

ACTIVE LEARNING STRATEGIES AS DETERMINANTS OF PRE-SERVICE BIOLOGY TEACHERS' LEARNING OUTCOMES

Olayemi Aderokun Asaaju
Adeyemi College of Education, Nigeria
modadeola64@yahoo.com

ABSTRACT

Available data showed that pre-service biology teachers at Colleges of Education in South-western Nigeria have low achievement in and exhibit negative attitude to population education. Previous studies largely focused on teachers and students' attitude to population education with minimal emphasis on intervention through group-based interactive learning strategies. This study, therefore, determined the impact of Team-Based Learning Strategy (TBLS) and 5E Learning Strategy (5ELS) on pre-service biology teachers' achievement in and attitude to population education. The moderating effect cognitive ability was also examined. Theory of Positive Social Interdependence provided the framework, while the pre-test post-test control group quasi experimental design was adopted. An intact class of second year pre-service biology teachers from three federal colleges of education was randomly assigned to TBLS (171), 5ELS (90) and Control (140) groups. Instruments used were PEAT ($r=0.80$), PTCAT ($r=0.81$) tests, PEAS ($r=0.82$) questionnaire, and Instructional Guides. Data were analysed using Estimated Marginal Means, ANCOVA and Bonferroni post-hoc test at 0.05 level of significance. There was significant effect of treatment on achievement ($F(2,378)=12.26$; partial $\eta^2=0.06$), also on attitude ($F(2,378)=27.90$; partial $\eta^2=0.13$). There was a significant effect of cognitive ability on pre-service biology teachers' attitude ($F(2,378)=3.2$; partial $\eta^2=0.02$). There was a significant interaction effect of treatment and cognitive ability ($F(4,376)=2.44$; partial $\eta^2=0.03$) on achievement in favour of high cognitive ability pre-service biology teachers from 5E group. Employing these two strategies to teach population education would be a strategic means of developing and improving pre-service biology teachers' ability to retain, construct and reconstruct knowledge from learning experiences. This also would help them to solve population issues whether personal or communal within and outside of the classroom.

Key words: Active learning strategies, population education, pre-service biology teachers, attitude and achievement

INTRODUCTION

In Nigeria's Colleges of Education, there are compulsory courses in biology such as population education, which pre-service biology teachers must offer and pass before they can be certified as Nigeria Certificate in Education (NCE) holders. Population education is multidisciplinary as it draws its content from, and, cuts across a wide range of other subject disciplines such as basic science, biology, social studies, health education, environmental education, population and family life education (Pop/FLE), family life and HIV education, family life and health education (FLHE), demography, geography, urban and regional planning and others.

One identified major problem militating against the effective teaching of courses in Nigeria's tertiary institutions is the use of conventional lecture strategy adopted by lecturers to teach (Aremu & Salami, 2013; Agoro, 2012). However, one germane reason for this could be due to the huge growth in knowledge in many areas of biological sciences which has created a untold confusion for lecturers in tertiary institutions, for not only must they transmit new facts and concepts to their students, they must also ensure that they comprehend and appreciate them (Mulley, 2015).

A critical look at the performance (Table 1.1) in the three colleges during the years under review revealed low achievement as a whopping 1527 (55.8%) candidates of the total 2736 performed below average; they failed to score 50 marks out of the maximum obtainable 100 marks. This calls for concern if the objectives of including population education in the curriculum of pre-service biology teachers are to be achieved. Also, studies (Medhi, 2017; Monika, 2013; Kavita, 2002) have revealed that school teachers have poor knowledge of, and, exhibit negative attitude to population education. Implication of this problem could be that learners under the tutelage of these teachers would likely not fare any better because they would neither be taught beyond their teachers' knowledge nor encouraged to exhibit

attitude better than their teachers.

Table 1.1: Data Showing Academic Achievement of Pre-service Teachers in Three Colleges of Education in South-western Nigeria

Session	College A				College B				College C			
	A-C	D-E	F	TOT	A-C	D-E	F	TOT	A-C	D-E	F	TOT
2010/ 2011	55 34%	61 37.7%	46 28.4%	162	33 23%	84 59.6%	24 17%	141	50 49%	34 33%	18 17.7%	102
2011/ 2012	117 71.8%	39 23.9%	07 4.3%	163	97 54.5%	65 36.5%	16 9%	178	55 51.4%	32 29.9%	20 18.7%	107
2012/ 2013	44 30.6%	78 54.2%	22 15.3%	144	98 38.7%	120 47.4%	35 13.8%	253	49 45%	47 43.1%	13 11.9%	109
2013/ 2014	65 41.1%	76 48.1%	17 10.8%	158	116 46.2%	123 49%	12 4.8%	251	47 35.9%	53 40.5%	31 23.7%	131
2014/ 2015	86 50.3%	66 38.6%	19 11.1%	171	133 52%	101 39.5%	22 8.6%	256	55 41.7%	53 40.2%	24 18.2%	132
2010 - 2015	367 46%	320 40.1%	111 13.9%	798	477 44.2%	493 45.7%	109 10.1%	1079	256 44.1%	219 37.7%	106 18.2%	581

Sources: Departments of Biology in the three Federal Colleges of Education

Note: A-C = 70% - 50%; D-E = 45% - 40%; F 0% - 39% (NCCE template for grading pre-service teachers)

Puerta (2015) in a study established a significant relationship between cognitive processes and academic performance. Despite the fact that cognitive abilities have been studied and linked to academic achievement, research continues to display gaps in the understanding and exploration of students' cognitive abilities (Finn et. al., 2013). Also, there is little research on cognitive ability which focuses on the tertiary level (Loveland, 2014).

OBJECTIVE OF THE STUDY

This study focused on adopting active learning strategies such as team-based and 5E strategies to remediate the performance deficiencies of pre-service biology teachers in, and negative attitude to population education in Colleges of Education in Southwest, Nigeria.

RESEARCH HYPOTHESES

Ho1: There is no significant effect of treatment on pre-service biology teachers' achievement in population education

Ho2: There is no significant effect of treatment on pre-service biology teachers' attitude to population education.

Ho3a: There is no significant interaction effect of treatment and cognitive ability on pre-service biology teachers' achievement in population education

Ho3b: There is no significant interaction effect of treatment and cognitive ability on pre-service biology teachers' attitude to population education

THEORETICAL FRAMEWORK: Theory of positive social interdependence

Though there are at least four major theories supporting the use of cooperative learning, social interdependence theory stands out as the most useful and influential theory underlying cooperative learning (Johnson and Johnson, 2015). Positive interdependence is an element of cooperative and collaborative learning where members of a group who share common goals perceive that working together is individually and collectively beneficial, and success depends on the participation of all the members (Johnson, Johnson and Holubec, 1998; Choi, Johnson and Johnson, 2011). Positive social interdependence is the first important element for a rewarding team-learning with combined rewards, shared resources, and supportive roles (Johnson, Johnson, and Holubec, 1998) but the success of one member is dependent on the success of the entire members of the team (Laal, 2013). The positive social interdependence theory is relevant and applicable to the TBL and 5E strategies as students work together cooperatively, cohesively, sharing knowledge, views and opinions with the goal of reaching a consensus decision. In the two

strategies, students depend on one another for the successful completion of tasks or assignments culminating in positive interdependence.

LITERATURE

Attitude and academic achievement are significant factors in ensuring students' success in science (Hussaini, Foong & Kamar, 2015; Kaya & Geban, 2011). Studies on the link between attitude and academic achievement have found that these two variables were closely related to each other (Kurbanoglu & Akin, 2010) while Hofstein & Mamlok-Naaman (2011) affirmed that students' disposition to science subjects is hinged on the level of their active involvement and participation in the instructional process. These submissions probably informed the suggestion of Khan & Ali (2012) that understanding students' attitude is crucial in reinforcing their achievement and interest towards a specific discipline.

Cognitive ability is another strong prognosticator of students' academic achievement (Deary et al., 2007) which Philipson and Philipson (2012) described as students' ability to carry out advanced mental processes that border on critical thinking, comprehension, and proffering solutions to problems. Cognitive abilities are neuron-dependent skills essential to execute any assignment from the easiest to the most difficult (Michaelon, 2006). These skills provide the most frugal and straight-to-point explanation that predict academic performance both by purpose and verifiable support (Loveland, 2014). For students to develop and use these skills, a call for a shift in pedagogical paradigm has been made by the Federal Republic of Nigeria (FRN) that, educational activities shall be learner-centred, teaching shall be practical, activity-based, and experiential (FRN, 2014). Despite this call, lecturers do not always employ strategies that can help improve pre-service teachers' cognitive ability thereby making them often times struggle to apply the knowledge learned to later classroom practice (Schafer, 2014). Though a lot of studies had been carried out to establish that cognitive ability can be used to forecast academic performance of students, little of this focused on the tertiary level (Loveland, 2014).

The use of active-learning strategies acknowledges the fact that learning is a spectacle of the human brain, and that the individuals engaged in learning must be actively involved in constructing meaning, assessing their prior ideas, and resolving misconceptions (Miller & Tanner, 2015). Scholars (Brame, 2016; Nelson & Crow, 2014; Eison, 2010) have established that adopting active-learning strategies could bring about enhanced student attitude and learning outcomes. Hence, this study considered Team-Based and 5E (Engage, Explore, Explain, Elaborate, Evaluate) learning strategies which are constructivist-based and have been proved by scholars to encourage students' active participation, engagement and involvement, self-directed learning, collaboration, and most importantly, application of knowledge to solving problems inside and outside of the classroom.

Team-Based Learning (TBL) is a tutor-directed strategy that incorporates multiple small groups in a single classroom (Middleton-Green & Ashelford, 2013), a pedagogy that facilitates students working collaboratively as teams to learn a subject (St Clair & Chihara, 2012) and encourages development of higher cognitive skills such as application, analysis and evaluation (Imazeki, 2015). However, Whitaker (2011) observed that there is very little evidence of the use of Team Based Learning Strategy (TBLS) in undergraduate teacher preparation despite its potential to moderate the negative effects of large class size and limited time.

Another active learning strategy this study employed is the 5E Learning (5EL). There are five phases and each has a definite role which supports the instructor's presentation of lessons and enables students to analyse and integrate current information in activity-based classes (Puteh & Nawastheen, 2013). The 5E strategy according to Warner and Myers (2013) shares features with guided discovery and teachers can use it to meet objectives and deliver specific concepts and explanations. A core benefit of 5E aside other benefits linked to constructivist approaches to instruction is making learning opportunities available for students (Moyer, Hackett & Everett, 2007). This study considered Team-Based Learning Strategy (TBLS) and 5E

Learning Strategy to address the aforementioned gaps.

RESEARCH METHODOLOGY

The study employed the pre-test post-test control group quasi experimental design. Variables considered in the study are: One independent variable (Instructional strategy) at three levels - Team-Based Learning Strategy (TBLS), 5E Learning Strategy (5ELS), and Conventional Strategy (CSIG), one moderator variable (Cognitive Ability) and two dependent variables (Achievement and Attitude). Purposive sampling of three Federal CoEs was based on availability of teaching/learning facilities and uniformity in academic calendar. An intact class of second year pre-service biology teachers from each college was randomly assigned to TBLS (171), 5ELS (90) and Control (140) groups. Instruments used were Population Education Achievement, PEAT ($r=0.80$), Pre-service Teachers Cognitive Ability, PTCAT ($r=0.81$) tests, Population Education Attitude Scale, PEAS ($r=0.82$) and three Instructional Guides- TBLSIG, 5ELSIG and CSIG. The PEAT and PEAS were developed by the researcher while PTCAT was adopted but modified from that developed originally by Newton and Bristoll (2009). The Instructional Guides were prepared by the researcher using the approved format for pre-service teachers' Teaching Practice (TP) as a guide. All instruments were administered on a non-participating government-owned College of Education to ensure their validity and reliability. KR-20 was used to establish the reliability co-efficient of PEAT while Cronbach Alpha was used for PEAS. The Instructional Guides were given to lecturers handling Population Education course in two Colleges of Education for face and content validity. Participants in the two intervention strategies were put into groups of 5-7 members using their class list to prevent subjective grouping. Treatment lasted ten weeks: one week for pre-test, eight weeks for treatment and one week for post-test. Data collected were analysed using Estimated Marginal Means, Analysis of Covariance, and Bonferroni post-hoc test at 0.05 level of significance.

RESULTS

Ho1: There is no significant effect of treatment on pre-service biology teachers' achievement in population education

Table 7.1: Analysis of Covariance (ANCOVA) of Post-Achievement by Treatment and Cognitive Ability

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1510.967 ^a	24	62.957	3.751	0.000	0.193
Intercept	9527.818	1	9527.818	567.687	0.000	0.602
Pre-Achievement	0.009	1	.009	0.001	0.982	0.000
Treatment	411.445	2	205.723	12.257	0.000*	0.061
Cognitive ability	13.871	2	6.936	0.413	0.662	0.002
TreatmentxCognitiveability	270.966	4	67.742	4.036	0.003*	0.041
Error	6310.629	376	16.784			
Total	262261.000	401				
Corrected Total	7821.596	400				

R Squared = .193 (Adjusted R Squared = .142) * denotes significant difference at 0.05

Table 7.1 shows that there is significant main effect of treatment on pre-service teachers' achievement in population education ($F_{(2,378)} = 12.257$; $p < 0.05$, partial $\eta^2 = 0.061$). The effect size is 6.1%. This means that the significant difference in the post-achievement scores of pre-service teachers in population education was due to the treatment. Thus, hypothesis 1a was rejected. To decide on the magnitude of the significant effect across treatment groups, the Estimated Marginal Means of the treatment groups were carried out and the result is presented in Table 7.2

Table 7.2: Estimated Marginal Means (EMM) for Post-Achievement by Treatment and Control

Groups

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Team Based Learning Strategy (TBLS)	24.73	0.528	23.693	25.770
5E Learning Strategy (5ELS)	28.69	0.789	27.143	30.245
Conventional Strategy (CS)	23.77	0.594	22.599	24.933

Table 7.2 reveals that the pre-service teachers in 5ELS had the highest adjusted post-achievement mean score in population education (28.69), followed by TBLS Group (24.73), while the Conventional Strategy (CS) control Group had the least (23.77).

Table 7.3: Bonferroni Post-hoc Analysis of Post-Achievement by Treatment and Control Groups

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Team-Based Learning Strategy	5E Learning Strategy	-1.4632*	.53280	.019	-2.7444	-.1819
	Conventional Strategy	2.5083*	.46632	.000	1.3869	3.6296
5E Learning Strategy	Team Based Learning Strategy	1.4632*	.53280	.019	.1819	2.7444
	Conventional Strategy	3.9714*	.55277	.000	2.6422	5.3007
Conventional Strategy	Team Based Learning Strategy	-2.5083*	.46632	.000	-3.6296	-1.3869
	5E Learning Strategy	-3.9714*	.55277	.000	-5.3007	-2.6422

*denotes significant difference at 0.05

Table 7.3 reveals that the post-achievement mean scores in population education pre-service biology teachers exposed to 5ELS were significantly different from their counterparts in TBLS and CS. This shows that both 5E and team based learning strategies were the main sources of significant differences in treatment.

Ho2: There is no significant effect of treatment on pre-service biology teachers' attitude to population education

Table 7.4: Analysis of Covariance (ANCOVA) of Post-Attitude by Treatment, and Cognitive Ability

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	9030.397 ^a	24	376.267	7.746	0.000	0.331
Intercept	9461.404	1	9461.404	194.767	0.000	0.341
Pre-Attitude	1473.918	1	1473.918	30.341	0.000	0.075
Treatment	2710.739	2	1355.369	27.901	0.000*	0.129
Cognitive ability	310.782	2	155.391	3.199	0.042*	0.017
Treatment x Cognitive ability	358.620	4	89.655	1.846	0.119	0.019
Error	18265.384	376	48.578			
Total	2174457.000	401				
Corrected Total	27295.781	400				

R Squared = .331 (Adjusted R Squared = .288) * denotes significant difference at 0.05

Table 7.4 shows that there is a significant main effect of treatment on pre-service teachers' attitude to population education ($F_{(2,378)} = 27.901$; $p < 0.05$; $\eta^2 = 0.129$). The effect size is 12.9%. Hence, hypothesis 1b was rejected. In order to determine the magnitude of the significant main effect across treatment groups, the estimated marginal means of the treatment groups was carried out, and the result is presented in Table 7.5.

Table 7.5: Estimated Marginal Means (EMM) of Post-Attitude by Treatment and Control Groups

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
TBLS	74.95	0.891	73.203	76.705
5ELS	79.81	1.340	77.171	82.442
CS	66.71	1.003	64.736	68.681

Table 7.5 reveals that pre-service teachers in the 5ELS Group 2 had the highest adjusted post- attitude mean score to population education (79.81), followed by the TBLS Group (74.95), while pre- service teachers in the CS Group had the least (66.71).

Table 7.6: Bonferroni Post-hoc Analysis of Post-Attitude by Treatment and Control Groups

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
TBLS	5ELS	-5.4117*	.94232	0.000	-7.6777	-3.1457
	CS	4.8550*	.82473	0.000	2.8717	6.8382
5ELS	TBLS	5.4117*	.94232	0.000	3.1457	7.6777
	CS	10.2667*	.97763	0.000	7.9158	12.6176
CS	TBLS	-4.8550*	.82473	0.000	-6.8382	-2.8717
	5ELS	-10.2667*	.97763	0.000	-12.6176	-7.9158

* denotes significant difference at 0.05

Table 7.6 reveals that pre-service teachers exposed to 5ELS were significantly different from their counterparts taught using TBLS and those exposed to Conventional Strategy CS in their post-attitude to population education scores. This implies that the significant differences originated from the intervention of the 5ELS and TBLS.

Table 7.7: Estimated Marginal Means of Post-Attitude by Cognitive Ability

Cognitive ability	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Low	72.56	.872	70.846	74.274
Medium	71.88	.756	70.391	73.363
High	77.08	1.579	73.970	80.181

Table 7.7 reveals that the high cognitive ability pre-service teachers had the highest adjusted post- attitude mean score to population education (77.08), followed by the medium cognitive ability level (71.88), and the low cognitive ability pre-service biology teachers (72.56).

Ho3a: There is no significant interaction effect of treatment and cognitive ability on pre-service biology teachers' achievement in population education

Table 7.1 shows that there is a significant two-way interaction effect of treatment and cognitive ability on pre-service teachers' achievement in population education ($F(4,376) = 2.440$, $p < .05$; partial $\eta^2 = 0.025$). The effect size is 2.5%. Thus, the null hypothesis 3a was rejected. This implies that treatment and cognitive ability had effect on pre-service biology teachers' achievement in population education.

Ho3b: There is no significant interaction effect of treatment and cognitive ability on pre-service biology teachers' attitude to population education

Table 7.4 shows that there is no significant two-way interaction effect of treatment and cognitive ability on pre-service teachers' attitude to population education ($F(4,376) = 1.846$, $p > 0.05$; partial $\eta^2 = 0.019$). Hence, the null hypothesis 3b was not rejected.

DISCUSSION OF FINDINGS

The finding from the study supports that of Ibrahim (2015) that pre-NCE Biology students exposed to 5E learning cycle in genetics concepts had higher mean performance scores than those in the control group exposed to lecture method of instruction. For team-based learning strategy, findings were in tandem with findings from studies undertaken by Koohestani and Nayereh-Baghcheghi (2016); Huggins and Stamatel (2015) who reported that students exposed to team-based learning strategy (TBLS) recorded improved academic performance than those exposed to the conventional strategy (CS). The finding alludes to that of Ibrahim (2015), Killins and Huitt (2015) who in their respective studies used active learning strategies and reported that students exhibited positive attitude and improved classroom engagement which promoted interactivity between learners.

Finding was consistent with that of Ewumi and Olubela (2015) who reported no significant interaction effect of treatment and mental (cognitive) ability occurred on students' achievement in and attitude to social studies. It also affirmed the outcome of the study undertaken by Babayemi & Akinsola (2014) that significant two-way interaction effect of treatment and mental (cognitive) ability on achievement in Basic science was not significant. However, results of this study did not support the findings of Awolere (2015) who reported that interaction effect of treatment and mental (cognitive) ability on students' attitude to biology was significant. This variance could be due to the educational level of participants in the aforementioned study because studies have shown that students' attitude to science declines as they advance in science education and school years (Potvin and Hasni, 2014; Sorge, 2007). While Awolere worked with secondary school biology students, this study focused on pre-service biology teachers in CoEs. It also means that as students advance in age and school years, their positive attitude to learning may wane unless efforts are geared toward sustaining it.

CONCLUSION

Teaching is a two-way communication process and any teacher who engages in this process should ensure that there is a connection between the speaker and the receiver which most often than not is lacking when the conventional strategy is adopted. In other words, the intuition of the teacher should spur him/her into ascertaining those factors that can ensure that this connection is sustained beyond the initial few minutes into the lesson. The two strategies have been found effective in enhancing pre-service Biology teachers' achievement in and attitude to population education. Cognitive ability was a contributory factor to pre-service biology teachers' achievement but not factors to their attitude to population education. Hence, these two strategies could be used to facilitate knowledge construction and application for improved achievement.

RECOMMENDATION

- i. Employing active learning strategies such as TBL and 5EL by lecturers to teach population education would be a veritable means of developing and improving pre-service biology teachers' ability to construct and reconstruct knowledge from learning experiences. This would impact positively on their ability to apply learned concepts to solving population issues in outside of the classroom.
- ii. Adopting these two strategies could be a formidable means of improving the academic achievement of pre-service biology teachers' in population education which could in turn enhance their attitude to the subject.

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