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Science Process Skills Advance Organizer and Students' Motivation Orientation in Secondary School Physics

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Abstract
This study was designed to investigate students' motivation orientation in the learning of electric current circuits in secondary school physics after exposure of Science Process Skills advance organizer. The study adopted the posttest only design. Students were exposed to various electric current circuits making activities using electric current components before a physics lesson which was conventionally taught before being post tested. A students' motivation questionnaire was then administered thereafter. A total of seventy two (72) form two secondary school physics students participated in the study. Data were collected using a six item students' motivation questionnaire (SMQ) with a reliability of 0.799. Principal Component Analysis was used to reduce student's responses of each of the six items to manageable variables for easy interpretation of students' motivation orientation in the learning of electric current circuits in physics. The results of the study indicated that students' exposure to the science process skills advance organizer made them develop confidence in the physics course, they were excited by the activities that had taken place before the physics lessons especially the experiments they engaged in themselves. The results also indicated students were stimulated when they made conclusions of the experiments exposed to them before the lesson and they were happy when they worked through experiments in groups. This study concludes that science process skills advanced organizer can be used to motivate students in the learning of Physics. The study recommends that teachers of Physics be encouraged to construct relevant science process skills advance organizers for other topics of Physics taught at secondary schools. The study also recommends that publishers and physics education experts publish current research on science process skills advance organizers that can be applied in other subjects.

Keywords: Physics, Science Process Skills advance organizer, Motivation

1. Introduction
The Kenya Vision 2030 is a vehicle for accelerating transformation of our country into a rapid industrializing middle-income nation by the year 2030 and physics is important for the country to achieve this (GOK, 2007). Reasons stated by International Union of Pure and Applied Sciences (IUPAP) (1999) to support Physics education and research include among others the ability of Physics to excite intellectual adventure that inspires young people and expand the frontiers of our knowledge about Nature. Studying physics helps in generating fundamental knowledge needed for the future technological advances that will continue to drive the economic engines of the world and contributing to the technological infrastructure thus provide trained personnel needed to take advantage of scientific advances and discoveries. Also physics is an important element in the education of chemists, Engineers and Computer scientists, as well as, practitioners of the other physical and biomedical services.

Physics extends and enhances our understanding of other disciplines, such as the earth, agricultural, chemical, biological and environmental sciences, plus astrophysics and cosmology, which are subjects of substantial importance to all the people in the world. It improves our quality of life by providing the basic understanding necessary for developing new instrumentation and techniques for medical applications, such as computer tomography, magnetic resonance imaging, position emission tomography, ultrasonic imaging and laser surgery, International Union of Pure and Applied Sciences (IUPAP) (1999).

Despite its importance to society as expressed by IUPAP and European Physical Society (EPS), many reports indicate poor performance of physics at Kenya Certificate of Secondary Education (KCSE) compared to other science subjects examined at the same level. Aina (2013) identifies that lack of qualified science teachers, lack of instructional materials; low students interest and lack of motivation among others are causes of low enrolment in science. Elsewhere as cited by Udo and Ubana (2013) referencing Abiam (1997) IIoputaife (1997) and Orji (2000) states that physics has the lowest popularity index among other sciences taught in Nigerian schools. They further suggest for efforts towards looking for innovative strategies that could be used to enhanced students' achievement and retention of physics concepts taught in Nigerian schools. In Kenya, the enrolment of students in physics at Kenya Certificate of Secondary Education from 2004 to 2014 was below 30% on average of the total number of candidates compared to that of chemistry and biology which were above 96% and 88% respectively (KNEC,2015). This study aimed at finding variables that would describe students' motivation orientation in electric current circuits among form two students taking physics as a learning subject.

Advance organizers have been effective in a variety of forms for a number of learning tasks. Mayer (1977) reported a series of studies supporting the positive but conditional effects of advance organizers. These conditions include occasions where learners lack pre-requisite skills or knowledge, the material to be learnt is poorly organized or difficult for learners to assemble, and where generalized outcomes will be measured.

Advance organizers are specifically effective for helping students learn the key concepts or principles of a subject area and the detailed facts and bits of information within these concept areas. According to Weil and Murphy (1982), an advance organizer is a highly effective instructional strategy for all subject areas where the objective is meaningful assimilation of concepts and principles. Research studies have shown all forms of advance organizers to be effective. Their merit in facilitating the meaningful learning of expository materials has been recorded by numerous researchers (Ausubel, 1960, 1978; Allen, 1970; Lawton & Wanka, 1977; Mayer, 1979; Egburgara, 1985). By using the tools of physics in their teaching, instructors can move children from mindless memorization to understanding and appreciation (Wieman, 2001). Students must develop the skills in order to learn science through inquiry. Science process skill will expose the students to the tools of physics before engaging into self-acquisition of the skill. Effective instructions are those which change the way students think about physics problems solving and cause them to think more like experts-practicing physicist (Hammer, 1997). Ndem & Ubana, (2013) conclude that retention in Physics is higher when graphic advance organizer is used and recommended that for better retention in Physics, teachers of Physics should be encouraged to adopt appropriate advance organizers in conjunction with other appropriately selected teaching methods. The good feelings of students while meeting the goals of physics may affect their performance and encourage more students to enroll. Students who require hands on methods to study are likely to benefit from this study. Physics teachers may appreciate the art of structuring their classrooms to maximize task involvement. Mayer (1979) on his evaluation of the assimilation theory stated that advance organizers should have a stronger effect for poorly organized text than for well-organized text and should have positive and stronger effect for the learners lacking prerequisite knowledge and prerequisite abilities respectively. However, there are researchers who have failed to prove the merit of organizers (Barnes &Clawson, 1975; Ibegbulam, 1980; Nwankpa, 1981). Explanations have been sought in terms of the nature and manipulation / rearrangement of various materials used. While studies have shown advance organizers to be effective with all grade and ability levels, the retention by lower ability students tends to profit most (Egbugara, 1985). This is not surprising for these students may be the most in need of these organization cues and the least able to generate them on their own. Studies indicate that the effectiveness of advance organizers is proportional to the level of unfamiliarity, difficulty and technicality of the material to be learned (Luiten, Wilbur &Gary, 1980). This provides teachers with the rule to follow in deciding when to invest the planning time needed to develop a good advance organizer to introduce a body of new information (Hartley &Davies, 1976). Because of the unfamiliarity of the concept of electric current flow to students, the use of an advance organizer would be expected to elicit a significant difference in conceptualization of the concept between the students exposed to the advance organizer and those not exposed. This study aimed at finding factors that motivate students in the learning of physics in secondary schools after exposure to science process skills advance organizers.

Purpose of the study

This study was to investigate students' motivation orientation in the learning of electric current circuits in secondary school physics after exposure of Science Process Skills advance organizer before a conversionary taught lesson.

Research Hypothesis

The following hypothesis was formulated to enable find the factors that orient students' motivation towards learning of electric current circuits topic in physics.

Ho: There are no factors explaining students' motivation on electric current circuits in physics on having been exposed to Science skills advance organizers

2. Methodology

The study adopted the posttest only design, one of the simplest methods of testing the effectiveness of an intervention. The two schools selected for the study were treated with the science process skills advance organizer and then given the regular lessons in the topic of electric current circuits for form two physics. This study was only interested on finding out the students' motivation orientation that would be caused by the activities of the science process skills advance organizer in the topic of electric current circuits in a form two physics class.

The study took place in Laikipia Central Sub-county which was purposively selected for the study due to it many schools that were spread across the Sub-county. The total population of students in all schools in the Sub-county was 4,100 students and there were 1,202 students in Form Two. Form two students study physics before choosing subjects to be enrolled for at Kenya Certificate of Secondary Examination. A total of 72 students were chosen from two schools, one school had 54 students and the other had 18 students. The students were first exposed to the science process skills advance organizer for a period of 2 weeks. After the treatment the students were taught a physics topic on electric current for 4 weeks and then post tested. A students' motivational questionnaire with six items was then administered to find out if the treatment had any effect on their motivation orientation in the learning of electric current circuits. Each of the six items had variables to be rated as either strongly disagree, disagree, undecided, agree and strongly agree. The statements were designed to evaluate students' motivation orientation in electric current circuits in form two physics.

The following were the six items and the variables to be rated:

i. Learning the Physics course by the teacher explain everything was…..and the variables were fun, satisfying, informative, useful, boring, frustrating, hard, challenging, too demanding and too stressful.
ii. Learning the Physics course by working through an experiment was….. And the variables were simulating, rewarding, time wasting, hard, too stressful, satisfying, informative, fun, challenging and boring.
iii. Learning the Physics course by doing the experiment myself made me……and the variables were feel confident about the physics course, feel eager to learn the physics course, doubt my ability to learn physics, want to apply my knowledge to solve practical problems, happy, excited, feel as if I was wasting time, frustrated, unhappy and interested in physics.
iv. Drawing conclusions of the experiments done by me was….. And the variables were stimulating, rewarding, time wasting, boring, useful, well organized, frustrating, fun, interesting and hard.
v. The practical lessons that I was exposed to before Physics lessons were…..and the variables were stimulating, rewarding, time wasting, fearful, useful, interesting, not enjoyable, doubtful and embarrassing.
vi. Learning Physics through experiments in groups and applying the knowledge to real life Situation made me….. and the variables were feel confident about the physics course, feel eager to learn the physics course, doubt my ability to learn physics, want to apply my knowledge to solve practical problems, happy, excited, feel as if I was wasting time, frustrated, unhappy and interested in physics.

The data collected were analyzed using principal component analysis.

3. Results

The results for the six items of the students' motivation questionnaire are presented in table 1 to 6. Each table shows the number of extracted variables which are uncorrelated from the set of variables given. The extracted variable(s) give the dimension(s) underlying students' motivation of electric current circuits' topic in physics after the students were exposed to the science process skills advance organizer.

Results for item 1. Learning the Physics course by the teacher explain everything was…

Table 1: Retained factors of Item 1 of the Students' Questionnaire

Component	Initial Eigen values	Extraction Sums of Squared Loadings	Rotation Sums of Squared Loadings

	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.243	20.389	20.389	2.243	20.389	20.389	1.760	16.002	16.002
2	1.513	13.758	34.147	1.513	13.758	34.147	1.467	13.335	29.337
3	1.261	11.465	45.612	1.261	11.465	45.612	1.406	12.785	42.122
4	1.146	10.418	56.030	1.146	10.418	56.030	1.372	12.472	54.593
5	1.135	10.322	66.352	1.135	10.322	66.352	1.293	11.759	66.352
6	.912	8.288	74.640						
7	.724	6.584	81.224						
8	.625	5.679	86.903						
9	.531	4.829	91.732						
10	.482	4.378	96.110						
11	.428	3.890	100.000						

Table 1 indicates results for Item 1 with the Kaiser – Meyer -Olkin (KMO) with a measure of sampling adequacy value of 0.596 and the Bartlett's Test of sphericity value of 79.351 had five variables describing student's motivation orientation. The five variables accounted for 66.352% and were boring, 16.002%, frustrating, 13.333%, useful, 12.785%, satisfying, 12.472% and too demanding accounting for 11.759%.

Results for item 2. Learning the Physics course by working through an experiment was…..

Table 2: Retained factors of Item 2 of the Students' Questionnaire

	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.384	33.836	33.836	3.384	33.836	33.836	3.069	30.687	30.687
2	1.365	13.645	47.481	1.365	13.645	47.481	1.679	16.795	47.481
3	.934	9.341	56.822						
4	.891	8.910	65.733						
5	.805	8.053	73.786						
6	.692	6.921	80.707						
7	.614	6.135	86.843						
8	.476	4.757	91.599						
9	.446	4.461	96.060						

10	.394	3.940	100.000						

Extraction Method: Principal Component Analysis.

Table 2 indicates results for Item 2 with the Kaiser – Meyer -Olkin (KMO) with a measure of sampling adequacy value of 0.804 and the Bartlett's Test of Sphericity value of 132.143 had two variables describing student's motivation orientation. The two variables accounted for 47.481% and were too stressful, 30.687%, and fun 16.795%.

Results for item 3. Learning the Physics course by doing the experiment myself made me……

Table 3: Retained factors of Item 3 of the students' Questionnaire

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.236	32.363	32.363	3.236	32.363	32.363	2.487	24.872	24.872
2	1.295	12.949	45.312	1.295	12.949	45.312	1.617	16.172	41.044
3	1.088	10.884	56.196	1.088	10.884	56.196	1.355	13.551	54.595
4	1.006	10.061	66.257	1.006	10.061	66.257	1.166	11.662	66.257
5	.998	9.983	76.240						
6	.713	7.128	83.368						
7	.675	6.754	90.123						
8	.495	4.951	95.074						
9	.272	2.723	97.797						
10	.220	2.203	100.000						

Extraction Method: Principal Component Analysis.

Table 3 indicates results for Item 3 with the Kaiser – Meyer -Olkin (KMO) with a measure of sampling adequacy value of 0.634 and the Bartlett's Test of sphericity value of 138.544 had four variables describing student's motivation orientation. The four variables accounted for 66.257%, feeling confident 24.872%, having desire to apply the knowledge 16.172%, feeling eager 13.551%, doubting 11.662%.

Results for item 4. Drawing conclusions of the experiments done by me was…

Table 4: Retained factors of Item 4 of the students' Questionnaire

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.771	37.705	37.705	3.771	37.705	37.705	2.623	26.229	26.229
2	1.414	14.136	51.841	1.414	14.136	51.841	2.561	25.612	51.841

3	.885	8.846	60.687
4	.814	8.138	68.825
5	.730	7.297	76.123
6	.692	6.923	83.046
7	.601	6.007	89.053
8	.441	4.410	93.463
9	.355	3.548	97.011
10	.299	2.989	100.000

Extraction Method: Principal Component Analysis

Table 4 indicates results for Item 4 with the Kaiser – Meyer -Olkin (KMO) with a measure of sampling adequacy value of 0.799 and the Bartlett's Test of sphericity value of 188.681 had two variables describing student's motivation orientation. The two variables accounted for 51.841% and were stimulation 26.229%, usefulness 25.612%.

Results for item 5. The practical lessons that I was exposed to before Physics lessons were…..

Table: 5

Retained Factors of Item 5 of the Students' Questionnaire

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Comp-onent	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.897	32.189	32.189	2.897	32.189	32.189	1.841	20.454	20.454
2	1.272	14.133	46.322	1.272	14.133	46.322	1.694	18.818	39.272
3	1.046	11.626	57.948	1.046	11.626	57.948	1.642	18.245	57.518
4	1.042	11.575	69.523	1.042	11.575	69.523	1.081	12.006	69.523
5	.864	9.601	79.124						
6	.649	7.206	86.330						
7	.455	5.060	91.390						
8	.445	4.943	96.333						
9	.330	3.667	100.000						

Extraction Method: Principal Component Analysis

Table 5 indicates results for Item 5 with the Kaiser – Meyer-Olkin (KMO) with a measure of sampling adequacy value of 0.673 and the Bartlett's Test of sphericity value of 130.990 had four variables describing student's motivation orientation. The four variables accounted for 69.523% and were useful 20.454%, fear 18.818%. embarrassed 18.245% and stimulation 12.006%.

Results for item 6. Learning Physics through experiments in groups and applying the knowledge to real life Situation made me…..

Table 6 Retained Factors of Item 6 of the Students' Questionnaire

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.041	30.413	30.413	3.041	30.413	30.413	2.086	20.864	20.864
2	1.453	14.527	44.940	1.453	14.527	44.940	2.062	20.621	41.485
3	1.291	12.909	57.850	1.291	12.909	57.850	1.636	16.364	57.850
4	.940	9.396	67.245						
5	.869	8.694	75.939						
6	.623	6.233	82.173						
7	.539	5.395	87.567						
8	.478	4.777	92.345						
9	.420	4.198	96.543						
10	.346	3.457	100.000						

Extraction Method: Principal Component Analysis

Table 6 indicates results for Item 6 with the Kaiser –Meyer-Olkin (KMO) with a measure of sampling adequacy value of 0.710 and the Bartlett's Test of sphericity value of 121.718 had three variables describing student's motivation orientation. The three variables accounted for 57.850% and were happy 20.864%, 20.621%, 16.364%.

4. Discussion

The results of this study indicate that there exists a relationship between science process skills advance organizer and students' motivation orientation in the learning of electric current physics taught in secondary schools. The motivation orientation seems to be determined by the source and also the level of engagement of the student in the learning activity. Study.com explains intrinsic motivation as performing an action or behavior because you enjoy the activity itself. In the study students were happy and interested in physics when they did the experiments themselves and were happy and felt confident when they did the experiments in groups. For the teacher explaining everything in item 1 of the students' motivation questionnaire, students found this boring and frustrating though they also described it as useful and satisfying. Bhat and Naik (2016) argue that "there is a significant, but negative correlation between the dimensions of extrinsic motivation that is peer acceptance, power motivation and fear of failure and psychological well-being among male students…" Dev (1997) classified intrinsic motivation as (a) participation in an activity purely out of curiosity, that is, for a need to know something. (b) The desire to engage in an activity purely for the sake of participating in and completing a task. (c) The desire to contribute. Amadalo, Ocholla and Memba (2012) in their study concluded that practical work in physics disposed the respondents (students) favorably to the subject.

5. Conclusions and Recommendations

From the findings Science Process Skills advance organizer, motivate students in the learning of Physics depending on their level of involvement in the activities before the physics lesson and they are able to describe their experiences during the Physics lessons.

This study recommends the use of Science Process Skills advance Organizer in the teaching of Physics in schools and for other topics taught at secondary school level. The Kenya Institute of Curriculum Development may organize for workshops to induct teachers on construction of relevant science process skills advance organizers so as to achieve specific skills in various physics topics. Publishers are encouraged to publish research on use of advance organizers. Teachers are keen on identifying variables that motivate students in the learning of physics.

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