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Volume 17 Number 1 March 2005

ISSN 1013–3445

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EFFECTS OF PROJECT-BASED LEARNING ON STUDENT PERFORMANCE OF HIGHER COGNITIVE SKILLS IN SECONDARY SCHOOL AGRICULTURE

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Abstract

This study used a quasi-experimented design to investigate the effect of project–based learning on student performance of higher cognitive skills in secondary school agriculture. A total of 354 Form Three students drawn from ten (10) randomly selected secondary schools in Nakuru District of Kenya were assigned to three (3) treatment groups based on the location of the projects (HFP, SFP and CFP) and one control group. Data indicates that the use of project-based learning has a significant impact on students' performance of higher cognitive skills. The results revealed that students in project-based learning groups outperformed their counterparts in regular classrooms in that their mean scores on a post-test measuring higher cognitive skills, were statistically significant (at 0.05 p level) than that of the control groups. The paper suggests that teachers should be trained and encouraged to incorporate project-based-learning in their planning of instruction.

Introduction

Studies seem to suggest that project-based learning can have a positive effect on students' acquisition of higher cognitive skills (Shepherd, 1998) during the instructional process. Project-based learning refers to complex tasks, based on challenging questions or problems, that involve students in design, problem-solving decision making, or investigative activities which give students the opportunity to work relatively autonomously over extended periods of time (Jones, Rasmussen, & Moffitt, 1997; Thomas, Morgendoller, & Richardson, 1999). Other defining features found in the literature include authentic content assessment, teacher facilitation but not direction, explicit educational goals (Moursund, 1999), co-operative learning, reflection, and incorporation of adult skills (Diehl, Grobe, Lopez & Cabral, 1999).

Gorb (1987) pointed out the superiority of the project approach over the case study method in training students for action. He argues that student projects require the student to organize, analyse and synthesize, which leads to the development of skills like self-direction, problem-solving, decision making and community skills. The unique thing about these skills is that they are transferable and provide a better preparation for life than other methods.

Henry (1994) identified six major benefits of using the project method. These include:

(a) indepth learning of the subject matter;

(b) motivating learners;

(c) helping the learners to acquire higher cognitive learning;

(d) helping the learners to acquires co-operative skills through working together;

(e) helping the learners to apply knowledge in real life settings therefore, making learning relevant; and

(f) integrating learning.

The need for students to develop higher cognitive skills is critical if students are to solve problems in the environment. Higher cognitive skills refer to the ability of the learner to deal with issues requiring application of skills in comprehension, application, synthesis, analysis, and evaluation (Kibett, 2002). These are the skills that students utilize in scientific approach required in problem solving.

Theoretical Framework

The theoretical perspective employed in this study is that of constructivism. According to this theory, the learner is viewed as an active participant in constructing his/her own knowledge (Kiboss, 2001). Rather, learning is seen as involving the altering of his/her existing conceptual framework as a result of one's exposure to new experience. The constructivist perspectives on concept learning draw on the idea that knowledge is actively constructed (Kibett, 2002).

According to Carey (1985), learning results in conceptual change. Conceptual change is the process of progressively reconstructing mental representation of events in one's environment. As such, learners are therefore expected to make their own sense of imposed ideas and skills, and extract meaningful pattern in order to integrate new ideas that explain phenomena (Hewson and Thorley, 1989).

In order to be successful, learners need to be assisted in representing and refining their models. Learners employ, knowledge and skills gained through interaction with their teachers, fellow students and parents to solve real life problems in their environment in order to help them develop a framework which fits with their experience. The basic assumption is that project-based learning has some advantages for learning.

Statement of the problem

The main problem that was addressed by this study was the lack of empirical data on the effect of project-based learning in secondary school agriculture especially in Kenya. Research on project–based learning has focussed on such out-come variables as motivation, resourcefulness, retention and student achievement. However studies documenting the effectiveness of the project-based learning on outcome variables such as achievement of higher cognitive skills were non-existent (Kibett, 2002).

The purpose of the study

The primary purpose of the study was to provide empirical evidence and to document the effect of project-based learning (PBL) undertaken in three different environments - Home-farm (HFP), School-farm (SFP) and community-farm (CFP), on performance of higher cognitive skills (HCS) by learners in secondary school agriculture. In pursuance of this problem, the following objective was stated:-

— To describe and compare the learners of HFP, SFP and CFP and CONTROL groups on their performance of higher cognitive skills.

From the above objective, one Null Hypothesis was formulated for testing as follows:-

— There is no statistically significant difference between the performance of learners in HFP, SFP, CFP and CONTROL groups on a measure of HCS.

Method

Subjects were drawn from Nakuru District among four clusters of schools in areas far apart from each other. Schools in each area were randomly selected as follows:

Naivasha-Gilgil (2 schools), Bahati-Subukia (3 schools), Njoro-Rongai (3 schools), Molo-Olenguruone (2 schools). A total of 354 Form Three students (219 males and 136 females), who were enrolled in agriculture classes were included in the study. Each cluster of schools was randomly assigned a treatment group as follows:

Njoro-Rongai (HFP), Naivasha-Gilgil (SFP), Molo-Olenguruone (CFP). The Bahati-Subukia cluster became the CONTROL group.

The variables of interest reported were the environment where the project-based learning was located and performance of higher cognitive skills. Project-based learning activities were located at the home-farm (HFP), school-farm (SFP) and at the community-farm (CFP). In the home-farm project, the subjects worked in groups, identifying problems relating to the growing of beans, seeking information and applying solutions to individual home-farm. In the school-farm projects and community farm projects, the subjects were involved in similar activities as in home-farm projects except the location of the project was different.

The students' performance skills variable was measured by an achievement test. The test comprised ten (10) items measuring higher cognitive skills (HCS). Two sets of tests were developed, one was used as a pre-test and the other was used as a post-test. The tests were developed and moderated by experts drawn from Egerton University and Kenya National Examination Council. The tests were pre-tested using two schools with similar characteristics to the sample schools in the same district but did not take part in the study. The analysis of the tests using Cronbach's alpha co-efficient yielded an average of 0.727.

Data was collected from the selected sample for a period of three months. A pre-test measuring higher cognitive skills was administered by the agriculture teachers. This was followed by a period of three months whereby the learners

undertook project-based activities relating to the growing of beans. At the end of this period, the learners were given a post-test. This post-test was similar to the pre-test in all aspects. The learners in control schools were not exposed to the project activities. Scoring of the tests was done by the researcher.

Both descriptive and inferential statistics were used for data analysis. Descriptive statistics were applied in order to describe the nature of performance of all the students and in order to obtain means and percentages useful for further analyses. Inferential statistics applied were the one-way analysis of variance (ANOVA) to test the stated hypothesis, the analysis of covariance (ANCOVA) to re-move the effects of the pre-test, and the LSD test to determine the direction of significance.

Results and Discussion

The scores obtained from the tests were tabulated and analyzed using SPSS version 9.0. The level of significance was set at $p = 0.05$. The results of these tests are displayed in tables and their implications are discussed.

Table 1. Means and standard deviations of learners' pre-test and post test-scores in higher cognitive skills per treatment.

Treatment		Pre-test		Post-test	
	N	$\bar{X}$	SD	$\bar{X}$	SD
HFP	109	27.94	7.94	26.51	7.50
SFP	64	26.25	9.26	28.91	5.60
CFP	85	29.82	8.43	26.41	7.30
CONTROL	96	32.97	7.42	25.52	6.47

An examination of Table 1 indicates high mean scores on post-test in favour of HFP SFP and CFP groups. This seem to imply that during project-based learning, the learners in the treatment groups displayed better skills requiring ability to deal with issues requiring application of skills in comprehension, application, synthesis, analysis and evaluation than their counterparts in the control groups.

In order to determine whether the difference in performance revealed in Table 1 was significant, post-test means were subjected to analysis of variance test (ANOVA). Table 2 shows a summary of the results.

Table 2 ANOVA summary table of higher cognitive skills by treatment.

Source	Sums of squares	df	Means squares	F	P
Between groups	455.05	3	151.68	3.217*	0.023*
Within groups	16503.22	350	47.15		

* P< 0.05

The results show that the calculated F value (F=3.217, 3, 350) is greater than the theoretical value (F= 2.60, 3, 350), therefore, the null hypothesis is rejected as untenable. It can be concluded that using ANOVA, there is strong evidence that the treatment effects on higher cognitive skills over the difference groups is significant at P<0.05.

The data were further subjected to an analysis of covariance test (ANCOVA) using the pre-test means as a co-variance in order to adjust for the effect of the pre-test. The results of the ANCOVA analysis are shown on Table 3.

Table 3 ANCOVA summary table of higher cognitive skills.

Source	Sum of squares	df	Mean Squares	F	P
Corrected model	2563.488	4	640.872	15.538	.000
Intercept	8266.055	1	8266.055	200.410	.000
Pre-test	2108.439	1	2108.439	51.119	.000
Treatments	1058.414	3	352.805	8.554*	.000
Error	14394.775	349	41.246		
Total	268425.000	354			
Corrected Total	10958.263	353			

* P<0.05

As shown in Table 3, the calculated F value is 8.554 (3, 349). Since the value is greater than the theoretical value (F = 2.60, 3, 349), the null hypothesis is rejected and the alternative hypothesis is accepted. Therefore, after removing the effects of the pre-test, there is still evidence to conclude that the performance on high cognitive skills over the different treatments differs significantly.

In order to determine which two means were significantly different, the data were subjected to an LSD test. The results of the LSD test are shown in Table 4.

Table 4 Multiple comparison, using LSD-test, of the treatments on higher cognitive skills

Dependent Variable	Treatment (I)	Treatment (J)	Mean diff (I-J)	Sig.
Higher Cognitive Skills	CFP	SFP	- 2.49	.029
		HFP	- .10	.918
		CONTROL	.891	.384
	SFP	CFP	2.49*	.029
		HFP	2.39*	.028
		CONTROL	3.39*	.002
	HFP	CFP	.10	.918
		SFP	.2.39*	.028
		CONTROL	.99	.302
	CONTROL	CFP	-.89	.384
		SFP	-3.39*	.002
		HFP	-.99	.303

*P< 0.05

The data displayed on Table 4 reveal that the performance on higher cognitive skills by SFP groups was significantly different from all the other treatments including CONTROL (Sig .029, .028 and .002). Secondly, the post-hoc test reveal that the performance on higher cognitive skills between CFP, HFP and CONTROL groups were significantly different.

The higher cognitive skills tests measured skills in application of knowledge to new situations. The data implies that the students in treatment groups outperformed their counterparts in control groups in all aspects requiring comprehension, synthesis, analysis and evaluation of information.

Conclusions and Recommendations

There is considerable evidence from the significant learning gains demonstrated by the results of the study to suggest that project-based learning activities were effective in influencing learners in acquiring higher cognitive skills. A logical

conclusion that can be drawn from the study is that the effectiveness of PBL has been empirically proven to influence learners' acquisition of higher cognitive skills. This conclusion agrees with other studies on PBL (Boeler, 1997; Gallagher, et al 1992; Shepherd, 1998; and Barron et al, 1998).

The fact that the treatment demonstrated the superiority of the project method in imparting high cognitive skills and given the fact that teachers are always encouraged to emphasize the attainment of these skills by their learners, is an important finding. The following recommendations are therefore made:

(a) Teachers should incorporate project-based activities in their planning.

(b) The Ministry of Education should improve the capacity of the teachers to plan and execute projects.

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