Eurasia Journal of Mathematics, Science & Technology Education, 2009, **5**(4), 413-420

Using Advance Organizers to Enhance Students' Motivation in Learning Biology

Hudson Shihusa and Fred N. Keraro
Egerton University, Egerton, KENYA

Received 14 May 2008; accepted 11 February 2009

This study investigated the effect of using advance organizers on students' motivation to learn biology. The research design used was quasi-experimental design where the non-randomised Solomon Four group was adopted. The focus was on the topic pollution. The sample comprised of 166 form three (third grade in the secondary school cycle) students in Bureti District, Kenya. Data was collected by using Students' Motivation Questionnaire (SMQ). A t-test, one-way ANOVA and ANCOVA statistical techniques were used to analyze the data. The findings indicate that students taught using advance organizers had a higher level of motivation than those taught using conventional teaching methods. The findings further indicate that following the intervention, male students had a significantly higher level of motivation than their female counterparts. This paper concludes by discussing the implications of these findings on current practice.

Keywords: Advance Organizers, Motivation, Learning Biology.

INTRODUCTION

Biological knowledge plays a fundamental role in most aspects of human life. It's applications in genetic engineering has resulted in the production of high yielding plant and animal species. This has made a tremendous contribution towards meeting the demand of food requirements for the ever growing human population (Burns & Bottino, 1989). Biological knowledge has also been applied in branches of medicine such as organ transplant and control of a wide range of diseases. Biological knowledge is also applied in industry such as the use of microorganisms in food processing. Other areas where biological knowledge has been applied include population control and environmental conservation (UNESCO, 1986).

Chaille and Britain (1997 have argued that most children come to school ready and willing to learn. The challenge, therefore, teachers are faced with, and in this particular case the science teachers is to foster and strengthen this disposition and ensure that children leave school with the motivation and capacity to continue learning science throughout life. Martin, Sexton, Wagner and Gerlovich (1998) posit that learners' attitudes carry a state of readiness or willingness to learn. They direct learners when they enter into new experiences and hence influence how they would respond to situations or events. It is, therefore, important for teachers to use approaches that would enhance learners' positive attitudes towards science and hence motivation to learn. Without the development of positive attitudes towards the learning of science, learners will not be well prepared to acquire scientific knowledge and skills necessary for meaningful contribution to debates and decisions on societal issues that have a scientific orientation. It is thus unlikely that such individuals can make any meaningful contribution to socio-economic development.

According to UNESCO (1975) and Osborne (1997), school biology should be relevant to real life and experience of a learner. There is need to change from closely directed learning of facts to conceptual understanding, application of acquired knowledge and skills to solve emerging problems. Students leaving high

Correspondence to: Fred N. Keraro, PhD in Education, Egerton University, Department of Curriculum, Instruction and Educational Management
P.O. Box 536, Egerton, KENYA
E -mail: fnkeraro@yahoo.com

ISSN: 1305-8223

schools should be able to apply scientific knowledge learned and solve some of the problems encountered in everyday life (Rose, 1971). Nelson (2000) posits that there is a relationship between motivation, cognitive engagement and conceptual change. An effective teaching approach should, therefore, utilize a wide variety of teaching methods to enhance learners' motivation and actively involve them in the learning process. Expository approaches cannot stand up to the challenges of the new demands and objectives of biology education hence the need to explore new teaching approaches (UNESCO, 1986). Teaching approaches that actively involve learners would likely lead to higher motivation and meaningful learning compared to those where they remain passive. UNESCO suggests including teaching approaches which are inquiry/discovery based and which requires some form of problem solving. These approaches have the capacity to motivate learners and actively involve them in the learning process.

Mills (1991) argues that a teaching approach that a teacher adopts is a strong factor that may affect a learner's motivation to learn and hence has a direct impact on the resultant cognitive gain. In recent years, science educators have used the constructivist approach to enhance students' learning (Trowbridge, Bybee & Powell, 2004). According to Good and Brophy (1995), in constructivist teaching, learners are seen not just as accessing information but also as constructing meaning. Aslop and Hicks (2001) point out that learning of science is essentially an active process. Keraro, Wachanga and Orora (2007) conducted a study to investigate the effects of cooperative concept mapping (CCM) teaching approach on secondary school students' motivation to learn biology. Their findings indicate that the CCM teaching approach significantly enhanced students' motivation to learn as students are actively engaged during the instructional process. Tella (2007) also adds his voice to this debate. He asserts that of all the personal and psychological variables that have attracted researchers in educational achievement, motivation seems to be gaining more popularity and leading other variables.

Academic motivation is the psychological process that determines the direction, intensity and persistence of behaviour related to learning (Husen & Postelthwaite, 1991). Beihler and Snowman (1997) argue that motivation determines arousal, selection, direction and continuation of learner's behaviour. Motivation is a crucial component in learning and it is critical in determining achievement of students (Sprinthall & Sprinthall, 1990; Hemke, 1990). Motivation of learners is one of the most important factors in teaching. As Kochhar (1992) states, without it, there can be no learning and with it, learners cannot be prevented from learning. This idea is concured by Slavin (1997) when he posits that students' motivation is an internal process that activates guides and maintains learners behaviour over time and will also propel and direct them to engage in learning activities. A motivated student is, therefore, one who has inner state that energizes channels and maintains his/her behaviour and directs it to some desired need or goal (De Cecco & Crawford, 1988).

Use of advance organizers in learning

An advance organizer is a kind of cognitive bridge, which teachers use to help learners make a link between what they know and what is to be learnt (Novak, 1980). Advance organizers can refer to a relatively short arrangement of material introduced to the learner before the lesson. It is designed to cue the relevant prior knowledge of a learner and it is usually presented at a higher level of abstraction, generality and inclusiveness than that of the planned lesson (Curzon, 1990). Advance organizers are therefore frameworks that enable students learn new ideas or information and meaningfully link these ideas to the existing cognitive structure.

According to Ausubel (1960), an advance organizer is a material that is introduced before an unfamiliar content so as to facilitate its assimilation. They, therefore, act as an anchor for the reception of new content (Ausubel, 1963). Ausubel further points out that cognitive restructuring process that is as a result of advance organizers leads to some positive learning outcome. In this study, a film, a chart and text handouts on pollution were used as a bridge to help learners link between what they knew about pollution and what was to be learnt.

Types of advance organizers

There are two broad categories of advance organizers. One of them is "Expository organizers' which are used whenever the new material is totally unfamiliar; they emphasize context and link the essence of the new material with some relevant previously acquired concepts. The other one is "Comparative organizers" which are used when the material to be learnt is not entirely new. They are intended to point out ways in which that material resembles and differs from that which is already known (Curzon, 1990).

According to Novak (1980), advance organizers would include analogy, metaphor, model or capsule of knowledge as well as concept maps. Graphic organizers provide a visual holistic representation of facts and concepts and their relationships within an organized frame. They exist in a variety of forms which include sequence chain, story map, main idea table, flow charts, matrix and venn diagrams (Anders, Bos & Filip, 1984). Graphic organizers may be productively utilized before instructional activities such as reading or viewing a film, to activate prior knowledge to provide a conceptual framework for integrating new information and encourage student prediction. During instruction, they can help students to actively process and re-organize information. Novak (1980) asserts that creative teaching, when well done, includes the selection and use of good advance organizers. In this study a film, a chart (expository advance organizers) and text handouts (comparative advance organizer) on environmental pollutions were the advance organizers. The film was in three sections which covered water, land, air pollution and their causes. The chart covered the effects and control measures of water, land and air pollution. The handouts covered radioactive and noise pollution, their effects and possible control measures. All the advance organizers were presented to learners before actual classroom instruction took place.

Effects of the use of advance organizers on learning

Research into the use of advance organizers suggests that they are of considerable value where the learner may not be able to recognize his or her prior knowledge as relevant and where the teacher wishes to focus students' attention on relationships among linked parts of an idea and on connections between parts and the whole (Curzon, 1990). Curzon further points out that Ausubel's own research suggests that the use of advance organizers can enhance the relationship between cognitive structure and new material, thus facilitating teaching and learning. A study by Nyabwa (2005) has demonstrated the effectiveness of using advance organizers in the teaching of mathematics in secondary schools. Their merit in facilitating meaningful learning of expository materials has been recorded by Allen (1970); Lawton & Wasnaka (1977). White and Tisher (1986) presented evidence suggesting that students who lack relevant prior knowledge are most likely to benefit from the use of advance organizers and that this may explain the contradictions among studies.

Weil and Murphy (1982), assert that use of an advance organizer is a highly effective instructional strategy for all subject areas where the objective is to achieve meaningful assimilation of concepts. According to Mayer (1979), advance organizers have positive but conditional effects on learning. Mayer further suggests that the most effective advance organizers are those that:

Allow the students to generate all or most of the logical relationships in the material to be learnt.

Point out relationships between familiar and less familiar material.

Are relatively simple to learn, and

Are used in situations in which the learner would not spontaneously use them.

As a result of this view it can be concluded that advance organizers have a positive influence on learning outcomes. A study by Willerman and Mac Harg (1992) investigated the effects of advance organizers on students' conceptualization of pollution in biology. In this study concept mapping was used as an advance organizer. The findings of this study revealed that students are not passive subjects in the learning process if they use concept mapping as an advance organizer. These findings, therefore, make a contribution to the literature on strategies that would be used to enhance students' motivation to learn. In the current study teachers of the experimental groups were inducted on how to use the advance organizer teaching strategy to ensure they successful incorporated it in their instructional process.

Purpose of the study

The purpose of this study was to determine the effect of using advance organizers as a teaching strategy on student's motivation. Specifically, the study attempted to find out the effectiveness of using advance organizers on students' motivation in biology as compared to the conventional teaching methods, methods that do not actively engage learners in learning activities such as a lecture and demonstration.

METHODOLOGY

Research design

This study adopted a quasi-experimental research design. This design was chosen because the unit of sampling, a class, was already constituted and, therefore, it was unethical to re-constitute one randomly. The design involved a random assignment of intact classes to four groups.

Group E_1 Received the pre-test, the treatment X and the post-test.

Group C_1 Received a pre-test followed by the control condition and a post-test.

Group E_2 Received the treatment X and a post-test

Group C_2 Received the post-test only.

Group C_1 and Group C_2 were taught using conventional methods.

This design controlled for all major threats to internal validity except those associated with interactions of selection and history, selection and maturation and selection and instrumentation (Cook & Campbell, 1979). To control for interaction between selection and maturation, the schools were assigned randomly to the control and treatment groups. No major event was observed in any of the sampled schools that would have resulted in interaction between selection and history. The conditions under which the instrument was administered were kept as similar as possible in all the schools to control for interaction between selection and instrumentation (Gall, Borg & Gall, 1996).

Four provincial co-educational secondary schools in the Republic of Kenya in Bureti District were purposively sampled. The District was chosen because it has been recording very low achievements in biology at the Kenya Certificate of Secondary Education (K.C.S.E) and motivation of the students to learn biology was thought to be one of the factors contributing to this low achievement. Only Form three (the third year in the secondary school cycle in Kenya) students from each of the four schools were included in the study sample. The topic covered in this study was pollution in secondary school biology. Form three students were purposively selected for the study because this is the level where the topic pollution is covered in secondary school biology. The average age of learners at this level is 16 years. A total of 166 students participated in the study.

Instrumentation

Students' Motivation Questionnaire (SMQ)

The Students' Motivation Questionnaire (SMQ) was used to collect data. The questionnaire had a total of twenty items constructed on a five point Likert scale. The items were based on the topic pollution which was the focus of this study. It contained 20 five-point Likert scale items which aimed at assessing the students' level of motivation to learn Biology using the advanced organizer teaching strategy and the regular methods. The maximum score for the SMQ was 100 and the minimum 20. The instrument was validated by two experienced science teachers and three science education specialists. The SMQ instrument was pilot tested in one secondary school in Kericho District, which neighbours Bureti District. Cronbach's coefficient alpha was used to determine the reliability of SMQ. A reliability coefficient of 0.71 was obtained.

The construction and use of instructional materials

The researchers developed an instructional manual for the teachers of the experimental groups. The teachers were inducted on the use of advance organizers for five days before the intervention period. A pre-test was administered to groups E1 and C1. This was followed by an intervention period of three weeks. At the end of the intervention period, a post-test was administered to all the four groups.

The advance organizers used in the study were a film, a chart and a handout. The film was in four sections addressing water, land and air pollution and their causes. Students in the experimental groups E1 and C1 were shown the film prior to classroom instruction. They were expected to watch the film and give an explanation on:

What is involved in pollution

Causes of pollution

Different type(s) of pollution (shown in the film)

During classroom instruction learners were given time to explain their understanding of the term pollution. The teacher actively engaged learners in the discussion. The chart, just like the film was presented to the learners prior to actual classroom instruction. The chart had three sections, A and B which had a dead fish and bird respectively and section C which showed the recycling of wastes and hand fills. Learners were required to explain the message presented by the chart. During the instructional process learners were actively engaged in a discussion in an effort to interpret the chart. The handout contained information on radioactive and noise pollution. This too was presented to the learners prior to instruction. Learners were expected to read the text and come up with the causes of radioactive and noise pollution and possible control measures.

Data collection

For this study, SMQ was used to collect data. The researchers administered the instrument with assistance from Biology teachers in respective schools. Groups E1 and C1 were given pre-test before the start of the treatment. This followed by treatment, which took three weeks. After treatment, the researchers with the assistance of Biology teachers for the groups in the study sample administered post-tests to the four groups. The researchers then scored the responses from students and generated quantitative data which was analyzed.

Data analysis

Data was analyzed using one-way ANOVA, analysis of covariance (ANCOVA) and a t-test. Analysis of variance (ANOVA) was used to determine if the four groups differed significantly among themselves on experimental variables. Analysis of covariance (ANCOVA) was used to cater for the initial differences among the groups. A t-test was used to test differences between the pre-test mean scores because of its superior quality in detecting differences between two groups (Gall, Borg & Gall,1996).

RESULTS

Pre-tests results

At the beginning of this study the assumption was that the groups to be used in the study were similar. The researchers, therefore, sought to assess the homogeneity of the groups before the application of treatment as recommended by Gall, Borg and Gall (1996); Wiersma and Jurs (2005). A pre-test was administered on two groups. The pre-test used was the Students' Motivation Questionnaire (SMQ). SMQ had a maximum score of 100. The groups that were pre-tested were experimental group (E1) and the control group (C1).

Table 1 shows that the mean for group E1 was 83.28 while that of C1 was 80.34. Thus the level of motivation between groups E1 and C1 is significantly different, $t(79)=2.08$, $p<0.05$.

The results in table 2 show that the mean for male students was 84.05 while that of their female counterparts was 79.59. The t-value is 3.29 and indicates that a statistically significant difference exists between the two means. The difference necessitated the researcher to use ANCOVA on the pre-test scores to analyze the effects of initial difference among the groups. The groups used in this study exhibited similar characteristics and were therefore found to be suitable for the study.

Results of post-test

The Students' Motivation Questionnaire (SMQ) mean scores of students from the four groups were compared using one way ANOVA. The results are shown in Tables 3 to 7.

The post-test mean scores for the four groups were different. Group E1 and E2 had means of 86.00 and 86.33 respectively while group C1 and C2 had means of 78.22 and 80.07 respectively. One–way ANOVA was carried out to find out whether these means were significantly different. The results are shown in Table 4.

Table 4 shows that the difference in the mean scores between the four groups were significant $F(3,162) =22.78$, $p<0.05$. After establishing that there was a significant difference between students taught the topic pollution using advance organizers and those taught using conventional teaching methods, it was important to carry out further tests to show where the difference occurred. This was done using post-hoc tests of multiple comparisons using Tukey test. The results are presented in table 5.

The results indicate that the differences in mean

Table 1. t-Test results of the pre-test scores on SMQ

Group	N	Mean	SD	Std. Error Mean	df	t-value	p-value
E_1	40	83.28	4.53	.72	79	2.08	0.04
C_1	41	80.34	7.70	1.20			

Table 2. t-Test results of the pre-test scores on SMQ by gender

Gender	N	Mean	SD	Std. Error Mean	df	t-value	p-value
Male	40	84.05	5.11	.81	79	3.29	0.00
Female	41	79.59	6.94	1.08			

Table 3.SMQ post-test mean scores obtained by students in the four groups.

Group	N	Mean	SD	Minimum	Maximum
E_1	40	86.00	5.67	75.00	98.00
C_1	41	78.22	7.03	59.00	90.00
E_2	43	86.33	4.27	75.00	96.00
C_2	42	80.07	4.96	68.00	88.00
Total	166	82.66	6.57	59.00	98.00

Table 4. Analysis of Variance (ANOVA) of the post-test scores on SMQ

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2113.86	3	704.62	22.78	.00
Within Groups	5007.25	162	30.91		
Total	7121.11	165			

Critical alpha = 0.05

Table 5. Tukey post-hoc pair-wise comparisons of the post-test SMQ for the four groups

	E_1	C_1	E_2	C_2
E_1	-	-7.78 (*)	-.33	5.93(*)
C_1	7.78(*)	-	-8.11(*)	-1.85
E_2	.33	8.11(*)	-	6.25(*)
C_2	-5.93(*)	1.85	-6.25(*)	-

* Denotes the mean difference is significant at the 0.05 level.

Table 6. ANCOVA of the post-test scores of SMQ with pre-test scores as covariate

Source	**Sum of squares**	**df**	**Mean square**	**F-value**	**Sig.**
Group	771.08	1	771.08	24.39	0.00
Pre-test SMQ	766.85	1	766.85	24.25	0.00
Error	2466.17	78	31.62		
Total	4458.69	80			

Table 7. T-test results of the post-test scores on SMQ by gender

Gender	N	Mean	SD	Std. Mean	Errordf	t-value	p-value
Male	41	87.51	4.04	.63	81	2.51	0.01
Female	42	84.86	5.46	.84			

scores of groups E1 and C1, groups E1 and C2, groups E2 and C1 and groups E2 and C2 were statistically significant at 0.05 margin of error. It was, therefore, necessary to carry out ANCOVA to help in confirming the results. Table 6 shows the results of ANCOVA of the post-test scores of SMQ.

An examination of Table 6 reveals that the difference between the two groups is statistically significant $F(1,78)$ 24.39, $p<0.05$. This would, therefore, suggest that advance organizers improved the motivation of students who were in the experimental groups compared to those in control groups.

Comparison of motivation on the Students' Motivation Questionnaire (SMQ) by gender

To establish the effect of advance organizers on gender motivation in biology, the post-test mean scores of the SMQ were analyzed. Table 7 shows the t-test results.

The data in Table 7 indicates that the difference in SMQ mean scores between the male and the female students were statistically significant $t(81) = 2.51$, $p<0.05$. Male students who had a mean of 87.1 were more motivated by advance organizer teaching strategy by the females who had a mean of 84.86. After treatment, the level of motivation for both male and female students went up though at the end there was a significant gender difference.

DISCUSSION

The findings of this study have shown that advance organizers enhance learners' motivation to learn. The use of advance organizers in this study, therefore, enabled learners to be active cognitively and hence was motivated to learn biology.

A study by Solomon (1986) on motivation shows that active involvement of learners enhances their understanding of new situations. In this study, a film on pollution was used as an advance organizer captured the learners' interest hence enhancing their motivating them to learn biology.

Kithaka (2004) working for the Strengthening of Mathematics and Science in Secondary Education (SMASSE) project in Kenya argued that there is a general feeling among students that science subjects are difficult. This feeling according to Kithaka is as a result of poor performance at National examinations, where anticipation of negative outcomes blocks or inhibits learning effort; saturation of the job market which discourage students; socio-cultural attitudes; and too much theoretical teaching of sciences. Science teachers are with students most of the time hence, they are the most important agents that can influence change in the students' attitude towards science through stimulating and motivating instructional strategies like advance organizers. The use of advance organizers proved interesting and stimulating since the learners were exposed to prior information that was to be learnt later (Ausubel, 1968). Parkinson (1994) points out that it is up to teachers to ensure that they make science as inviting as possible. Indeed, as demonstrated in this study, this can be achieved by the use of advance organizers.

The other major finding in this study was that there was a significant gender difference in motivation to learn biology in favour of male students (see tables 2 &7). This seems to contradict earlier studies which show that girls have more positive attitudes towards biology (and hence should be more motivated to learn the discipline) than boys (Keeves & Kotte, 1992; Dawson, 2000; Proko, Tuncer & Chuda, 2007). This may be attributed to the fact that as Wachanga (200) has argued, teachers treat boys and girls differently and in ways that often are not beneficial to girls motivation and achievement. Puhan and Hu (2006) in their study also found that motivation is an important predicator of science achievement than gender. Proko, Tuncer & Chuda (2007) also posit that teacher characteristics have a significant role on students' attitude towards biology. Perhaps this would also explain the gender differences in motivation noted in this study. This also seems to suggest that more research needs to be devoted to the role of teacher characteristics on students' motivation to learn science.

CONCLUSION

ANOVA and ANCOVA results indicated that a significant difference was identified between group means of students who were taught using advance organizers and those taught using conventional teaching methods. Even though there was a significant gender difference in motivation in favour of male students there was an improvement in both mean scores after the treatment. Thus advance organizers enhance students' motivation to learn biology compared to conventional teaching methods.

IMPLICATION

The findings of this study have indicated that the use of advance organizer teaching strategy results in higher students' motivation in biology. Thus the strategy should be incorporated into the teaching of biology at secondary school level. This in turn would improve students' motivation to learn biology. Curriculum developers in their efforts to improve the effectiveness of biology teachers should encourage the use of advance organizers. Teacher training institutions should also make the use of advance organizers part of the biology teacher education curriculum.

REFERENCES

Allen, D.I. (1970). Some effects of advance organizers and level of question on the learning and retention of written social material. *Journal of Education Psychology,* 61 (5), 333-339.

Alsop, S. & Hicks, K. (2001). *Teaching Science.* A handbook for primary and secondary school teachers. Glasgow: Bell and Basin Ltd.

Anders, P. L., Bos, C. S. & Filip, D. (1984). *The effects of semantic feature analysis on the reading comprehension of learning disabled students.* Illinois: University of Illinois Press, Inc.

Ausubel, D. P. (1960). The use of advance organizers in learning and retention of meaningful material. *Journal of Education Psychology*, **51**-267-272.

Ausubel, D.A.P. (1963). *The psychology of meaningful verbal learning.* New York: Grune & Stratton Inc.

Ausubel, D. A. P. (1968). *Educational psychology: A cognitive view.* New York: Holt, Rinehart and Winston, Inc.

Beihler, R. F., & Snowman, J. (1997). *Psychology applied to education.* (8th ed). Boston: Houghton Mifflin Company.

Burns, W. G., & Bottino, J. P. (1989). *The science of genetics* (6th ed.) New York: Macmillan Publishing Company.

Chaille, C. & Britain, L. (1997). *The young child as scientist.* A constructivist approach to early childhood science Education 2nd Edition. New York ,Longman

Curzon, L. B. (1990). *Teaching in further education: An outline of principles and practice* (4th ed.) London: Cassel Education Ltd.

Dawson, C. (2000). Upper primary boys'and girls' interest in science: Have they changed since 1980? *International Journal of Science Education, 22(6), 557-570.*

De Cecco, J. P., & Crawford, W. (1988). *The psychology of learning and instruction: Education psychology,* (2nd ed). New Delhi, India: Prentice Hall of India Private Limited.

Eggen, P. D., Kuchak, D. P., & Harder, R. J. (1978). *Strategies for teachers: Information processing models in the classroom.* New Jersey; Prentice Hall, Inc.

Gall, M. D., Borg, W. R., & Gall, J. P. (1996). *Education research an introduction* (6th ed.). White plains N.Y: Longman.

Good, L. T, & Brophy, J. (1995). *Contemporary educational psychology* (5th ed.). New York, Longman Publishers.

Hamilton, L. C. (1985). The retentive effects of advance organizers. *Journal of Studies in Education,* 1(**1**); 112-118.

Hemke, A. (1990). Mediating processes between children's self-concept of ability and mathematics achievement: A longitudinal study. In H. Mandhl, E. Decorte, S. N. Bennet & H. F. Friedrich (Ed). *Learning and instruction: European research in an international context. Vol. 2.2. Analysis of complex skills and complex knowledge domains.* (pp. 537-549). Oxford: Pergamon Press.

Husen, T., & Postlethwaite, T. N. (1991). *International encylopaedia of education.* New York, N.Y: Pergamon Press.

Keeves, J. & Kotte, D. (1992). *Disparities between the sexes in science education:* 1970-84. In J. Keeves (Ed.), The IEA study of science III. New York: Pergamon, pp. 141-164.

Keraro, F. N., Wachanga, S. W., & Orora, W. (2007). Effects of cooperative concept Mapping teaching approach on secondary school students motivation in biology, Gucha District, Kenya. *International Journal of Science and Mathematics Education,* 5, 111-124.

Kiboss, J. K. (1997). *Relative effect of a computer based instruction in physics on students attitudes, motivation and understanding about measurement and perception of classroom environment.* Unpublished Ph.D. Thesis, Republic of South Africa, University of Western Cape, Bellville.

Kithaka, J. N. (2004). Attitudes towards mathematics and science. Paper Presented During SMASSE Project Cycle One, Nairobi, April 2004.

Kochhar, S. K. (1992). *Methods and techniques of teaching*. New Delhi: Sterling Publishers Pte. Ltd.

Lawton, J. T., & Wasnaka, S. K. (1977). Advance organizers as a teaching strategy: A Reply to Barnes and Clawson. *Review of Educational Research,* 47, 233 – 244.

Martin, R. Sexton, C, Wagner K & Gerlovich J. (1998) *Science for All children. Methods for constructing understanding*. Boston, Allyn & Bacon

Mayer, R. E. (1979). Twenty years of research on advance organizers: Assimilation theory is still the best predictor of results. *Instructional Science* 8(**2**), 133- 167.

Mill, H. R (2000). *Teaching and training*. A handbook for instructors, 3rd edn. London, Macmillan.

Nelson, R. M (2000). Motivation to learn science: Differences related to gender. *Journal of Educational Research, 93 (4) 245 – 255*

Novak, J. D. (1980).Learning theory applied to the biology classroom. A useful tool for science education. *The American biology teacher*, 42, (*5*) 280-285).

Nyabwa, R.A. (2005). *Effects of advance organizers on form three students' mathematics self-concept and performance in commercial arithmetic in selected secondary schools in Nakuru district*. Unpublished Masters Thesis, Egerton University, Njoro.

Okere, M. I. O. (1996). *Physics education*. Egerton University: Education Materials Center and Lectern Publication limited.

Osborne, J. (1997). The relevance of biology. *New Scientist* (**154**) 28 – 30.

Parkinson, J. (1994). *The effective teaching of secondary science*. New York: Addison Wesley Longman Inc.

Prokop, P., Tuncer, G. & Chuda, J. (2007). Slovakian students' attitudes towards biology. Eurasia Journal of Mathematics, Science and Technology Education, **3(** 4), 287-295.

Puhan, G., & Hu, H. (2006). Motivation or cognition: What leads to performance differences in science? On-line. http://www.educ.ualberta.ca/educ/psych/crame . Retrieval date 21. 07. 2008.

Slavin, E. R. (1997). *Educational Psychology: Theory and practice* (5th ed.). Boston: Allyn and Bacon Company.

Solomon, J. (1986). Motivation for learning science. *The School Science Review,* **67** (240) 436-442.

Sprinthall, N. A., & Sprinthall, R. C. (1990). *Educational psychology: A development approach*. (5th ed.) New York: McGraw Hill Publishing.

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*.

Trowbridge, W. L., Bybee, W. R., & Powell, P. C. (2004). *Teaching secondary school sciences: Strategy for developing scientific literacy* (8th ed.). New York: Pearson Education Inc.

Tsuma, O. G. K (1998). *Science education in the African context*. Nairobi: Jomo Kenyatta Foundation.

U.N.E.S.C.O. (1975). *Science in basic functional education: Philosophy, approaches, methods and materials: Report*. Bangkok UNESCO. Online http://www.iubs.org/test/bioint/39/8. htm. Last visited 25/9/2004.

U.N.E.S.C.O. (1986). *A handbook for biology teachers in Africa*. Paris: United Nations Educational, Scientific and Cultural Organization.

Wachanga, S. W. (2002). Effects of cooperative class experiment teaching method on secondary school students' motivation and achievement in chemistry. Unpublished Ph.D Thesis, Egerton University, Njoro, Kenya

Weil, B. J & Murphy, R. T. (1982). The retentive effects three modes of advance organizers. *Journal of Studies in Education,* 1 (**I**) 112-118.

White, R.T & Tisher, R .P. (1986). Guided discovery. In Lefrancois, G R. (1997). *Psychology for teachers*. Wadsworth,Wadsworth Publishing Company.

Wiersma, W, & Jurs, S. G. (2005) Research methods in education: An introduction 8th Edition. Boston: Pearson Publications.

Willerman, M., & Mac Harg, R. A. (1992). The concept map as an advance organizer. *Journal of Research in Science Teaching,* 28, 705-712.

◈◇◈