Project Method and Learner Achievement in Physics in Kenyan Secondary Schools

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Abstract

There is a growing demand for the science educators to improve the learning of physics particularly in the developing world due to the critical role it plays in terms of technological advancement. Many approaches and methods are applied with the intention of improving learner achievement in the subject. Methods that promote learner participation have been cited to enhance learner achievement. Project method is one such approach that promotes not only the necessary scientific skills but also the application of the knowledge learnt in solving daily problems. This article presents the findings of a research on the impact of project method on learner achievement in physics in Kenyan public secondary schools. Quasi experimental design was applied. Stratified random sampling was used in selecting eighty four schools from seven provinces in Kenya. Learner achievement was compared using Analysis of Variance (ANOVA). It was realized that use of project method produced better results when compared to traditional methods like discussion and lecture method. The study recommends the use of the project method to supplement other methods of teaching physics. Physics teachers also need to be sensitized on the benefits that accrue as a result of the usage of this method through in-service courses.

Key Words: Physics, Learner Achievement, Project Method.

The Nature of the Problem

The project method is based on the strong conviction that learning by doing raises mastery of physics concepts by the learners. According to Helm (2001), learners gain better understanding and learn new ideas from experiences, and therefore, the use of project method provides a good example where learners are actively engaged in the learning process. This engagement involves
an in-depth investigation of a topic which sometimes culminates in making a scientific device in application to the knowledge learnt. Katz (1994) contends that the project method of teaching is not new in the field of education. It was introduced as a central part of progressive education movement

and was used extensively in the British schools in the 1960s and 1970s (Smith, 1997). The method has since found its application in the study of sciences, which includes physics.

According to Howell and Mordini (2003), physics teachers use the project method as a means of teaching technical skills, tool use, and problem-solving as it provides a mean for increasing student participation in the learning process. This has led to paradigm shift in physics education whereby teaching has moved from teacher dominance where the teacher was the centre of the learning process to learner-centered approach where the teacher's role is to guide and facilitate the learning process. This paradigm change has caused a debate and a split in the profession related to the methods used to teach physics. An overriding question the profession must ask is,
"Has this paradigm shift been beneficial to students learning physics?"

The project method is a teacher-facilitated collaborative approach in which students acquire and apply knowledge and skills to define and solve realistic problems using a process of extended inquiry (Validya, 2003). It is also referred to as Project-Based Learning (PBL) as it involves the making of actual projects by the students. Projects are student-centered, following standards, parameters, and milestones clearly identified by the teacher. Students have control over the planning, refining, presenting, and reflecting of the project. Through projects, students are engaged in innovation and creativity (Project Lead the Way, 2003).

Project-based learning involves assignments that call for students to produce something, such as a process or product design, a computer code or simulation, or the design of an experiment and the analysis and interpretation of the data. The culmination of the project is normally a written or oral report summarizing what was done and what the outcome was (Wambugu, 2008). Project-based learning implementations in science curricula have not been extensively reported (Draper 2004; Kesner and Eyring 1999; O'Hara, Sanborn, & Howard 1999).
According to Zhaoyao (2002), in project- based learning, students mainly apply previously acquired knowledge and the final product is the central focus of the assignment, while in problem-based learning, students have not previously received formal instruction in the necessary background material and the solution process is more important than the final product.

In practice, both the lecture and project method are use together and when used independently, they produce results that are almost similar (Kolmos; Tan et al., 2003; Galand & Frenay 2005).
Studies comparing project-based learning to conventional instruction have yielded results similar to those obtained for problem-based learning, including significant positive effects on problem-solving skills, conceptual understanding, and attitudes to learning, and comparable or better learner achievement on tests of content knowledge (Thomas 2000; Mills and Treagust 2003). However, Mills & Treagust (2003) noted that students taught with project-based learning sometimes gain less mastery of scientific concepts than those taught using the conventional methods. They further noted that some of the students may be unhappy over the time and effort required to complete the projects and the interpersonal conflicts they experience in teamwork.

If the project work is done entirely in teams, students may be less equipped to work independently. Project-based learning falls between inquiry and problem-based learning in terms of the challenges it poses to instructors (Twoli, 1998). Projects and the knowledge and skills needed to complete them may be relatively well-defined and known from previous parts of the curriculum, which lessen the likelihood of student resistance, and they may be defined in a manner that constrains students to territory familiar to the instructor, which further reduces the difficulty of implementation (Santrock, 2004). Projects are usually done by student teams but they may also be assigned to individuals to avoid many logistical and interpersonal problems but also cut down on the range of skills that can be developed through the project.

The challenge of project method is to define projects with a scope and level of difficulty appropriate for the class, and if the end product is a constructed device or if the project involves experimentation, the appropriate equipment and laboratory and shop facilities must be available (Sood, 1989). Hybrid (problem/project- based) approaches encompass all of the difficulties associated with both methods and so can be particularly challenging to implement.

According to Jean, 2007), the project method encourages the learners to be self-directed, build research skills and help them to determine their own needs. This method is based on John Dewey's philosophy that education begins with the curiosity of the learners (Wertz, 1997).

When this method is used, students arrive at an understanding of concepts by themselves and the responsibility of learning rests with the learners. In a study investigating the effects of project-based learning on students' performance of higher cognitive skills in secondary school agriculture, Kibett and Kathuri (2005) observe that those taught using the project method in agriculture outperformed their counterparts in regular classroom. The project method differs from the traditional method where teachers come to class with highly structured curricula and activity plans, sometimes referred to as "scope and sequence".

Jean (2007) notes that project method is based on constructivist learning theory which contends that learning is deeper and more meaningful when students are involved in constructing their own knowledge. White (1993) is of the view that project method is a teaching–learning activity that requires the learners to determine either the strategies, resources and or the target which allows for a range of solutions. Project method makes the learner to take charge of the learning process under the guidance of the teachers (Maundu, 1997). According to Twoli (2006), individual project method is a measure of how capable and responsible one is at individual level with minimum supervision. This method helps the learner to develop capabilities such as the intellectual skills, cognitive faculty, motor skills and positive attitude towards physics (Chiapetta & Koballa, 2006). The teacher brings to the attention of the learners the need for them to undertake the projects. S/he then introduces the projects, discusses the procedure and then encourages the learners to undertake those projects that require the use of using locally available materials. The teacher acts as a facilitator and also helps in the evaluation of the processes and product of the project (Woolnough, 1994). In some cases, learners initiate their own projects which are generated during learning process.

Over the years, the performance of physics in the summative evaluation after the secondary school cycle has been poor (KNEC, 2010). The number of students' dropping the subject after the second year in secondary school has also been increasing. Many reasons for this scenario have been postulated by the educationists, chief them being the methods and approaches used by the teachers. This study sought to investigate the impact of one method of teaching physics, the project method and its impact on learner achievement in physics.

Research Objectives

The study was guided by the following objectives:

i. Establish if there is any significant difference in achievement between learners exposed to project method and those who are not.
ii. Determine if there is any significant difference in achievement between boys exposed to project method and those who are not.
iii. Examine if there is any significant difference in achievement between girls exposed to project method and those who are not.

Null Hypothesis

The hypotheses tested were:

HO1: There is no significant difference in achievement in physics between learners who are exposed to project method and those who are not.

HO2: There is no significant difference in achievement in physics between boys who are exposed to project method and those who are not.

HO3: There is no significant difference in achievement in physics between girls who are exposed to project method and those who are not.

Research Methodology

This study employed quasi-experimental design involving Solomon's Four Non-Equivalent Control Group. According to Mutai (2000) quasi-experimental design of the non-equivalent group helps in comparison of effects of two groups, where one is treated and the other is not. This design was suitable for this study because the achievement of the group taught with the project method was compared to the achievement of those not taught with project method. It is of the non-equivalent design because the learners used in the study varied in number and characteristics. Experimenting with the project method was done without affecting the already classroom setup. Regular teachers were used to teach their normal classes without the presence of the researcher. This helped in controlling the reactive effect where the learners would have behaved in a way to please the researcher had they known that they were being observed for a particular purpose.

In the study, the students were either in the experimental category or the control group. Each of these groups was further organized such that half of the group was pre-tested while the other half was not. Effectively, this brought about the four categories described as the Solomon Four group.

Each of these groups was further sub-divided into boys, girls and mixed school categories as shown in Table 1. Each of these sub-groups formed the control and treatment category.

Table 1: Grouping of the Respondents

Experimental Group						**Control Group**					
Category 1 Pre-test done			Category 2 No pre-test			Category 3 Pre-test done			Category 4 No pre-test		
TB1 N=7	TG1 N=7	TM1 N=7	TB2 N=7	TG2 N=7	TM2 N=7	CB1 N=7	CG1 N=7	CM1 N=7	CB2 N=7	CG2 N=7	CM2 N=7

T stands for treatment, C for control, B for boys and G for schools. Treatment in this case involved the teaching of the topic "Magnetic Effect of an Electric Current" by use of project method. The projects made were the electric bell and an electromagnet. The control group was taught the same topic using lecture and discussion methods.

The study applied stratified random sampling procedure to obtain a sample of eighty-four schools out of the eight hundred and ninety provincial public secondary schools in Kenya. To ensure that each school in a given strata had a chance of being selected; the formula given by Mutai (2000) as indicated below was applied.

$$Nf = n*N/ (1+n)$$

Where Nf = desired sample size

n = the estimate of the sample size

N= total number of schools

The use of this formula ensured that the size of each stratum was kept proportional to the required sample. This resulted in having four schools of each category in seven out of eight provinces in Kenya by the time the study was conducted in the year 2011. Two boys', two girls' and two mixed schools in each province were selected randomly to form the experimental group while the other two formed the control group. One of these schools was pre-tested while the other was not. The need for this comparison explains why eighty-four schools were selected

All physics teachers in the selected schools were involved in the study. They taught the topic as agreed, tested the students, marked the tests and also filled the teachers' questionnaires. Data was collected using the Student Achievement Test (SAT) which consisted of seven semi-structured questions covering the topic under study, "The magnet effect of an electric current". The test was used to check learners' achievement in both groups that included those in the experimental and those in the control groups. The mean mark of each group of learners was calculated for both experimental and control groups. Analysis of Variance (ANOVA) was used to determine whether there was any difference in learners' achievement between the group exposed to project method and those who were not. According to Mutai (2000), Analysis of

Variance (ANOVA) is one of the most useful statistical procedures available for analyzing data. It is used to compare mean score for different groups. The F-ratio was calculated using the formula: F=MSb / MSw

where MSb refers to the mean square between groups while MSw refers mean square within groups.

If the obtained value of F exceeded or was equal to the tabled value at the p-value of 0.05, the null hypothesis was rejected. This meant that the alternative hypothesis was accepted that there was a significant difference between the groups. The opposite was also the case that when the calculated value of F is smaller than the tabled value, then the hypothesis was retained. The conclusion made was that the difference in group means could be a function of chance and therefore not statistically significant.

Findings and Discussions

HO1: There is no significant difference in achievement in physics between learners who are exposed to project method and those who are not.

To test whether the use of project method had any impact on learner achievement in physics, the results for all students in the experimental group was compared to the results of the students in the control group. Analysis of variance, (ANOVA), was used. Table 2 shows the result of this analysis.

Table 2: ANOVA Results of Experimental and Control Groups

	Sum of Squares	Mean Square	F	Sig.
Between Groups	925.396	28.919	7.678	.039
Within Groups	11.300	3.767		
Total	**936.696**			

The results of F=7.678 and significance 0.039 are greater than the tabled value of 4.36 (v1=32; v2=5) at.05 significant level, indicating that the overall effect of treatment was quite large. The results suggest that the null hypothesis that there existed no significant difference between scores of learners exposed to project method and those who were not was rejected. This suggests that there is significant difference in achievement in physics between the learners who were exposed to project method and those who were not.

HO2: There is no significant difference in achievement in physics between boys who are exposed to project method and those who are not.

Table 3 shows the analysis of variance for the scores attained by boys in the experimental and in the control groups. This analysis helped in testing the hypothesis that: There is no statistically significant difference in achievement scores between boys exposed to Project Method and those who are not so exposed.

Table 3: Experimental against Control results for boys

	Sum of Squares	Mean Square	F	Sig.
Between Groups	847.448	193.243	12.812	.349
Within Groups	45.250	15.083		
Total	**892.698**			

The F ratio of 12.812 at .05 level of confidence is far greater than the tabled value of 8.53 (v1=31, v2=3). This implies that the treatment had a huge effect on the achievement of boys implying that the use of project method helped in influencing their performance in physics.
Hence, the hypothesis that there is no statistically significant difference in achievement scores between boys exposed to project method and those who are not so exposed was rejected and the alternative hypothesis that there was statistically significant difference in achievement scores between boys exposed to project method and those who are not so exposed was accepted.

HO3: There is no significant difference in achievement in physics between girls who are exposed to project method and those who are not.

The analysis of variance for girls exposed to project method compared their achievement to those in the control group. This enabled the researcher to test the third hypothesis that there is no statistically significant difference in achievement scores between girls exposed to Project Method and those who are not exposed.

Table 4: Experimental against Control Results for Girls

	Sum of Squares	Mean Square	F	Sig.
Between Groups	1810.410	27.430	1.739	.719
Within Groups	78.853	15.771		
Total	**1889.263**			

Table 4 indicates that the variance within the group is less than the variance between the groups, implying that the experimental effect is present. This in effect means that the use of project method among the girls had a positive impact on their achievement in physics. Hence, the hypothesis that there is no statistically significant difference in achievement scores between girls exposed to project method and those who are not so exposed was rejected and the alternative hypothesis that there was statistically significant difference in achievement scores between girls exposed to project method and those who are not so exposed was accepted.

Discussions

In their study on the use of project method in agriculture in Kenyan secondary schools, Kibet and Kathuri (2005) observed that the use of project method yielded better results among the learners. They noted that this method has the advantage of allowing learners to conceptualize the knowledge learnt. Noting that the features of the project method are essential, Samson (2008) observed that this method allows the learners to apply physics knowledge using locally available resources, which leads to better understanding and motivating the learners.

The results further agree with Mordini (2003) who argues that the use of project method is an excellent way of increasing student participation which ultimately leads to high content retention. It can be argued that the use of project method is effective in mitigating academic achievement of the learners. This is because learners are put in a position to apply the knowledge learnt as they make the project.

The results also agree with the findings of Thomas, (2000); Mills and Treagust (2003) who noted that project method produced superior grades compared to those exposed to the traditional methods as the project method inculcated in the learners problem-solving skills, conceptual understanding, positive attitude to learning and high retention of knowledge.

However, the results suggest that both girls and boys achieve higher grades when project method is used. The result suggests that both girls and boys have the capability of achieving high grades when effective methods are applied during the instructional process.

Conclusion and Implications

The study found that there was a significant difference in academic achievement between the learners who were exposed to project method and those who were not. This implies that the use of project method improves learners' achievement and is a better way of teaching. The mean score of students exposed to project method was found to be statistically significant ($F=7.678$, significant at 0.0390) when compared to those who were exposed to lecture and question/answer method. The use of project method inculcates the required physics knowledge, skills and values in the learners in a better way compared to the use of lecture and discussion methods. This was evidenced by the superior grades achieved by learners exposed to project method. According to Esler, (2001), the project method enables learners to gain knowledge through the activities taken. Jevons, (2008), argues that use of project method enables the learners to utilize the knowledge gained in a better way in solving daily problems in life. Further use of projects enables the learner to acquire the scientific skills (Reznick, 1998).

Recommendations

Based on the conclusions the following recommendations are made:

i. There is need for the Ministry of Education to in-service physics teachers on the role of project method in the learning of physics. The quality assurance officers and other in-service training institutes like the Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA) can organize seminars and workshops to sensitize teachers on the role of project method.

ii. There is need to restructure teacher training programs so as to train the teacher trainees on the use of the project method, among other methods of teaching physics. Methods that make teaching learner-centered have been found to yield better results in the process of skill development.

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