Assessing the Effectiveness of Padlet Instructional Tool in the Teaching and Learning of some Ecological Concepts

M. Baidoo¹, Y. Ameyaw², J. N. Annan²

¹National Council for Curriculum and Assessment, Ministry of Education, Ghana

²Department of Biology Education, Faculty of Science Education, University of Education, Winneba, Ghana

Abstract: The study investigated padlet instructional (PLI) tool as an activator of students' performance in some ecological concepts in some selected Senior High Schools in the Greater Accra Region of Ghana. The Quasi-experimental design was adopted for the study. A sample size of 102 was purposively sampled from the accessible population. Biology Concept Achievement Test (BCAT) was used for data collection. Data obtained from the study were subjected to both descriptive and inferential analysis. The mean, standard deviation, box plot, mean plot, *eta* squared effect size, one-way ANOVA, two-way ANOVA and Post-Hoc Tukey HSD were calculated using SPSS version 21. It was established that students in PLI-1 who were taught in the school ICT laboratory and PLI-2 who were taught at home during COVID-19 vacation using the padlet tool instructional approach statistically outperformed their counterparts taught with conventional lecture-based instructional approach in terms of their academic performance (mean scores) (p < .05). However, the paired comparison PLI-1 and PLI-2 showed no statistically significant difference between the two instructional groups in terms of their academic performance (Md = 1.84, *p*-value = .442 > .05) (mean scores). One of the reasons for this result, might be because the use of the tool was a novel, and far more productive than the use of the conventional lecture-based instructional approach in the teaching and learning of ecological concepts. It could be deduced that the tool allowed the teachers to engage the students in an interactive virtual session, where they instantly submitted, and shared completed class task and group assignments. The study again, revealed that the interaction effect of the instructional approach and gender was not statistically significant as evidenced in the *p*-value > .05 [F(2, 94) = .113, p = .893).

Keywords: Padlet Instructional Tool, Academic Performance, Ecological Concept

Introduction

The method of teaching and learning biology in today's pre-tertiary education system and in most parts of the world involves mobile and online applications, which enhances communication among learners and teachers. This enables learning to go beyond the walls of the classroom. Incorporating these elements in the class results in increased motivation, more fun and effective learning. There are a number of applications and web tools used by educators all over the world such as the Moodle, Google Classroom, MOOC, Edmodo and many others.

There has been a number of significant and substantial research on how most of these web applications could enhance biology learning through insightful collaboration among teachers and learners. Though most research in education focused on the use of biology software that highlighted biology, this was solely monitored or used by the teacher. Learners never got the opportunity to see what their classmates had also produced in the learning process. This study however employs an on-line tool to enable collaborative tasks to be done both in and out of the classroom by learners and teachers, either through individual or group learning. This study uses an application called Padlet, a free web-based application available online. It can be accessed through a computer or any mobile phone with internet connectivity.

It is worth noting that, even though much research has been conducted on the Padlet, much less study seems to have been conducted with regards to using Padlet in biology teaching and learning in senior high schools. There has even been less research on how teachers diversify their instructions to accommodate learners with different learning styles even when using the Padlet to teach. Reports from other researchers such as Rashid, Yunus and Wahi (2019) have shown that Padlet was used more often in language learning to improve language and communication skills.

According to research done by Haris, Yunus and Bandusah, (2017) padlet was effective in enhancing students' performance in language learning particularly in English grammar. Padlet was used in an experimental study to investigate the effectiveness of using Padlet in improving learners' learning in English grammar with thirty first-year undergraduate learners. This study showed significant improvement in learners' performance when padlet was integrated in grammar learning and language acquisition. This was parallel with other previous studies which showed the effective usage of padlet in learning (Dembo & Bellow, 2013; Fuchs, 2014; Ellis, 2015).

This article is published under the terms of the Creative Commons Attribution License 4.0 Author(s) retain the copyright of this article. Publication rights with Alkhaer Publications. Published at: <u>http://www.ijsciences.com/pub/issue/2022-04/</u> DOI: 10.18483/ijSci.2554; Online ISSN: 2305-3925; Print ISSN: 2410-4477



A research conducted by Algraini (2014) to investigate the effect of using Padlet to enhance female Saudi EFL students writing performance. It was conducted in the first semester of the academic year 2014/2015. The sample was taken from twentyfour (24) students who were randomly selected and were studying in the fifth level. The result of the research showed that padlet was very effective in improving the participants' writing skills.

Gender is a constructed phenomenon that is brought about as society attributes diverse roles, duties, behaviours and mannerism to boys and girls (Manguwal, 2006). It is a social meaning that has wide-ranging psychological background, and used to denote explicit cultural patterns of behaviours that are attributed to human genders. Hence, gender relates to cultural attributes of both males and females (Akpochafo, 2009).

The issue of gender is an essential one in science education specifically with growing emphasis on methods of heightening manpower for technological development as well as increasing the population of females in science and technology fields (Ogunkola & Bilesanmi, 2000). In Ghana, and possibly the whole of Africa, gender bias is still very widespread (Arigbabu & Mji, 2004).

Though it is a common place to see gender stereotype manifested in the day-to-day life of an average Ghanaian, Arigbabu and Mji (2004) pronounced that there are no longer distinguishing differences in the affective and psychomotor cognitive, skill achievements of learners in respect of gender and that girls are being encouraged and sensitized into developing positive attitudes towards the study of biology. Pandian (2004) investigated the effects of cooperative computer-assisted learning method on male and female learners' achievement in biology and reported that male and female learners in the cooperative computer-assisted instruction group showed remarkable post-test mean differences over the respective counterparts who learned the same biology concepts through traditional method. Bilesanmi (2002) found that there was no significant main effect of gender on learners' achievement in biology. However, Croxford (2002) reported that male learners achieved significantly better than female learners in science education

There has never been any published research on using padlet in teaching ecological concepts in schools being it primary, secondary or the tertiary levels in Africa and the interaction effect of the padlet instructional tool and gender on students' academic performance in ecological concepts. It is for this reason that the researchers focused on using padlet in teaching biology in Senior High Schools because of the existing gap in research.

The study was guided by using the null hypotheses at 0.05 level of significance:

- H_{01} : There is no significant difference in the mean performance scores of students taught ecological concepts using padlet tool instructional approach (both in school ICT and at home) and conventional lecture-based instructional approach.
- H_{02} : There is no significant interaction effect of the padlet instructional tool and gender on students' academic performance in ecological concepts.

Methodology

Research Design

This study used quasi experimental research design. Quasi experimental research design is used when there is non-randomization of research subjects (Nworgu, 2006). This design was adopted because it was not possible for the researcher to randomly sample the subjects and assign them to groups. Hence, this design was very suitable for this study. Three intact second year biology classes from three different schools were used and assigned Padlet instructional group 1, Padlet instructional group 2 and control group (Conventional lecture-based instructional group). The groups were randomly assigned to one of the treatments (instructional approaches).

The research design is symbolically presented in Figure 1.

Padlet Instructional Group 1:	T1	X1	T2	
Padlet Instructional Group 2:	T1	X2	T2	
Conventional Lecture-based Group (Control group):	T1	X 3	T2	
Figure 1: Design of the Study				

Key:

----- = no randomization is done

X1= Treatment for padlet instructional group 1 through the use of padlet tool in School ICT Lab

X2= Treatment for Padlet instructional group 2 through the use of padlet tool at Home during COVID-19 vacation (e-learning)

X3= Treatment for control group through the use conventional lecture-based approach group

T1 = pre-treatment test

T2 = post-treatment test

Sample and Sampling Procedures

The accessible population comprised three selected senior high schools' biology students in the Accra Metropolitan of the Greater Accra Region of Ghana representing schools A, B and C. Purposive sampling technique was used to select these schools with one intact biology class from each of the selected schools constituting a total sample size of 102. The sample is viable in accordance with Central Limit Theorem that recommends 30 participants as minimum sample size for experimental study (Usman, 2000).

Table 1: Classification of Participants in Gro	ups		
Instructional Groups	Male	Female	Total
Conventional lecture-based Group	26	13	39
(School A)			
Padlet Instructional Group 1	24	12	36
(School B)			
Padlet Instructional Group 2	17	10	27
(School C)			
Total	67	35	102

Table 1: Classification of Participants in Groups

Data Collection Instrument

Biology Concept Achievement Test (BCAT) was used for data collection in the study. The Biology Concept Achievement Test (BCAT) was made up of thirty (30) multiple choice test items, five (5) true or false items and fifteen (15) fill-in the blanks for a maximum of 50 marks. Kudder-Richardson formula 20 (KR-20) was used to calculate the reliability and internal consistency of the BCAT and this method of estimating the reliability and internal consistency of an instrument is appropriate for dichotomously scored items (items with correct and wrong answers) such as the BCAT which consists of multiple-choice test items, true or false and fill-in the blanks with correct and wrong answers, and it is easier to use. The reliability coefficient of BCAT was calculated to be 0.89. The reliability coefficient of 0.89 means that 89% of variability in scores was due to true score differences among the examinees, while the remaining 11% was due to measurement error. Thus, BCAT was considered to be reliable enough for data collection in the study because it was within the acceptable benchmark of reliable instruments (Leedy & Ormrod, 2005).

Data Collection Procedure

The heads of department, biology teachers and the selected students of the two schools to apply padlet instructional approach were oriented on how to use the Padlet instructional web-based tool. After the orientation on the Padlet use, a pre-test was administered to all the three instructional groups prior to the study (treatments) to examining the homogeneity of the groups' performance in ecological concepts which indicated no statistically significant difference in pre-test scores between the instructional groups. Each of the three study groups were randomly assigned to one of the three instructional approaches (treatments) using sample balloting method. Padlet instructional group 1 were assigned to Padlet tool instructional approach in which they were taught in their school ICT lab, Padlet instructional group 2 were assigned to Padlet tool instructional approach where they were taught from their various home during COVID-19 vacation (E-learning) and control group were assigned to conventional lecture-based instructional approach in which they were taught in their classroom through traditional lecture-based without incorporating the

padlet tool. Padlet instructional group 1 and 2 were taught and learned the ecological concepts through the use of multiple videos, animations and simulations that enabled them to learn using the padlet tool. This made the teachers practice varied assessment for learning strategies. Students were able to submit on the spot their task online. Teachers similarly provided prompt feedback to reinforce learning.

The teaching of the study groups was done by their biology class teacher after taking them through vigorous orientation exercise. This is to ensure that the padlet teaching procedures are followed accordingly as required by the study. Each group attended four periods per week with each period having forty (40) minutes duration and each lesson was a double period which lasted for eighty (80) minutes. The post-BCAT was administered right after the four weeks treatment period. Post-BCAT scores served as data to measure students' academic performance.

Data Analysis

The Data obtained were analysed using quantitative approach based on the research hypothesis formulated for this study. The data collected from the study were analyzed using both descriptive statistics such as mean and standard deviation and the inferential statistics such as one-way analysis of variance (One-way ANOVA), two-way analysis of variance (2-Way ANOVA), Tukey HSD post hoc test, Cohen *d* effect size using Statistical Package for Social Sciences (SPSS) software, version 21. Mean plot and box plot were used to show pictorial illustration of the results.

Results

Examining the Homogeneity of the Instructional Groups' Performance in Ecological Concepts Prior to Intervention

In order to determine whether the sampled students selected from the three schools are equivalent in terms of knowledge in the ecological concepts, their BCAT pre-test scores were analysed using both descriptive and inferential statistics (One-way ANOVA). The outcome of the analysis is shown in Tables 2 and 3, respectively.

Table 2: Descriptive Statistics of Homogeneity of the InstructionalGroups Performance in Ecological Concepts Prior to Intervention

F								
Instructional Groups	Ν	Mean	Std. Dev.	Std. Error				
Conventional Instructional Group	39	16.36	2.42	.388				
(In Classroom)								
Padlet Instructional Group 1	36	16.31	3.98	.663				
(In School ICT Lab)								
Padlet Instructional Group 2	27	17.89	3.89	.748				
(At Home During COVID Vacation)								
Total	102	16.75	3.47	.344				

The data on students' achievement in the ecological concepts prior to the study, which is indicated in Table 2 reveals that students in conventional instructional group had a mean achievement score of 16.36 with standard deviation of 2.42 while that of padlet tool instructional groups 1 and 2 had mean achievement scores of 16.31 and 17.89 with standard deviations of 3.98 and 3.89, respectively.

Moreover, One-way ANOVA was used to determine whether there was any statistically significant difference in the mean achievement scores among the three instructional groups using their pre-BCAT test scores and result is shown in Table 3.

Table 3: One-way ANOVA Analysis of Homogeneity of Instructional Groups Performance in Ecological Concepts Prior to Intervention

	Sum of					
	Squares	df	Mean Square	F	Sig. ((p-value)
Instructional Groups	48.09	2	24.05	2	2.04	.136
Error	1169.28	99	11.81			
Total	1217.37	101				

There was no statistically significant difference in pre-BCAT scores between the instructional groups at p<.05 level (Table 3). That is, prior to the study, the three study groups (Conventional lecture-based instructional group, Padlet tool instructional group 1 and Padlet tool instructional group 2) were almost at the same entry point in terms of their knowledge on ecological concepts and therefore appropriate for the study.

Research Null Hypothesis 1

There is no significant difference in the mean performance scores of students taught ecological concepts using padlet tool instructional approach (both in school ICT and at home) and conventional lecture-based instructional approach.

Table 4 presents the descriptive statistics of the students' posttest scores among the three teaching groups after the interventional period.

Table 4: Descriptive Statistics of Students Performance in the Ecological Concepts after Intervention

Instructional Groups	Ν	Mean	Std. Dev.	Std. Error	Min.	Max.
Conventional Instructional Group (In Classroom)	39	27.51	5.41	.88	16	39
Padlet Instructional Group 1 (In School ICT Lab)	36	34.64	6.38	1.06	24	48
Padlet Instructional Group 2 (At Home During COVID Vacation)	27	36.48	5.67	1.09	27	49
Total	102	32.40	6.99	1.01		

It is observed from Table 4 that padlet instructional group 2 students who were taught the ecological concepts using Padlet tool approach at home during COVID-19 vacation had the highest mean score of 36.48 followed by padlet instructional group 1 students who were taught the concepts using padlet tool approach at school ICT lab with a mean score of 34.64 and conventional instructional group taught the concepts through the conventional lecture-based approach with the lowest mean score of 27.51. To determine whether this mean scores among the three instructional groups are statistically different, the post-test scores were further subjected to two-way analysis of Variance (2-Way ANOVA) at a significant level of .05. The result is shown in Table 5.

Table 5: Two-Way Analysis of Variance (2-Way ANOVA) of the Students Performance Mean Score with Instructional Method and Gender Interaction Effect

Source	Type III Sum	df	Mean	F	Sig.	Eta
	of Square		Square		Sq	luare
Instructional Methods	1501.69	2	750.85	21.452	.000	.309
Gender	3.24	1	3.24	.093	.762	.001
Instructional Method*Gender	7.93	2	3.96	.113	.893	.002
Error	3360.15	96	35.00			
Total	4873.01	101				

a. R Squared = .319 (Adjusted R Squared = .284)

Result of the two-way ANOVA statistics in Table 5 shows that significant difference exists among the three instructional groups of students at the p<.05 significance level in the post-BCAT [F(2,96) = 21.452, p = < .001] with large effect size of .309 calculated using *eta* squared. Since significant difference exists between the three instructional groups, multiple comparison analysis was further carried out using Tukey HSD post hoc test to ascertain where the difference exists among the groups. In light of the number of comparisons that were made, the Tukey post hoc approach was applied because of its power to control for alpha inflation. The result of the multiple comparison test of the groups is presented in Table 6.

Table 6: Tukey HSD Post Hoc Test (Multiple Comparison Analysis) of the Students' Performance Mean Scores (Post-BCAT test Scores)

Instructional Groups	Instructional Groups	Mean Diff. (Md)	SE	Sig. 9	5% Confidenc	e Interval
(E)	(F)	(E - F)			Lower	Upper
					Bound	Bound
Conventional Group	Padlet in School ICT L	ab -7.13*	1.38	.000	-10.38	-3.87
	Padlet at Home during	COVID -8.97*	1.48	.000	-12.49	-5.44
Padlet in School ICT L	ab Conventional Group	7.13*	1.38	.000	3.87	10.38
	Padlet at Home during	COVID -1.84	1.51	.442	-5.43	1.74
Padlet at Home during	COVID Conventional	Group 8.97*	1.48	.000	5.44	12.49
	Padlet in School ICT	Lab 1.84	1.51	.442	-1.74	5.43

Dependent Variable: Post-BCAT test Scores * The mean difference is significant at the .05 level

The Tukey HSD Post Hoc test (multiple comparison analysis) of the students' performance mean scores test (Post-BCAT test scores) in Table 6 indicates that performance mean difference between the conventional instructional group (group that were taught the ecological concepts in conventional classroom through the use of conventional lecturebased approach) ($\overline{x} = 27.51$, SD = 5.41) and padlet instructional group 1 (group that were taught the ecological concepts in the school ICT lab through the use of padlet tool instructional approach) ($\overline{x} = 34.64$, SD = 6.38) was statistically significant (Md = 7.13, p) = < .001) in favour of padlet instructional group 1. Again, there was a statistically significant performance mean difference (Md = 8.97, p = <.001) between conventional lecture-based instructional group ($\overline{x} = 27.51$, SD = 5.41) and padlet instructional group 2 (group that were taught the ecological concepts at home during COVID-19 vacation through the padlet tool approach) ($\overline{x} = 36.48$, SD = 5.67) in favour of padlet instructional group 2. However, the performance mean difference between padlet instructional group 1 and padlet instructional group 2 was not statistically significant (Md = 1.84, *p*-value = .442 > .05).

Pictorially, the mean scores of the three instructional groups is presented in Figure 2.



Figure 2: Box Plot Analysis of Students' Performance in Post-BCAT after Intervention

It can be observed from Figure 2 that students in both padlet instructional groups 1 and 2 equally did well in the ecological concepts as their minimum scores (padlet instructional group 1 in school = 24 and padlet group 2 at home = 27), maximum scores (padlet instructional group 1 in school = 48 and padlet instructional group 2 at home = 49) and median scores (padlet instructional group 2 at home = 36 and padlet instructional group 2 at home = 38) were almost on the level. However, these groups tremendously outperformed their counterparts in the conventional lecture-based instructional group who recorded minimum score of 16, maximum scores of 39 and median score of 27.

Meaning using padlet tool instructional approach in teaching and learning of biology is very effective both in school (as a face to face teaching and learning tool) and at home (as an E-learning tool) in that the padlet tool instructional group 2 who were taught the ecological concepts from home during COVID-19 school break through padlet tool approach equally did better as those in padlet instructional group 1 who were taught the concepts in the school ICT lab using same padlet tool instructional approach. This means that when padlet tool is effectively used in teaching and learning of biology, it could improve students' academic performance more than that of conventional lecture-based approach.

Research Null Hypothesis 2

There is no significant interaction effect of the padlet instructional tool and gender on students' academic performance in ecological concepts

Again, the result in Table 5 reveals that there was no interaction effect of the instructional approach and gender on the students' academic performance in the teaching and learning of ecological concepts. That is, the interaction effect of the instructional approach and gender was not statistically significant as evidenced in the *p*-value > .05 [F(2, 94) = .113, p = .893). This means that the effectiveness of the padlet tool instructional approach in the teaching and learning of ecological concepts does not depend on gender or is not sensitive to gender and therefore gender friendly.

The mean plot illustration shown in Figure 3 gives a visual inspection of the interaction effect among the instructional groups and gender.



Figure 3: Mean Plot Showing Interaction Effect of Teaching Methods and Gender

It could be inferred from Figure 3 that male and female students among all the three instructional groups almost had the same mean scores and that there was no significant estimated marginal mean between the males and females within the instructional groups though male students in the conventional class group had slightly higher estimated marginal mean from their female counterparts though not significant. This proves that the padlet instructional approach is not sensitive to gender as required by a good instructional method and that both male and female learners can equally learn through this approach.

4.2 Discussion of the Results

Results in Tables 5 and 6 show that there is no statistically significant different between students in padlet instructional groups 1 and 2 in terms of their performance mean scores difference in ecological concepts (Md = 1.84, *p*-value = .442 > .05). However, these groups tremendously outperformed their counterparts in the conventional lecture-based instructional group. This finding suggests padlet instructional approach has proven to be more than conventional effective lecture-based instructional group in enhancing students' academic performance in ecological concepts. The reason is not far from the fact that the benefits of using the Padlet is based on the ability of such a tool to adapt to learners' differences by providing various means of presentations (pictures, sounds and videos) and the ability to provide instant feedback to learner, and again give them control over their learning. The finding of this study is in agreement with some past research findings such as Freeman, Eddy, McDonough, Smith, Okoroafor, Jordt and Wenderoth (2014), Weller (2013), Zhang, Trussell, Gallegos, and Asam (2015) and Moratelli and DeJarnette (2014). All reported positive effect of padlet tool

instructional approach on academic performance in teaching and learning of students and suggested that student learning may be improved through the use of Padlet tool.

The study again reveals that there was no interaction effect of the instructional approach and gender on the students' academic performance in the teaching and learning of ecological concepts. That is, the interaction effect of the instructional approach and gender is not significant as evidenced in the *p*-value > .05 [F(2, 94) = .113, p = .893]. This means that the effectiveness of the padlet tool instructional approach in the teaching and learning of ecological concepts does not depend on gender and therefore gender friendly. That is the padlet instructional approach is not sensitive to gender as required by a good instructional method and that both male and female learners can equally learn through this approach. The finding concurs with the findings of Bilesanmi (2002) found that there was no significant main effect of gender on students' achievement in Biology. It however, contracts the study of Usman (2000) and Croxford (2002) who indicated that the effectiveness of an instructional strategy on student's performance significantly depends on the student gender and that male students achieved significantly better than female students in science education.

Conclusions

From the findings of the study, it was revealed that the use of the Padlet tool was a novel and far more productive than the use of the conventional instructional approach in teaching and learning of ecological concepts. The outcome of the use of the Padlet tool in improving learning outcomes among second year science students in selected schools in the Greater Accra Region shows that, Information and Communication Technology tool in education should be given greater attention. The 4th industrial revolution is hinged on digitization and therefore there is the need to promote and integrate diverse ICT tools in the teaching and learning of biology. Effective use of web-based tools will enable both teachers and students to cope with the numerous challenges that arise from the (conventional) orthodox ways of teaching and learning.

Recommendations

On the basis of the findings, the following recommendations have been proposed:

1. Existing Science Education Policies and Senior High School Education Policies should be periodically reviewed to elaborate on the need for all biology teachers to continuously use more Padlet tool and other web-based applications in the teaching and learning of biology in Senior High Schools.

- 2. Biology teachers who teach at the Senior High School level could be equipped with the necessary knowledge and skills to enable them to apply the Padlet tool and other web-based applications in teaching, through Continuous Professional Development.
- 3. The government could provide all Senior High Schools with more computers, projectors and other ICT compliance to enable biology teachers have access to use the Padlet tool and other digital content into their teaching.

Acknowledgements

Appreciation to Science Teachers and Students of Dansoman Senior High School, Wesley Grammar Senior High School and Ebenezer Senior High School all in the Greater Accra Region of Ghana.

References

- Akpochafo, W. P. (2009). Social Studies and Feminist Issues for Teacher Education. Benin City: Justice Jeco Press and Publishing Ltd
- Algraini, F. N. (2014). The Effect of Using Padlet on Enhancing EFL Writing Performance. University name: Al-Imam Muhammad Ibn Saud Islamic University, (Master's Thesis). Retrieved from (Arab World English Journalhttp://awej.org/index.php?option=com_content&view =article&id=878:farah-nasser-algraini &catid=20&Itemid=117
- Arigbabu, A. A., & Mji, A. (2004). Is gender a factor in Mathematics Performance among Nigerian Preservice Teachers? *Sex role*, 51, 749-753.
- Bilesanmi, J. B. (2002). Concept-mapping, Students' Locus of control, and Gender as Determinants of Nigerian High School Students Achievement in Biology, *Ife Psychological*, 10(2), 98-110.
- Croxford, L. (2002). Participation in Science, Engineering and Technology at School and in Higher Education. Report to Scottish Executive. Edinburgh: CES, University of Edinburgh.
- 6. Dembo, S. E., & Bellow, A. S. (2013). Untangling the web: 20 tools to power up your teaching. SAGE, London.
- Ellis, D. (2015). Using Padlet to Increase Engagement in Lectures. Paper presented at the 195-XIII. Retrieved from httpsearch. proquest. comdocview1728004496accountid=1464

- Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences USA*, 111(23), 8410–8415.
- Fuchs, B. (2014). The writing is on the wall: using Padlet for whole-class engagement. *LOEX Quarterly* 40(4), 7-9. Retrieved from http://uknowledge.uky.edu/libraries_facpub/240 Gallup, Inc. (2013). U.S. overall: Gallup Student Poll Results. 1-6.
- Leedy, P. D. & Ormrod, J. E. (2005). Practical Research: Planning and Design. Prentice Hall, Upper Saddle River, NJ. http://www.worldcat.org/title/practical-research-planningand-design/oclc/53831701
- Haris, M., Yunus, M. & Bandusah, J. (2017). The effectiveness of using padlet in esl classroom. *International Journal of Advanced Research (IJAR)*, 5(2), 783-788
- Manguwal, C. (2006). Gender difference in cognition: A function of Maturation role. *Journal of School Psychology*, 7(4), 22-28.
- Moratelli, K., & DeJarnette, N. K. (2014) Clickers to the rescue. *The Reading Teacher*, 67(8), 86–593. doi: 10.1002/trtr.1261
- Nworgu, B. G. (2006). Educational Research. Basic Issues and Methodology. (2nd ed).84-91. University Trust Publishers.
- Ogunkola, J. B., & Bilesanmi, A. (2000). Effects of laboratory and lecture methods on students' achievement in Biology. *African Journal of Education*, 5(2), 247–260.
- Pandian, S. S. (2004). Cooperative learning in Biology: the effects of computers, Yupia, India: Department of Education, Arunachi University India.
- Rashid, A. A., Yunus, M. M., & Wahi, W. (2019). Using Padlet for Collaborative Writing among ESL Learners. *Creative Education*, 10, 610-620. Received: January 8, 2019 https://doi.org/10.4236/ce.2019.103044.
- Usman, I. A. (2000). The relationship between students' performance in practical activities and their academic achievement in integrated science using NISTEP mode of teaching. Unpublished PhD. dissertation, Ahmadu Bello University, Zaria, Nigeria
- Weller, A. (2013) The use of Web 2.0 technology for preservice teacher learning in science education. *Research in Teacher Education*, 3(2), 40–46.
- Zhang, M., Trussell, R., Gallegos, B., & Asam, R. (2015) Using math apps for improving student learning: An exploratory study in an inclusive fourth grade classroom. *Techtrends*, 59(2), pp. 32–39. doi: 10.1007/s11528-015-0837-y.