

## Enhancing Students' Self-Concept of Physics Concepts through Analogy Teaching

Peter Githae Kaboro

Laikipia University,  
P.O Box 1100-20300 Nyahururu, Kenya

---

### Abstract

Research in concept learning in science reveals that analogy is an effective instructional strategy within a constructivist paradigm. Efficacy of analogy teaching has been established in conceptualization of abstract concepts, addressing misconceptions and motivating learners. However, there is paucity of literature on the effect of analogy teaching on students' self-concept of science concepts. This study investigated the effect of using a traditional dance analogy on students' self-concept of physical heat concepts. Using the Solomon Four Non-equivalent Control Group Design, data were collected from Form I (Grade 9) students in four secondary schools in Nyandarua County, Kenya. The schools were assigned to the four groups of the study design. The instrument was a Heat Concepts Test (HCT) in two equivalent forms, one used for pretest and the other for posttest. The two forms of HCT were systematically assessed for validity and reliability by involving experts in science education and through pilot study. 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 analogy had significantly higher self-concept of physical heat concepts compared to those taught using usual conventional methods. Based on the finding, the study concludes that analogy is an effective teaching strategy which teachers should be encouraged to use as a way of boosting learners' self-concept of physics concepts.

---

**Keywords:** analogy, constructivism, physical heat concepts, self-concept, traditional dance

---

### INTRODUCTION

An important aspect of academic achievement in science learning is learners' self-concept of science concepts. Self-concept generally refers to the belief, whether accurate or not, that one has the potential to produce a desirable effect (Bandura, 1993). According to Chang (2008), students who believe in their abilities tend to perform more successfully than those who do not. Sahranavard and Hassan (2012) described science self-concept as the confidence in one's own capability to accomplish scientific tasks through organizing and executing knowledge and skills required to manage a science content or process. Studies have found significant positive relationships between self-concept and achievement in science (Kaya, 2008; TIMSS, 1999; West & Fish, 2003). However despite demonstrating clearly the positive correlation, the studies did not address the important question of how students' science self-concept can be enhanced.

Mason and Kahle (2009) have articulated that students who engage in active learning experiences develop higher self-concept than those who do not. Analogy is a general teaching-learning strategy that operates within the tenets of constructivism. The learner is guided to learn a new concept by linking its aspects with those of a familiar phenomenon with which it shares common attributes (Glynn, 1991). The underlying efficacy of a teaching analogy is a function of the magnitude of conceptual gains as well

as development of psychological dimensions of the curriculum that can be derived. (Harrison & Coll, 2005). According to Wachanga (2002) effective learning is associated with a well-designed set of instructional activities that involves learners. Therefore, in designing and selecting teaching analogies, it is important to consider the important question of active learner involvement in the learning process.

Various researchers have used analogy as an instructional strategy in science to facilitate conceptual change (Clement & Brown; 1989; Kigo, 2006; Tsai 1999), address students' misconceptions (Dilber & Duzgun, 2008), motivate learners (Shihusa & Keraro, 2009) and address gender differences in achievement (Lakoge, Jegede & Oyebanji, 2007). Review of literature did not identify any study that seeks to establish the effectiveness of analogy teaching in enhancing students' self-concept of science concepts.

A needs assessment survey 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). Explanation of observable behavior of heated or cooled matter is based on particulate nature and kinetic theory of matter (Feynman, 1995). The theory deals with the behavior

of sub-microscopic particles of matter and therefore there are no readily available practical activities to facilitate students' conceptualization. According to the study by CEMESTE, most teachers resorted to explaining observable physical phenomena associated with heating and cooling using theoretical approaches. As a result, students in the county have not only developed misconceptions of physical heat concepts as found out by Kaboro (2003) but also a negative attitude towards learning of the concepts. This observation motivated location of the present study in the county, focusing on learning of physical heat concepts.

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 in Kenya that attempts to use learners' socio-cultural knowledge as the basis for selecting or designing analogies to be used in concept learning in science. According to Harrison and Coll (2005), the factor of social climate to provide a basis for designing instructional experiences is important in developing the affective dimensions of curriculum. This study employed teaching using a traditional dance analogy and investigated its effect on learners' self-concept of physical heat concepts.

#### **STATEMENT OF THE PROBLEM**

Self-concept is an important psychological dimension of the physics curriculum, given its significance in attainment of expected learning outcomes. Review of literature indicated that there is paucity of information on the effect of analogy teaching on students' self-concept of science concepts in general and physics concepts in particular. This study focused on investigating the effect of teaching using a traditional dance analogy on physics students' self-concept of 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' self-concept of physical heat concepts. The effect was deduced by comparing analogical teaching with conventional teaching methods. Conventional teaching methods were identified as those employing the usual minds-on approaches that teachers regularly employ in science classrooms. These methods included among others, explanations, discussion and question and answer techniques.

#### **OBJECTIVES OF THE STUDY**

The specific objective of the study was to compare physics students' self-concept of physical heat concepts between those taught using traditional dance analogy and those taught using conventional methods.

#### **HYPOTHESIS**

The following null hypothesis was tested at an alpha level of .05

**Ho1:** There is no statistically significant difference in students' self-concept of physical heat concepts between those taught using traditional dance analogy and those taught using conventional methods.

#### **LIMITATIONS OF THE STUDY**

The study was limited to public secondary schools within Nyandarua County. As such, generalizations of results apply to students enrolled in public secondary schools and with caution to those in private secondary schools within the County. The aspects of physical heat concepts covered addressed by the study were limited to temperature, thermal expansion, heat energy transfer and phase change due to heating and cooling.

#### **DESIGN OF TRADITIONAL DANCE ANALOGY**

Dance formation and movement can be effectively used as a means of facilitating learning of science concepts (Skoning, 2008). Throughout history, educational philosophers and educators have advocated creative movement as a way of promoting learning. According to Jackson (2013), science is about movement and therefore concrete and functional movement in dance can be effectively connected to abstract scientific ideas. This study employed the idea of using traditional dance formation and movement to teach aspects of physical heat concepts. Traditional dances were preferred to other contemporary dances for moral considerations. Nyandarua County is located within the central part of Kenya which is predominantly occupied by the Kikuyu ethnic community. The community is endowed with a rich cultural heritage in which music and dance are highly valued.

'Ndumo' and 'Mwomboko' are popular folk dances among the kikuyu ethnic community that have survived even after the disappearance of other genres of neo-traditional dances (Kinyua, 2013). 'Ndumo' is usually performed by elderly women and is characterized by a formation where the dancers sway their bodies to and fro with the feet fixed to the ground. This movement was identified by this study as resembling movement of particles of solid matter. 'Mwomboko' is performed by dancing pairs, usually male and female. Its rhythm and tempo is controlled by the rate and intensity of sound from accordion and iron cymbals. Gethoi (2010) has analyzed the rhythmic, melodic and structural aspects of the dance in the context of Kikuyu traditions. The dancers move as they count two steps and then bend down rhythmically with heads bowing and hands held

together and stretched sideways. The dancers move back and forth within the dancing arena and often bump against one another. This movement was identified as comparable to the behavior of particles of liquids and gases in different temperature conditions. It was reasoned that, if the intensity of sound from the musical instruments represented the intensity of heat energy from the source and consequently the temperature of the environment, then the dancers and their movement would resemble that of particles of matter.

The foregoing ideas were used to design an instructional analogy to teach aspect of physical heat concepts. Links between aspects of the two concepts were mapped as illustrated in figure 1.

Figure 1: Traditional dance analogy with physical heat concepts

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: Author

Besides explaining the association of the linked ideas of the two concepts, emphasis was also laid on cases where the analogy broke down. These cases included, non-comparability between the number of

particles of matter with those of the dancers; emptiness of spaces between particles of matter and those between dancers; non-comparability of the size of particles in relation to space occupied by matter with the size of dancers in relation to dancing arena; and non-comparability of rate of motion of particles of matter with that of the dancers.

**THEORETICAL FRAMEWORK**

The study was guided by the social cognitive theory articulated by Bandura (1986). The theory emphasizes the role of observational learning and social experience in the development of personality traits. Because self-concept is developed from external experiences and self-perception and is influential in determining the outcome of many events, it is an important aspect of social cognitive theory. Self-concept theory describes self-concept as learned, organized and dynamic (Parajes, 2009). Graham (2011) identifies experience or enactive attainment as the most important factor in determining self-concept. According to Graham, the experience of mastery builds confidence and enhances expectations of success in tasks. The present study was undertaken with the assumption that analogous teaching would provide learners with a rich experience to ground their learning and hence bolster their self-concept of the physical heat concepts.

The main question addressed by the study was whether students taught using the traditional dance analogy would have significantly higher self-concept of physical heat concepts compared to those taught using the conventional teaching methods. Figure 2 shows the relationship among variables subsumed in the study.

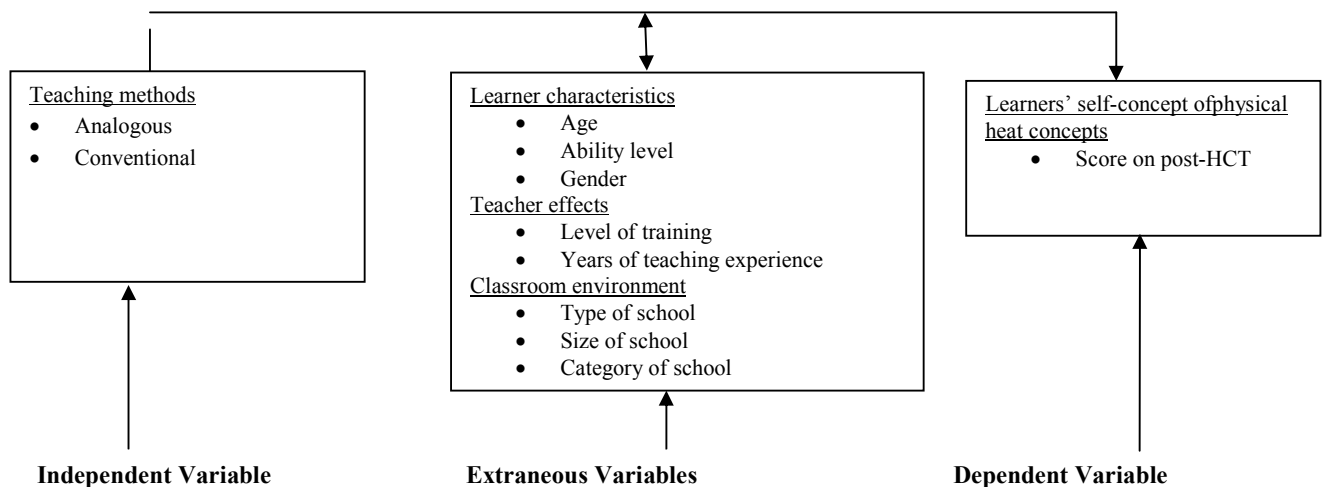


Figure 2: Relationship among variables of the study

Source: Author

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 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 & 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 were found to have no significant effect on learning outcomes.

The extent to which school related factors may influence learning outcomes has been investigated (Coon, Carey & Fulker, 2003; Stevenson & 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.

**METHODOLOGY**

**Research design**

Quasi-experimental research involving the Solomon Four Non-Equivalent Control Group Design was used. 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 & 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
E <sub>1</sub>	O <sub>1</sub>	X
C <sub>1</sub>	O <sub>3</sub>	O <sub>4</sub>
E <sub>2</sub>	X	O <sub>5</sub>
C <sub>2</sub>		O <sub>6</sub>

Figure 3: The Solomon Four Non-Equivalent Control Group Design.

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

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<sub>1</sub> was the true experimental group which received pretest O<sub>1</sub> the treatment X and posttest O<sub>2</sub>. Group C<sub>1</sub> was the true control group which received pretest O<sub>3</sub> followed by the control condition and then the posttest O<sub>4</sub>. Groups E<sub>2</sub> and C<sub>2</sub> received similar conditions as E<sub>1</sub> and C<sub>1</sub> respectively but did not receive pretests. The treatment groups E<sub>1</sub> and E<sub>2</sub> were taught using the dance analogy while the control groups C<sub>1</sub> and C<sub>2</sub> 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 by graduate 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 <sub>1</sub>	Nyandarua central	44
C <sub>1</sub>	Nyandarua North	48
E <sub>2</sub>	Nyandarua West	46
C <sub>2</sub>	Kipipiri	37
<b>Total (N)</b>		<b>175</b>

**Instrumentation**

The construct of self-concept has been variably defined and measured. While self-concept can be measured as a whole, as with the General self-Concept scale (Schwarzer& Jerusalem, 1995), it can also be measured in particular functional situations. For example, Smith and Betz (2000) defined self-concept as an individual’s ability to engage in interactional tasks necessary to initiate and maintain interpersonal relationships. They measured self-concept using an instrument of their own device called the Scale of Perceived Social Self-Concept (SPSS). Matsushima and Shiomi (2003) measured self-concept by focusing on self-confidence about social skill in personal relationships.

Academic self-concept has been described as the belief that one can successfully engage in and complete a course-specific academic task (Jimenez, 2006). According to McColsky and Sullivan (2000), self-assessment can be used to determine how learners perceive themselves in respect of their knowledge, skills and quality of their work. Self-assessment may involve learners reflecting on their own knowledge and the importance of their awareness about what they know. Learners can be asked to evaluate their understanding at any point in the instructional process (Harrison &Harlen, 2006). Yager and Kelleman (2002) designed a form of questionnaire where learners were asked to rate themselves on their understanding of science concepts before and after instruction. Responses were in four levels namely high, fairly high, medium and low. This design was adopted in this study with a slight modification where the four levels were described as very confident, confident, fairly confident and not confident. This was in response to learners’ answers to items in a Heat Concepts Test (HCT).

The HCT consisted of 12 multiple choice items. Each item comprised two parts. The first part asked respondents to give an answer to the multiple choice question where four alternatives were provided. The

second part required respondents to indicate their level of confidence in the answer they gave in the first part. A sample item in the instrument is illustrated in figure 4.

---

**Q. Which of the following statements correctly explains expansion of matter when heated?**

- A. Molecules of matter increase in size causing the whole matter to occupy more space
- B. Molecules of matter move faster and further causing the matter to occupy more space
- C. Molecules of matter multiply and increase in number causing the matter to occupy more space
- D. Molecules of heat mix with those of matter causing the matter to occupy more space

How confident are you that the answer you have indicated is the correct answer?

Very confident   Confident   Fairly confident   Not confident

**(Tick appropriately)**

---

Figure 4: Sample item in the Heat Concepts Test (HCT)

Source: Author

The concepts covered in the HCT included temperature, direction of heat energy transfer, expansion caused by heating, change of state, effect of heating/cooling on space between molecules of matter, effect of temperature on random motion of gas molecules and effect of temperature on size of molecules of matter. In constructing the items, specific syllabus objectives related to physical heat concepts were considered (KIE, 2012). Two equivalent forms of the HCT were developed one for use as pretest and the other for posttest. The items in the two forms were similar in form and content except for the specific situations in which the concepts were applied and ordering of items in the test.

The instrument was validated by four experts in science education and pilot tested in two schools within Nyandarua County. The schools were located in sub-counties different from those sampled for the main study. Reliability was determined using the internal consistency technique where Cronbach’s coefficient alpha was computed both the pre-HCT and Post-HCT. Reliability coefficients were .79 and .81 respectively. These were above the threshold of .75 recommended for social sciences research (Mugenda & Mugenda, 2003) and the instruments were therefore considered appropriate.

**Data Collection**

Teachers in the experimental groups E<sub>1</sub> and E<sub>2</sub> were trained by the researcher on how to use the dance activity to explain physical phenomena associated with heating and cooling. Pretest was administered to groups E<sub>1</sub> and C<sub>1</sub> followed by teaching of physical heat concepts in four instructional periods. In the experimental groups E<sub>1</sub> and E<sub>2</sub>, 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. Teachers also explained cases where the analogy broke down. Usual conventional methods were used to explain the behavior of heated or cooled matter for the control groups C<sub>1</sub> and C<sub>2</sub>. At the end of the teaching period, post-HCT was administered to all the groups.

**Data Analysis**

Students’ responses in the second part of the items in the HCT were scored using the score chart in table 2.

Table 2: Score Chart for Students’ Self-Concept of Physical Heat Concepts

Response	Score
Very confident	4
Confident	3
Fairly confident	2
Not confident	1

The total score for each student was computed which could range from 12 to 48. The mean score of students in each group was computed and the means compared. To test the significance of the difference between pre-HCT means for groups E<sub>1</sub> and C<sub>1</sub>, students’ t-test was used while ANOVA was used to test the significance of the difference among all group means on post-HCT. 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 using traditional dance analogy on students’ self-concept of physical heat concepts. This was to be achieved by comparing students’ self-concept scores on HCT between those taught using the analogy and those taught using the usual conventional methods. The Solomon Four Group Design enabled the researcher to compare students’ of the experimental and control groups E<sub>1</sub> and C<sub>1</sub> respectively with respect to their self-concept of physical heat concepts using pre-HCT 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 3.

Table 3: t-Test Analysis of the Significance of the Difference between Means for Groups E<sub>1</sub> and C<sub>1</sub> on pre-HCT Self-Concept Scores

Group	N	Mean	SD	dft-Value	P-
E <sub>1</sub>	38	28.79	2.59	78	0.665
C <sub>1</sub>	42	29.33	2.91		

Not significant t(78) = 0.665, P>0.05

Examination of the results displayed in table 3 shows that the mean score for the control group C<sub>1</sub> (mean = 29.33, standard deviation = 2.91) was higher than that of the experimental group E<sub>1</sub> (mean=28.79, standard deviation = 2.59). However, results of the t-test analysis indicated that the difference between the means was not significant (t(78) = 0.665, p>0.05). Hence the two groups were similar with respect to their self-concept of physical heat concepts prior to administration of experimental treatments.

The next step was to compare students’ scores on self-concept of physical heat concepts for all the groups E<sub>1</sub>, C<sub>1</sub>, E<sub>2</sub> and C<sub>2</sub> using post-HCT. Table 4 shows the means and standard deviations for the scores.

Table 4: Means and Standard Deviations of Students’ Scores on the Self-Concept of Physical Heat Concepts using Post-HCT

Group	N	Mean	SD
E <sub>1</sub>	38	38.47	4.07
C <sub>1</sub>	42	30.38	3.33
E <sub>2</sub>	44	39.07	4.45
C <sub>2</sub>	35	31.77	3.94

It is evident from the results in table 4 that the means of the experimental groups E<sub>1</sub> and E<sub>2</sub> (Mean = 38.47, SD =4.07 and mean = 39.07, SD = 4.45 respectively) were both higher than those of the control groups C<sub>1</sub> and C<sub>2</sub> (mean = 30.38, SD = 3.33 and mean = 31.77, SD = 3.94 respectively). The significance of the difference among the means was tested using ANOVA. Table 5 shows the results of the analysis.

Table 5: ANOVA Test of Significance of the Difference among Group Means on the Self-Concept of Physical Heat Concepts using Post-HCT

Source of variance	Sum of squares	df	Mean square	F-value	P-value
Between groups	887.33	3	295.78	13.33	0.000
Within groups	3438.35	155	22.18		*
Total	4325.68	158			

\*significant F (3,155) = 13.33, 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 6.

**Table 6:** Tukey-Kramer Post Hoc Comparisons of Students' Self-Concept 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
$E_1$	$C_1$	8.09	0.00*
	$E_2$	-0.60	0.91
$C_1$	$C_2$	6.70	0.00*
	$E_1$	-8.09	0.00*
	$E_2$	-8.69	0.00*
$E_2$	$C_2$	-1.39	0.00*
	$E_1$	0.60	0.91
	$C_1$	8.69	0.00*
$C_2$	$C_2$	7.30	0.00*
	$E_1$	-6.70	0.00*
	$C_1$	1.39	0.87
	$E_2$	-7.30	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 developed more students' self-concept of physical heat concepts compared to teaching the concepts using usual conventional methods. Consequently the hypothesis  $H_01$  was rejected. The results also suggest that use of the analogy had comparable effect on students' self-concept of physical heat concepts for the pretested and unpretested groups.

## DISCUSSION

The findings of the study indicated that students in the experimental groups  $E_1$  and  $E_2$  developed higher self-concept of physical heat concepts compared to those taught using the usual conventional methods. This finding is consistent with a number of studies that established significant positive relationships between learners' achievement and self-concept in science concepts. Kaya (2008) found science self-concept to be consistently correlated positively with science achievement. Sahranavard and Hassan (2012) carried out a study on lower secondary school students (grade 8) to investigate the relationship between a number of personality constructs and science performance in Iran. The constructs studied included self-concept, self-efficacy, self-esteem and anxiety. Their finding was that of all the constructs, only science self-concept had a significant influence on science performance. Their conclusion was that science self-concept has a significant role in students' learning of science concepts.

Mason and Kahle (2009) found that students who were engaged actively in learning experiences indicated higher self-concept in science. It can be explained that the dance analogy provided learners with an opportunity to link familiar knowledge with the new concepts. The learners were also engaged in developing their conceptions through active

participation. This may have boosted the learners' confidence thus enhancing their self-concept.

The psychological theory of attribution postulates that individuals develop beliefs about self-perception based on their success in tasks. Self-concept is enhanced by success and diminished by failure (Ormrod, 2006). Thus people will attribute their failures to stable factors such as difficulty of a task and will expect or believe to fail in the task. This implies that the higher the mastery expectations, the higher the self-concept developed (Jimenez, 2006). It can be hypothesized that teaching using the dance analogy developed a higher expectancy of success in mastering physical heat concepts thus enhancing more self-concept in students compared teaching using the usual conventional methods.

## CONCLUSIONS

Based on the findings of the study and with respect to the hypothesis posited for testing, a number of conclusions can be reached. Firstly, the results demonstrated that the dance analogy developed significantly higher self-concept of physical heat concepts compared to conventional instructional techniques. This implies that choice of appropriate instructional technique has a direct consequence on learners' science self-concept. Review of literature revealed that there is paucity of research in the area of learners' self-concept of science concepts, yet this is an important aspect of science learning because it provides an indicator of learners' confidence and self-evaluation of their own capacity to handle science tasks.

Secondly, the traditional dance analogy used in this study utilized social interactions within the classroom setting. 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 utilizing learners' socio-cultural knowledge to design learning experiences (Lakoye, Jegede & Oyebanji, 2007).

Thirdly, the finding strengthens the case for considering instructional techniques where learners are actively engaged in interesting instructional activities. As noted by Wachanga (2002), learners' interest and active participation should be an integral part of classroom science learning. It can be explained that as learners participated in the dance activities in this study, they actively took the responsibility over their own learning, thereby producing greater relevance, confidence and consequently higher self-concept.

## RECOMMENDATIONS

As demonstrated in this study, experiences grounded in learners' socio-cultural environment can be usefully exploited and integrated in learning scientific concepts leading not only to improved attainment but also enhanced psychological outcomes. The finding strengthens the case in favor of considering instructional activities that facilitate learning through learners' continuous engagement in processes that utilize social interactions within the classrooms. Given the interest and enthusiasm that secondary school students in Kenya show towards the annual schools music and drama festivals, teachers could integrate scientific themes within the music and dances thereby enhancing attainment of diversified learning outcomes.

Review of literature revealed that self-concept is not receiving adequate attention in science education in Kenya, despite the importance it plays in the attainment of learning outcomes. Studies have proved that there is positive correlation between science self-concept and attainment. There is therefore need to strengthen learners' self-concept during instruction. This should be achieved by making self-concept an integral part of science teaching through explicit statement as expected learning outcomes. It is also important for science educators and researchers to explore other means of enhancing learners' self-concept during instruction.

## REFERENCES

- Ary, D., Jacobs, L. & Razavieh, A. (1979). *Introduction to Research in Education*. New York, NY: Holt, Rinehart and Winston Inc.
- Bandura, A. (1986). *Social Foundations of Thought and Action*. Englewood Cliffs: Prentice-Hall
- Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist*, 28(2), 117-148.
- CEMASTE. (2010). *The Extent of Practice of ASEI-PDSI Approach to Teaching Mathematics and Science at Secondary School Level in Kenya*. Nairobi: CEMASTE.
- Chang, Y. (2008). Gender Differences in Science Achievement. Science Self-Concept and Science Values. Proceedings of the IRC-2008 TIMSS, Taiwan.
- Clement, J. & Brown, D. (1989). Overcoming misconceptions via analogical reasoning: Factors influencing understanding in a teaching experiment. *Instructional Science*, 18, 237-261.
- Cohen, L. & Manion, L. (2012). *Research Methods in Education*. London: Routledge Taylor and Francis Group Limited.
- Coon, H., Carey, G., Fulker, D. (2003). Influence of school environment on academic achievement scores. *Intelligence*. 17 (1), 79-104.
- Dilber, R. & Duzgun, B. (2008). Effectiveness of analogy on students' success in eliminating misconceptions. *Journal of Physics Education*, 2(3), 174-181.
- Feynman, R. (1995). The concept of energy. *Physics Education*, 9, 490-498.
- Fraenkel, R. & Wallen, E. (2000). *Educational Research: A Guide to the Process*. New York: McGraw-Hill Inc.
- Gethoi, M. (2010). History of mwomboko dance. Online <https://groups.yahoo.com/neo/groups/africa-oped/conversations/topics/42565> Retrieval date: 6/2/2015
- Glynn, S. (1991). Explaining science concepts. A teaching with analogies model. In S.M. Glynn, R.H. Yeany and B.K. Britton (Eds.). *The Psychology of Learning Science* (pp. 219-239). Hillsdale, NJ: Erlbaum.
- Graham, S. (2011). Self-concept and academic listening. *Journal of English for Academic Purposes* 10(2): 113 -117.
- Hall, R. (1998). *The Psychology World: Virtual Statistician*. New York: RAWA Inc.
- Harrison, A. & Coll, R. (2005). *Using Analogies in Middle and Secondary Science Classrooms: An Interesting Way to Teach*. New York: Plenum Ltd.
- Harrison, C. & Harlen, W. (2006). Children's self and peer assessment. In W. Herlen (Ed) *ASE Guide to Primary Science Education* (pp. 256-301) Hatfield: Association for Science Education. [
- Jackson, L. (2013). Dancer teaches science through movement. Online <http://m.trib.com/news/local/jackson/article-7d5071fl-7eb> Retrieval date 8/10/2014
- Jimenez, S. (2006). Inspiring academic confidence in the classroom: An investigation of features of the classroom experience that contribute to the academic self-concept of undergraduate women enrolled in gateway courses. Dissertation completed at the University of Wisconsin-Madison.
- KIE, (2012). *Science Syllabus for Kenya Certificate of Secondary Education*. Nairobi: Kenya Literature Bureau.

- Kaboro P. (2003). Influence of intellectual and cultural environments on students' conceptions of the topic "Heat" in secondary school and university physics education. An Unpublished M. Ed. Thesis: Egerton University, Njoro (Kenya).
- Kaya, S. (2008). The effects of student-level and classroom level factors on elementary students' science achievement in five countries. *American Journal of Scientific Research* 3:26-37.
- 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/123456789/7484](http://ir.libraryku.ac.ke/handle/123456789/7484). Retrieval date 20/06/2014.
- Kruger, I. (1999). Experimental estimates of education production functions, *Quarterly Journal of Economics* 8(3), 18-33.
- Lakoge, B., Jegede, O. & Oyeibanji, 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.
- Mason, C. & Kahle, J. (2009). Draw-a-scientist test. Future implications in school science and mathematics. *Review of Research in Education* 91(5), 193-198.
- Matsushima, R. & Shiomi, K. (2003). Social self-concept and interpersonal stress in adolescence. *Social Behaviour and Personality*, 31(2): 114 – 125.
- Mbeche, I. (2002). Sampling methods. In P. Ngau & A. Kumsa (Eds). *Research design, data Collection and Analysis: A training manual* (pp. 108-139). United Nations centre for regional Development, Africa office.
- McClosky, W. & Sullivan, R. (2000). *How to Assess Performance in Science: Going Beyond Multiple Choice Tests*. Carolina: University of North Carolina.
- Mugenda, M. & Mugenda, A. (2003). *Research Methods: Qualitative Approaches*. Nairobi: Act Press.
- Ormrod, J. (2006). *Educational Psychology: Developing Learners* (5th ed). Upper Saddle River, N. J: Pearson Practice Hall.
- Parajes, F. (2009). Self-concept beliefs in academic contexts: Online, <http://www.des.emony.edu/mfp/efftalk.html>. Retrieved date: 5/10/2015.
- Park, A. & 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.
- Sahranavard, M. & Hassan, S. (2012). The relationship between self-concept, self-efficacy, self-esteem, anxiety and science performance among Iranian students. *Middle East Journal of Scientific Research*, 12(9), 1190-1196.
- Schwarzer, R & Jerusalem, M. (1995). Generalized self-concept scale. In J. Weinman, S. Wright and M. Johnston. (Eds). *Measures in Health Psychology: A user's portfolio. Causal and control beliefs* (pp. 35 – 37). Windsor, UK: NFER – NELSON.
- Shihusa, H. & Keraro, F. (2009). Using advance organizers to enhance students' motivation in learning biology. *Eurasia Journal of Mathematics, Science and Technology Education*, 5 (4), 413-420.
- Skoning, S. (2008). Teaching exceptional children plus. *European Journal of Science Education* 8(3), 148-188.
- Smith, H. & Betz, N. (2000). Development and validation of a scale of perceived social self-concept. *Journal of Career Assessment*, 8(3): 285-286.
- Stevenson, H. & Lee, S. (2009). Impact of school resources on students' achievement. In W. H Sewel, R. M. Husses & D.L. Featherman (Eds). *Schooling and Children in American Society*, (pp.123-183). New York: Random House.
- TIMSS, (1999). An empirical study analyzing the status quo, the efficacy and some problems of the integration of students' preconceptions. A Paper presented at the Third International Mathematics and Science Study Conference, University of Bern, Switzerland, 1999.
- 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.

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

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.

West, C. & Fish, J. (2003). Relationships between self-concept and school achievement. *American Journal of Psychology*. 21(1) 106-110.

Wright, S., Sandra, P. & 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.

Yager, R. & Kellerman, L. (2002). *Assessment Ideas for Science: Six Domains*. IOWA: University of IOWA.