I acquired adequate information that will help me answer questions on the concept of 'heat'					
10	The knowledge I have acquired has no basis as a foundation for future learning of 'heat' concepts					
11	I developed considerable doubts about the concepts of heat during the lessons.					
12	The procedure of the lessons was not captivating					
13	The knowledge I have acquired during the lessons has helped me answer many questions about nature					
14	The knowledge I have gained will help me solve life problems related to the concept of 'heat'.					
15	I found the knowledge on the heat concepts hard to learn					
16	On the whole I can confidently say that the activities during the lessons were useful to me in any way					
17	I am not quite sure I will be able to answer examination questions using the knowledge I gained during the lessons					
18	The knowledge I have gained during the lessons has not positively influenced my attitude towards learning physics					
19	I am confident I can answer a good percentage of questions based on the concept of 'heat' in the Form 1I syllabus					
20	The knowledge I have gained may not help me answer a good proportion of questions in the Physics syllabus					
21	The knowledge I have acquired during the lessons has positively influenced my decision to consider physics as a career subject.					
22	I highly doubt my ability to learn physics concepts after going through the lessons					
23	Going through the lessons has made me realize that learning physics concepts is not all that difficult					
24	Going through the lessons has enhanced my view that physics is not a hard subject to learn					
25	I was quite encouraged during the lessons to learn about the heat concepts.					
26	The knowledge I acquired during the lessons will have no input on my success in physics subject					
27	I am not satisfied with the way the lessons were taught					
28	I was demoralized during the progress of the lessons of heat.					
29	It was a wastage of time doing the activities during the lessons					
30	Learning during the lessons was internally stimulating and rewarding					
31	The activities during the lessons positively influenced my desire to learn about the concepts.					
32	The activities during the lessons made me unhappy and frustrated					

Instructions

- This questionnaire is designed to collect your genuine views about teaching and learning of physics. The information you provide will be significant in improving teaching and learning of Physics in secondary schools. You are therefore asked to be as truthful as possible in your responses.
- The information you provide will be treated confidentially. Do not indicate your name anywhere on the questionnaire.
- Respond to all questions by putting a tick (√) inside the appropriate box
- The questions require you to indicate the extent to which you agree with the given statements. Use the key provided below:

Key

- Strongly Disagree
- Disagree
- Not Sure
- Agree
- Strongly Agree

Instructions

- This questionnaire is designed to collect your views regarding the lessons on kinetic theory of matter and its application in explaining physical phenomena associated with 'heat'. It is hoped that the responses you give will provide useful information to the curriculum developers and educators in improving the strategies of presenting the topics in schools. You are therefore asked to be as truthful as possible.
- The information you provide will be treated confidentially. Therefore do not indicate your name anywhere on the questionnaire.
- Respond to all questions by putting a tick (√) inside the appropriate box
- You are required to indicate the extent to which you agree with the given statements. Use the key below:

Key

- Strongly Disagree
- Disagree
- Not Sure
- Agree
- Strongly Agree

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