Improving Students' Acquisition of Science Process Skills in Biology Subject: Moving Towards a Learner-Centred Classroom

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Abstract

The purpose of this study was to investigate the effect of inquiry-based learning (IBL) on students' level of acquisition of integrated science process skills (ISPS) in Biology subject. The objective of the study was to determine the difference between students' level of acquisition of ISPS when taught using IBL approach and Traditional Learning approach (TL) in Biology. The Non-equivalent Control Group Post- test only Design was employed in the study as a quasi experiment. The study was carried out in Kesses Sub County of Uasin-Gishu County, Kenya where there has been persistent low achievement in Biology subject at KCSE level. The study sample comprised of 116 students selected from form three students from two mixed day secondary schools. The sampling techniques used were stratified, systematic and simple random sampling. The experimental groups received instructions through use of IBL approach and control groups using the TL approach. Biology Integrated Science Process Skills Questionnaire (BISPSQ) was used for data collection. The results of the study indicated that students in the experimental groups outperformed the control groups in the acquisition of selected science process skills. It was concluded that IBL had a positive output on students' acquisition of integrated science process skills than the TL method. Teachers and students of Biology in Kenya should be encouraged to incorporate IBL in teaching and learning so as to enhance the acquisition of integrated science process skills.

Keywords: Inquiry-Based Learning (IBL); Acquisition of Biology Integrated Science Process Skills and Biology subject.

1. Introduction

Acquisition of Science Process Skills (SPS) is vital because this enables individuals to manage their routine tasks by utilising skills such as communication and problem solving making it possible for them to survive in a demanding world of the current century. The 21st century role of science education should be significant to the interests of learners, providing an environment for them to relate science and day to day life. Through the investigations of authentic examples by application of science process skills, students gain insight that will enable them to relate with their surrounding effectively (Cruz, 2015). When students apply SPS they develop the critical thinking and problem solving skills that are required for the enhancement of learning that is student oriented. Thus the teaching and learning methods used should enable learners to acquire and develop necessary skills that focus on student centred learning. The skills acquired should be relevant beyond the walls of the classroom, thus should be applicable in the learners day to day life as suggested by Ngesu *et al.* (2014). With this view in mind, it therefore presents a situation that the pedagogical approaches applied for learning in the 21st century should provide adaptability for both the teacher and student in terms of their roles in the teaching and learning process (Nuangchalerm, 2014). Inquiry Based learning, is one such teaching approach that allows for adaptability in terms of the teacher and student roles during instruction. The teaching of Science Process Skills is one of the most important aims of teaching Science (Aydogdu, 2015) and a demand of the 21st century learners of Science is to acquire and develop SPS (Chebii, 2011). It is therefore necessary to understand the interpretation of SPS in this century.

The Republic of Kenya (RoK) identified quality education that is globally competitive as a pertinent element that

will help her arrive at her destination of Vision 2030 (RoK, 2012a). The education reforms in Kenya therefore advocated for instructional approaches that actively involve learners and that will expose them to acquire the skills for industrialization. Science process skills are part of these skills that are required for industrialization. For effective teaching and learning to take place, the approach adopted by a teacher is paramount (Muraya & Kimamo, 2011). The goal of any Biology teacher should therefore be to promote and nurture the development of SPS. The Kenya Institute of Education-KIE) succeeded in the reorganization and rationalization of the current Biology curriculum with a strong recommendation for the use of student-centred learning approaches (KIE, 2002).

There has been no marked improvement in Biology subject in the decade starting 2010 (RoK, 2012b). Similar concerns have also been voiced by the Kenya National Examination Council –KNEC (2017). The performance of Biology subject in the component papers (1, 2 & 3) has been low over the past five years as indicated by the statistics from KNEC (Table 1). The statistics indicate that candidates recorded low mean scores in the KCSE Biology examination as per component papers. This statistics are alarming owing to the drive to be an industrialised nation by the year 2030, as is stated in the country's blueprint -Vision 2030. With this thought in mind, there is a need for the adoption of teaching and learning approaches that will enhance students' ability to acquire skills such as SPS hence improve their achievement in Biology. This will therefore allow graduates from secondary school to enrol into skilled careers that are useful in the fulfilment of Vision 2030. According to KNEC (2013a, 2017), the low mean scores are attributed to instruction that is based on mere transfer of factual information, lacking creativity, coupled with simple memorization of biological facts and at the same time, failing to link these biological facts to biological processes. This also implies that students lack the ability to relate practical activities to scientific concepts that are taught in the classroom. Similar sentiments have been echoed in the subsequent KNEC reports (2017), which observes that teaching and learning of Biology requires the emphasis on the exposure to a variety of practical work rather than using theoretical teaching approaches to deliver content in the secondary school Biology curriculum. The KNEC report (2017), recommends that teachers should expose students to elemental Science Process Skills and underpin understanding of content through hands-on tasks that are learner centred. Biology subject has been recording significant low performance over the years as illustrated in Table 1.

Table 1: Candidates Mean Score in Biology Paper 1, 2 and 3 (2013-2017)

Year	Paper	Maximum Score	Mean Score
2013	1	80	28.03
	2	80	22.36
	3	40	12.88
2014	1	80	23.91
	2	80	18.92
	3	40	20.82
2015	1	80	27.42
	2	80	19.56
	3	40	22.62
2016	1	80	27.30
	2	80	20.11
	3	40	10.99
2017	1	80	13.74
	2	80	16.43
	3	40	7.68

Source: KNEC (2017)

1.2 Statement of the Problem

In a rapidly growing and challenging world, the demand for pedagogical approaches which foster the acquisition of 21st century competencies among students has become imperative. So far, studies have shown that the

persistent use of traditional teaching methods do not promote science process skills among students. Despite the dismal performance of students in Biology at KCSE over the years, attempts through research to improve students' results have merely confirmed the critical need for teaching methods that will involve students' active participation and imbue in them the skills that will also facilitate their achievement in Biology while making the teaching and learning of Biology meaningful in their daily lives. Though, inquiry learning has been shown to enhance investigative skills among learners, its implementation for the teaching of Biology in Kenya has been sparse. In the same vein, facilitation of acquisition of skills through the application of SPS in Biology has been uncommon. It is on this basis that the study was designed to establish the effect of IBL on acquisition of ISPS in Biology subject.

1.3 Purpose of the Study

The purpose of this study was to investigate the effect of inquiry-based learning (IBL) on students' level of acquisition of integrated science process skills (ISPS) in Biology subject.

1.4 Objective of the Study

The objective of the study was to determine the difference between students' level of acquisition of Integrated Science Process Skills when taught using IBL approach and Traditional Learning approach (TL) in Biology.

1.5 Research Question

What is the difference between students' level of acquisition of ISPS when taught using IBL approach and Traditional Learning approach (TL) in Biology?

1.6 Hypothesis of the Study

The hypothesis that guided this study at $\alpha = .05$ was: There is no significant difference between students' level of acquisition of Integrated Science Process Skills when taught using IBL and TL approach in Biology subject.

2. Methodology

Quasi experimental design was used where form three classes were involved as school authorities do not allow randomization reconstituting and disrupting classes during administration of the treatment (IBL). The students in the experimental group received instruction through IBL on one selected topic (ecology). The study was conducted in two mixed day secondary schools in Kesses Sub-County in Uasin-Gishu County, Kenya. The target population for the study was 2,594 students of form three classes in the secondary schools in Kesses Sub-County as at the time of the study. The accessible population was made up of form three students in 25 mixed day schools. The sample population comprised of 116 students drawn from two mixed day schools owing to the non-equivalent control group post test only design as a quasi experiment. Stratified sampling was used to select the mixed day category of schools and systematic sampling was used to select two schools from the list of mixed day schools that were obtained from Kesses Sub-County education office. Simple random sampling was used to place the two schools into the experimental and control groups. A Biology Integrated Science Process Skills Questionnaire (BISPSQ) was developed and used after the treatment was administered to the experimental group to establish the students' views on their acquisition of ISPS. The BISPSQ was validated by supervisors from Science Education department, University of Eldoret. Cronbach's alpha coefficient was used to calculate the reliability coefficient of the BISPSQ, which was established to be 0.83.

2.1 Intervention

The experimental and control group received instruction for a period of five weeks. Students in the experimental group were instructed using IBL while those in the control group were taught using TL. Students carried out investigations on factors in an ecosystem and interactions in the ecosystem. The students were divided into groups comprising of ten students each. Before the commencing of the lessons, the teacher instructed students on what they were required to do. A self-rating scale, a BISPSQ was administered to the experimental and control group after teaching to measure the level of acquisition of ISPS among form three students. The scores from the questionnaire were coded and used for data analysis. Descriptive statistics (means) and inferential statistics (2 by 2 ANOVA) were used to describe and compare students' level of acquisition of ISPS in Biology. This comparison helped to determine the effectiveness of IBL in acquisition of ISPS.

3. Results

The objective of the study sought to establish the difference between students' level of acquisition of Integrated

Science Process Skills when taught using IBL approach and Traditional Learning approach (TL) in Biology. The respondents who participated in the study were 116 students, the experimental group (those taught using IBL approach) comprised of 52 students while the control group (those taught using TL approach)

3.1.1 Post-test Results

After grouping the respondents into the experimental and control groups, the experimental was taught using IBL approach (as the treatment) while control group was taught using TL. After the treatment period which lasted for a period of four weeks, the students filled the BISPS. The mean of their views on the ISPS was obtained. The results are shown in Table 2.

Table 2: ISPS Mean and Standard Deviation for IBL and TL

Variable	Mean	N	Standard Deviation
IBL	3.58	312	1.437
TL	2.34	384	1.450

Table 2 shows the means and standard deviations for the experimental and control groups during the post-test. The mean for the experimental group taught using IBL was 3.58 while that for the control group taught using TL was 2.34. The mean of the experimental group was higher than that of the control group. The interpretation was that the level of acquisition of ISPS in the experimental group was higher than that of the control group. This implied that IBL (treatment) was more effective than TL on acquisition of ISPS.

3.2 Hypothesis Testing

The hypothesis (HO) that guided the study at $\alpha = .05$ was: There is no significant difference between students' level of acquisition of Integrated Science Process Skills when taught using IBL and TL approach in Biology subject. This was done by conducting a 2 by 2 ANOVA for ISPS versus teaching approach. The results are shown in Table 3.

Table 3: 2 by 2 ANOVA Table for Variable versus Approach

Source	Df	Sum of squares	Mean sum of squares	F	Sig
Variable (ISPS)	5	11.46	2.292	1.0968	0.3608
Approach	**1**	**265.10**	**265.100**	**126.8406**	**0.0000**
Interaction (Variable * Approach)	5	6.78	1.356	0.6487	0.6626
Residuals	684	1429.58	2.090		

Table 3 shows the significance value ($p = .0000$) for the type approach is less than the level of significance, $\alpha = .05$. The null hypothesis was rejected which stated that the means for IBL and TL were the same. Hence it was concluded that there was sufficient evidence to reject the null hypothesis. This means that depending on the type of approach (IBL or TL) used, the means were different. In this case, IBL had a higher mean of 3.58 than that of TL which was 2.34., that is, IBL was more effective on acquisition of ISPS than TL approach.

4. Discussion

The findings of this study indicate that Inquiry Based Learning is more superior to Traditional Learning in terms of the acquisition level of ISPS. This may be attributed to the active participation of students in the learning process through engagement by inquiry thus acquiring and involving various Integrated Science Process Skills (ISPS). These results are similar to the findings from a study conducted to investigate the effect of ethno science based and traditional laboratory practical method on Science Process Skills (SPS) acquisition of secondary school Biology SS2 students in Igboland-Nigeria (Ibe & Nwosu, 2017). This study established students taught using ethno science based method performed better in the Test of Science Process Skills Acquisition (TOSPSA) and recorded a mean score of 35.42 compared to those taught by traditional laboratory practical method who

recorded a mean score of 26.22. The study concluded that ethno science based teaching is preferred because it helped students acquire the necessary Science Process Skills by being actively involved in the learning process.

The findings of this study are also in concurrence with a study conducted by Athuman (2017) on the effectiveness of Inquiry Based Approach (IBA) on students' scientific process skills by comparing it with the conventional style of teaching using the topic of Genetics using a Biology Science Process Skills Test (BSPST). According to Athuman, students taught Genetics using IBA outperformed those taught using the conventional teaching method in the BSPST. The study concluded that IBA is more effective than the conventional method in science process skills development. This study Athuman also established that Inquiry Based Approach (IBA) teaching method was effective in promoting students scientific understanding, building their knowledge base and problem-solving capabilities.

Another Study conducted by Ghumdia (2016) on the effects of inquiry-based teaching strategy on students' science process skills acquisition in some selected Biology concepts in secondary schools in Borno state-Nigeria using a Biology Student Process Skill Achievement Test (BSPSAT) outlined similar findings. The results of this study revealed that inquiry-based teaching helped to cultivate science process skills in students of Biology in topics of ecology, genetics and evolution compared to the lecture method. Students in the experimental group (inquiry strategy teaching) performed better than those in the control group (lecture method), experimental group had a mean score of 20.16 while the control group had a mean score of 12.87. Students taught using the inquiry strategy are able to use science process skills to navigate through the various learning activities and find solutions to the problems at hand. According to Ghumdia, students were able to effectively apply science process skills in the course of their learning because of the systematic and organized procedure that inquiry lends to learning process.

According to KNEC report (2017), it is noted that learners should be guided to developing an understanding of inquiry through scientific processes by employing science process skills approach for both instruction and assessment whilst encouraging collaboration in the classroom. Such a scenario helps to create a suitable learning environment for students to develop and strengthen key scientific skills for example, experimenting, hypothesising, investigating, analysing data and interpreting data among other Integrated Science Process Skills. A study conducted by Suryanti and Lede (2018), observe that when students carry out practical activities that engage the utilisation of science process skills such as observation, communicating through group discussion, experimenting, predicting and data interpretation, their learning outcomes are increased.

5. Conclusion

This study concludes that inquiry-based learning in Biology is an effective teaching-learning method on the acquisition of Integrated Science Process Skills. Inquiry-based learning leads to a higher level of Integrated Science Process Skill acquisition. IBL approach recorded a higher mean value than TL approach in the Study. Hence IBL can be considered to be an effective method that can bring about a positive learning outcome on the level of acquisition of Integrated Science Process Skills in Biology subject at secondary school level. Teaching through IBL is important in the acquisition and development of Integrated Science Process Skills among secondary school Biology students.

6. Recommendation

Inquiry-Based Learning has the potential to help students acquire and develop Integrated Science Process Skills, therefore it should be enhanced as a teaching-learning method in secondary schools as a means to help learners participate in the learning process through investigations of assigned tasks thus gain SPS that will help them in their day to day life, particularly in the development and achievement of Sustainable Development Goals.

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