My Education is in My Pocket: A study on the Use of a Custom Learning Management System (LMS) in Enhancing Students' Achievement in Basic Science in FCE(T) Akoka Secondary School.

Dr. Benjamin O. OKUNDAYE,
benjaminokundaye@gmail.com; Federal College of Education (Technical) Akoka, Lagos
Dr. Adejare A. A. OKEDIJI,
adejare.okediji@gmail.com, Federal College of Education (Technical) Akoka, Lagos
Aremo Bamidele
aremobd@gmail.com, Federal College of Education (Technical) Akoka, Lagos
Osaze Otoighile,
otoosaze@yahoo.com, Federal College of Education (Technical) Akoka, Lagos

Abstract

This paper examined the impact of the use of a custom Learning Management System called "Pocket" on students' achievement in Federal college of education (Technical) Akoka Junior secondary school for Basic Science Education. The LMS is designed to use Videos, HTML Simulations, Interactive Textbooks, Students Activity reporting amongst others in the teaching and learning process even when students are offline. This study mainly focused on the impact of "Pocket" on students' academic achievement in Basic Science in Junior Secondary School. A sample size of 76 out of a population of 513 students studying basic science at the Junior secondary level was chosen for the study using simple random sampling. A pretest-post-tests quasi experimental research design was used for the study. T-test and ANOVA statistical analysis was done using Excel. The findings revealed that the use of the LMS in lesson delivery was found to significantly impact the learning outcome when compared to both traditional teaching and entry behaviour. The LMS is thus found to be superior to traditional teaching approach and is therefore recommended for general adoption by schools. The results of the study showed that the use of LMSs in our educational institution requires more financial commitment in the procurement of ICT facilities and the training and retraining of teachers and students for optimal benefits to be obtained. Further research on long term impact, user interface suitability, ease of deployment, comprehensiveness of its students' activity reporting system and acceptability will have to be made for a more complete assessment of its usefulness to our educational institutions.

Keywords: *Blended learning, flipped classroom, learning management system*

Introduction

Basic science as an integrated science is a subject that deals with the study of living things and non-living things. It's also a branch of science that deals with the fundamental study of the universe where there is observation of nature and natural phenomenon. The construction of deep scientific knowledge results from actively practicing science in a structured learning environment. The shift in emphasising science as a body of knowledge revolutionised the idea of how students learn science. The claim that science is a uniquely objective area of human intellectualism is being critiqued and the proposition of learning science within social and personal context started gaining momentum in the academic world. As a result, science teachers are pressurised to provide a variety of experiences to learners, which are consistent with the nature of science. As well as becoming scientifically literate, students must be equipped with basic skills that will enable them to observe keenly, successfully communicate, reflect objectively and analyse logically.

The old pedagogy was criticized for presenting content in lecture format to be memorized. Our school pedagogic practices, learning tasks and the texts we create for learners tend to focus on receptive feature of children according to National Council of Educational Research and Training (NCERT, 2005). Science teaching becomes all the more challenging in the case of integrating technological tools and techniques into the process of learning. A lot of strategies were used to teach Basic Science yet, there is still low achievement in students' results in Basic Science, hence the need for an E-Learning Strategy. In this context, E- Learning has its relevance in enriching the quality of learning science by tapping the wide potentialities of providing more flexible ways of learning through online mode and the richness of the 'social presence' in the classroom. The impact of E-learning is increasingly dominating the current educational system as the impact of technology continuously dominates our day to day activities worldwide (Ahmad 2015).

The integration of technological awareness and learning in secondary schools is today making significant strides towards use of more interactive e-learning strategies to effectively enhance overall achievement of school students and their trained personnel. In many developed economies, several academic institutions make use of extremely interactive e-learning that directly enhances students' achievement (Reayalkoonandeh, 2016). In the recent era, technologies have indeed become devices accustomed to get rid of physical obstacles and allow students to learn at anytime and anywhere without having physical interaction with the instructor. Against this background, E-Learning therefore improves easy access to effective teaching and learning, and thus enhancing students' academic efficiency.

This research used a custom blended learning software (Allier-Gagneur et al., 2020) to teach Mathematics and Science at the junior secondary school level that will allow learning to take place with or without internet connection. The learning will take place through the use of interactive tutorial videos, simulations of hard-to-understand topics and virtual laboratory practical sessions and quizzes with immediate feedback, amongst others. Teachers will also be able to supervise the academic progress of the students remotely whenever the student has internet connection or directly on any computing device without internet. These learning resources can also be shared between students through Wi-Fi without internet connection. This will eliminate internet data costs and allow academic studies to continue during a pandemic like COVID-19 (Aslam & Sonkar, 2021; Aute, 2020; Otamas et al., 2021; Patil, n.d.; Pontoh et al., 2021; Teferra et al., 2015; Toquero, 2021).

Statement of the problem

Science is made of subjects that serve as bedrock to most scientific, engineering and medical fields of study (Isman et al., 2007). Physics, Chemistry and Mathematics are subjects that instil a lot of fear in the minds of students. The fear of these subjects is generally termed "Science Phobia" (Yaratan & Kasapoğlu, 2012). Science and Technology is what is reigning in the world economy today and as a result students are encouraged to be technology oriented (Okediji, 2015).

In this study, the under listed observations will be relevant to this study.

More than 70% of the schools in Nigeria do not have enough science teachers to adequately teach basic science in our educational system.

The low teacher/student ratio prevents basic science teachers from devoting enough time to each student or pupil in order to ensure full understanding of the topic or subject; hence most parents hire home teachers for their children.

Many basic science teachers reduce the number and frequency of needed assignments or exercises given to students because they cannot cope with the resultant volume of marking.

Research shows that many students find basic science lessons or classes boring or uninteresting hence the need for a custom Learning Management System (LMS).

A custom LMS is our solution to addressing these and other deficiencies in basic science in Nigeria's educational system.

Research questions.

1. Do LMS based learning systems (Pocket) significantly affect students' achievement in basic science?
2. Are the pretest scores of the treatment group significantly different from that of the control group?
3. Does previous learning significantly affect research outcomes of pretest / post-test studies like this one?
4. Is LMS based blended learning superior to traditional classroom teaching?
5. Does gender affect students' achievement in basic science?

Research Hypotheses

The research hypotheses are drawn directly from the research questions

Hypothesis one

H0: LMS based learning systems (Pocket) do not significantly affect students' achievement in basic science.

Hypothesis two

H0: There is no significant difference between the pretest scores of the treatment and control groups.

Hypothesis three

H0: There is no significant impact of previous learning on pretest/post-test research study.

Hypothesis four

H0: There is no significant difference between using "Pocket" to teach and traditional chalkboard only based teaching.

Hypothesis five

Ho: There is no significant difference between the academic achievements of male and female students when using "Pocket" or the traditional chalk board-based approach to teach Basic Science in FCE (T) Junior secondary school.

Objectives of the study

The following problems existing in Basic science and Mathematics at the JSS level will be addressed.

- The problem of disruptions in studies due to strikes, lack of adequately trained teachers (Fatoba et al., 2020), teacher absenteeism and pandemics like COVID-19 (Aslam

& Sonkar, 2021; Aute, 2020; Otamas et al., 2021; Patil, n.d.; Pontoh et al., 2021; Teferra et al., 2015; Toquero, 2021).

- The high data costs from internet connectivity charges in Nigeria (Adomi, 2005; Echezona & Ugwuanyi, 2010; Emeka et al., 2021; Oyelaran-Oyeyinka & Adeya, 2004; Plaza et al., 2018) can be completely eliminated for the students by using our software local WiFi and flash storage capability to share learning resources.
- The problem of dearth of Learning Management Systems (LMS) (Adzharuddin & Ling, 2013; Ahmad et al., 2012; Ajijola et al., 2019; Damola et al., 2016, 2016; Eyyam & Yaratan, 2014; Mustapha et al., 2020; Olanrewaju et al., 2015; Ramadhani et al., 2019; Shaame et al., 2020) in our educational system and their low adoption rate due to lack of experience and cost of adoption will be addressed through provision of software training and our LMS gratis respectively.
- The problem of constant sourcing for adequate and relevant teaching aids and resources for use in the classroom (Jacob & Jegede, 2019) will be resolved with the abundance of teaching resources and aids that will be freely available in the system.
- The problem of inadequate computers in most school labs (Jacob & Jegede, 2019) and at home will be addressed by the availability of our resources on all computing platforms i.e mobile phones, Linux, Apple, Windows, Chromebook, Raspberry Pi and USB drives.

Mathematics and science education in Nigeria have had a number of issues for some time now - from not enough experienced and well-trained teachers (Enyeneokpon & Maureen, 2016) to not having enough laboratory materials and equipment to teach science at all levels of our educational system. The result is the violation of the suggested 60/40 science to arts student admission ratio in our tertiary institutions. There is a large number of arts to science students in our educational system, because of the students' perceived difficulty of learning maths and science subjects.

Computer aided learning (CAL) has been on for a long time, but has had little impact on Nigeria's educational system. CAL addresses the large teacher: student ratio, as each student now has the equivalent of a personal tutor that will not only teach but also provide feedback on level of comprehension by asking questions and indicating right and wrong answers.

Simulation software on the other hand, allows students to see and manipulate equipment

and fragile equipment and experiments can be conducted without fear. The cost of laboratory work is greatly reduced by performing all or initial laboratory work in a virtual computer environment as often as needed for the students to fully understand the concepts or ideas involved before actually using expensive consumable materials in the laboratories.

Drill and practice software on the other hand will allow students to prepare for test, end of term exams, JSS 1-3 exams, and any other exams as often as they wish to, with immediate feedback on their performance without needing to go to their teachers. Some advanced uses of these kinds of software are to explain the systematic solution to the students and allow students to know where they made a mistake or got stuck.

Test question banking will allow teachers to create sets of questions, which they can use for exams, assignments or even homework. This makes it easy for teachers to quickly set questions by picking some from their test question database.

Computer managed instruction (CMI) allows teachers to see at a glance, which students are doing well in a given topic and those that are having difficulties with specific topics. This will allow them to assist the students. This approach to education is called blended learning and has been found to be highly successful in many parts of the world.

This project would solve all the aforementioned problems by using all the aforementioned technologies in a cost effective, elegant and efficient manner.

Research Methodology

The research design is both qualitative and quantitative (Bimodal). The qualitative aspect will comprise a small group of about 20 students' assessment of both the learning management systems (LMS) user interface in terms of ease of use, quality of learning resources and whether it enhanced their academic interests and class participation. The quantitative aspect will consist of pre-test post-test quasi experimental study of the impact of this software on the academic performance of students in FCE(T) Akoka Junior secondary school, Lagos state. The permission of the school authorities was obtained before this research was conducted. The population is JSS students of FCET Akoka secondary school. A sample size of 76 students was selected using simple random sampling, where the students were given serial numbers. The sample size was divided into two after the pretest by separating the odd and even numbered students into two groups. The control group was taught using the traditional chalkboard method while the treatment

group was taught using our learning management system (LMS) called "Pocket".

Research Instruments

Four instruments were used for the study as stated below:

1. Student Basic Science Achievement Test (SBSAT)
   Teachers' Instructional Guides on the:
2. My Education in my Pocket E- Learning Strategy (MEPELS)
3. Modified Conventional Strategy (MCS)
4. Evaluation Sheet to Assess Teachers' Performance during Training (ESATPT)

Student's Basic Science Achievement Test (SBSAT)

The instrument was designed by the researchers. The instrument which consisted of only one section had 30 questions with various degrees of difficulties. The validation of the instrument was done by presenting it to three Science Education experts. Their input led to the reduction of the test items to 20. The final draft was later administered to twenty students (Eleven males and nine females) as a trial test. Test with a reliability test of 0.78 using Cohen's D test was obtained.

Teacher Instructional Guide on My Education in my Pocket: E-Learning Strategy

The main features of the guide were: general information which consists of subject, topic, sub-topics, class, duration, general objectives, instructional materials, reference book, introduction, presentation, evaluation and assignment.

My Education is in my Pocket: E-Learning Strategy has the following steps:

Step I: Teacher presented the topic in form of observation through simulation/demonstration and

Step II: Students answered questions on the topic in the form of quizzes.

Step III: Students answered the questions individually without assistance from their mates.

Step IV: Students received reward from the teacher.

Step V: Students copied assignment on the topics.

Validation of Teacher Instructional Guide on My Education in my Pocket: E-Learning Strategy

This is an instructional guide for teachers participating in the experimental group one (My Education in my Pocket: E-Learning Strategy)

This instrument was validated using Scott Pi's inter-rater reliability index and the value 0.83 was obtained which shows substantial agreement between the raters making the instrument reliable for use.

Modified Conventional Strategy Instructional Guide

This contains the roles of the teacher and the students in Modified conventional learning situation. Here students would sit individually and not in group throughout the lesson.

Validation of Teacher Instructional Guide on Modified Conventional Strategy

This instrument was validated using Scott Pi's inter-rater reliability index and the value 0.76 was obtained which shows substantial agreement between the raters, making the instrument reliable for use.

Evaluation Sheet for Assessing Teachers' Performance on the use of the Learning Strategies (ESATPLS).

These instruments were used for the selection of participating research assistants on each strategy before the commencement of the treatment. This gives the guidelines for evaluating performance of the trained teachers on the effective use of these strategies.

(1) Custom LMS: E-Learning Strategy
(2) Modified Conventional Strategy

This was a rating scale that was made up of two sections

Section A – This consisted of the personal data of the trained teacher containing name, school, period, date and the summary of the concept discussed in the class.

Section B - This consist of items that were placed on a 5-point rating scale ranging from Very Good (VG), Good (G) Average (AV) Poor (P) and Very Poor (VP).

The scoring of ESAT was as stated below:

Very Good (VG) - 5marks, Good (G), - 4 marks, Average (AV) - 3 marks, Poor (P) – 2 marks and Very Poor (VP). – 1 mark

Validation of ESATPLS

The instruments were given to the experts in the field of Science Education. Their comments, criticism and contributions and suggestions were used to modify the items. The reliability coefficient of ESATPLS in

(a) Custom LMS: E-Learning Strategy 0.81
(b) Modified Conventional Strategy was 0.78

Method of data collection

The data collection lasted twelve weeks. The phases were:

- Visitation to the school for familiarization with the students and permission from the school for one month
- Training of teachers (research assistant) for one month
- A total number of nine months was used for this study.

Training of Teachers for My Education in my Pocket: E-Learning Strategy and Modified Conventional Teaching Method

The researchers trained the research assistants (Teachers) one months. The training of the teachers was focused on the use of My Education in my Pocket: E-Learning Strategy and Modified Conventional Strategy.

Results

Hypothesis one

H0: LMS based learning systems (Pocket) do not significantly affect students' achievement in basic science.

T Test: Two Independent Samples (Experimental)

SUMMARY	Hyp Mean Diff	0.000000	
Groups	Count	Mean	Variance	Cohen d
Pre-test	38.00	12.24	7.48
Post-test	38.00	14.50	4.96
Pooled		6.22	0.906177

T-TEST : Equal Variances Alpha 0.05

	std err	t-test	Df	p-value	t-crit	lower	upper	sig	effect r
Two Tail	0.57	3.96	74.00	0.000171	1.99	-3.39	-1.13	yes	0.42

T TEST Unequal Variances Alpha 0.05

	std err	t-stat	Df	p-value	t-crit	lower	upper	sig	effect r
Two Tail	0.57	3.96	71.08	0.000176	1.99	-3.39	-1.13	yes	0.43

The fact that the test is significant means we accept that our custom software has a significant impact on students' achievement.

Hypothesis two

H0: There is no significant difference between the pretest scores of the treatment and control groups.

SUMMARY	Hyp Mean Diff		0.00
Group	Count	Mean	Variance	Cohen d
Group 1		38.00	12.76	6.94
Group 2		38.00	12.24	7.48
Pooled			7.21	0.19

T TEST Equal Variances Alpha 0.05

	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
Two Tail	0.62	0.84	0.84	0.40	1.99	-0.71	1.75	no	0.10

T TEST Unequal Variances Alpha 0.05

	std err	t-stat	Df	p-value	t-crit	lower	upper	sig	effect r
Two Tail	0.62	0.84	73.90	0.40	1.99	1.99	-0.71	1.75	no	0.10

The result means we accept the null hypothesis that " There is no significant difference between the pretest scores of the treatment and control groups "

Hypothesis three

H0: There is no significant impact of previous learning on pretest/post-test research study.

The first assumption of ANCOVA is that there should be no significant difference in the pretest values of the treatment and control group (hypothesis two). This is again tested in

SPSS and the group row has a sig. value of 0.396 which satisfies the first assumption of ANCOVA and confirm our hypothesis one findings.

The Group*Pretest row has a sig. value of 0.031 which rejects the homogeneity condition of ANCOVA. This means that previous knowledge which is evaluated in pretest scores has significant interaction with the post-test scores. We therefore reject h0 and accept h1

Using ANCOVA (Zaiontz, 2023) also confirms our findings for hypotheses three mentioned above and four which comes next.

R Square Test

F-stat	4.8528680717
df1	1.0000000000
df2	72.0000000000
p-value	0.0308013873

The p-value of 0.03 also confirms the strong interaction between pretest and post-test.

Regression Analysis

OVERALL FIT

Multiple R	0.64	AIC	111.9784188407
R Square	0.41	AICc	112.8355616978
Adjusted R Square	0.39	SBC	121.3013522018
Standard Error	2.04		
Observations	76.00		

ANOVA — Alpha 0.05000000

	df	SS	MS	F	p-value	sig
Regression	3.00	205.51	68.50	16.5060240964	0.00000003	yes
Residual	72.00	298.53	4.15p			
Total	75.00	504.04				

	coeff	std err	t stat	p-value	lower	upper	vif	
Intercept	13.69	0.33	41.48	0.0000000000	13.03215702	14.35		
Experimental	0.92	0.47	1.96	0.0538664436	-0.01692788	1.86	1.01	
Pre-test	0.78	0.13	6.00	0.0000000724	0.52084974	1.04	2.10	
experimental-test	-0.39	0.18	-2.17	0.0333071999	-0.74882344	-0.03	2.09	

The regression row p-value of 0.00000003 which is less than 0.05 means we reject the fourth null hypothesis and accept the h1 hypothesis which states that “There is significant difference between using 'Pocket' to teach and traditional chalkboard only based teaching”

Hypothesis four

H0: There is no significant difference between using "Pocket" to teach and traditional chalkboard only based teaching.

T Test: Two Independent Samples

SUMMARY		Hyp Mean Diff		0.00
Group	Count	Mean	Variance	Cohen d
Group 1		38.00	1.13	4.55
Group 2		38.00	2.26	6.52
Pooled			5.54	0.480091

T TEST Equal Variances Alpha 0.05

	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
Two Tail	0.54	2.09	74.00	0.040054	1.99	-2.20	-0.06	yes	0.24

T TEST Unequal Variances Alpha 0.05

	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
Two Tail	0.54	2.09	74.00	0.040164	1.99	-2.20	-0.06	yes	0.24

The test of significance using t-test agrees with the result we obtained using ANCOVA light when discussing hypothesis four which means that we reject the null hypothesis and accept the alternative one that states that using "Pocket" is superior to conventional teaching.

Hypothesis five – Gender Analysis

Ho: There is no significant difference between the academic achievements of male and female students when using "Pocket" or the traditional chalk board-based approach to teach Basic Science in FCE(T) Junior secondary school.

Pretest Hypothesis test

T Test Two Independent Samples (Pretest)

SUMMARY		Hyp Mean Diff		0.00
Groups	Count	Mean	Variance	Cohen d
F		32.00	12.22	5.79
M		32.00	12.97	8.48
Pooled			7.14	0.28

T TEST: Equal Variances Alpha 0.05

	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
Two Tail	0.67	1.12	62.00	0.27	2.00	-2.08	0.58	no	0.14

T TEST: Unequal Variances Alpha 0.05

	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
Two Tail	0.67	1.12	59.87	0.27	2.00	-2.09	0.59	no	0.14

There is no significant difference between male and female students in the pretest.

Post-test Hypothesis test

T Test: Two Independent Samples (Post-test)

SUMMARY Hyp Mean Diff 0.00

Groups	Count	Mean	Variance	Cohen d
F	32.00	14.69	4.93	
M	44.00	13.84	7.86	
Pooled		6.63	0.33	

T-TEST : Equal Variances Alpha 0.05

	std err	t-test	Df	p-value	t-crit	lower	upper	sig	effect r
Two Tail	0.60	1.41	74.00	0.16	1.99	-0.35	-2.04	no	0.16

T-TEST : Unequal Variances Alpha 0.05

	std err	t-test	Df	p-value	t-crit	lower	upper	sig	effect r
Two Tail	0.58	1.47	73.41	0.15	1.99	-0.30	2.00	no	0.17

There was also no significant difference between male and female students in the post-test.

Improvement or gain is the difference between their pretest score and their post-test score. It represents the amount of learning that took place in the course of the study.

Gain hypothesis test
T Test: Two Independent Samples

SUMMARY		Hyp Mean Diff	0.00
Groups	Count	Mean	Variance	Cohen d
F	32.00	2.47	6.39
M	44.00	1.14	4.73
Pooled		5.42	0.57

T-TEST : Equal Variances Alpha 0.05

	std err	t-test	Df	p-value	t-crit	lower	upper	sig	effect r
Two Tail	0.54	2.46	74.00	0.02	1.99	0.25	2.41	yes	0.28

T-TEST : Unequal Variances Alpha 0.05

	std err	t-test	Df	p-value	t-crit	lower	upper	sig	effect r
Two Tail	0.55	2.40	60.67	0.02	2/00	0.22 .	2.44	yes	0.29

Surprisingly there was a significant difference in the learning gained between girls and boys in the short term. The mean of the girls' scores is significantly higher than that of the boys in this study. This may be because the females were generally more attentive and concentrated.

Using ANCOVA for test of significance of the difference between the experimental and control group with gender as covariate also validated hypothesis four which asserted that pocket is superior to conventional teaching. The results are shown below.

Homogeneity of Slopes Test

R-sq Full	0.13
R-sq Red	0.13
df1	1.00
df2	72.00
F	0.01
p-value	0.91

ANCOVA: Single Factor (gain)
ANCOVA

	SS	df	MS	F	p-valuep	eta-sq
Covariate	30.03	1.00	30.03	5.77	0.02	0.07
Between	21.47	1.00	21.47	4.13	0.05	0.05
Within	379.68	73.00	5.20			
Total	434.04	75.00				

TUKEY HSD/KRAMER: ANOVA Alpha 0.05

Group	adj mean	count	cov mean	cov ssbet	cov sswmsw	df	q-crit
Experimental	2.23	38.00	1.55				
Conventional	1.17	38.00	1.61				
				76.00 1.58	0.05 18.47	5.20 73.00	2.82

Q TEST

group 1	group 2	mean	std err	q-stat	lower	upper	p-value	mean-crit
Experimental	Conventional	1.06	0.37	2.87	0.02	2.11	0.05	1.04

Setting up a class for LMS use is usually more physically and mentally engaging than for traditional teaching. The lack of adequate power or insufficient computing facilities can impart negatively on projected educational outcomes.

The topic work, energy and power was used for the research topic because it was a constant source of questions at the JSS level and it was one that the students found most difficult to understand. It also requires some time to fully understand. The LMs provided a lot of simulations and videos which they did not have enough time for. The reduced exposure of the students to the LMS in terms of the time spent would also have impacted significantly on the outcome as the students spent out of the time allotted to the study on familiarising themselves with the software. A longer time use of the LMS might need to be done in order to have a more realistic assessment of the impact of our system on achievement scores. This also negatively impacted on the students' academic performance in our study.

The topic chosen was not entirely new to the students. This would explain the marginal difference in the scores of both the control and treatment groups in both their pretest and post-test scores in some instances. Another study may involve the use of topics not previously taught in the school's scheme of work to see if the result would be more significant.

Conclusion

The use of our LMS can greatly impact the enthusiasm of students towards learning and can positively impact their achievement scores. The use of our LMS was significant despite short treatment time, small sample size and good previous knowledge of subject matter on the part of the students. The flipped classroom model implies that students were supposed to have been exposed to the learning materials at home or before class. However, this could not be done because the students could not be provided with the computing devices for home use.

Exhaustion or boredom as a result of studying and writing multiple tests on the same topic could be responsible for some of the negative scores noted in both the control and treatment groups when comparing the post-test scores with the pretest ones. Also, extraneous factors beyond the control of the researchers like the desire of the students to quickly finish with the study and return to their revision classes as it was literally the last day of revision before their exams could also have impacted on the study outcomes.

Recommendations

A modified flipped classroom model should be adopted in the use of LMSs in general and our LMS in particular in order to make education more accessible to our students.

Computing devices (smart phones, tablets and laptops) should be made available to students both at home and in the school in order to further enhance teaching and learning in our educational system.

The use of a learning management system like our 'Pocket', with both online and offline capabilities will allow students to study with or without internet capabilities, anytime and anywhere..

Additional facility for peer to peer transfer of educational content means that students can share learning materials wirelessly in a local area network (LAN) or via USB drive without needing to spend money on internet bandwidth or data.

Our software is also recommended for home use by parents and home tutors for easy monitoring of their wards or pupils due to the rich reporting capability of our LMS which was another one of the features not explored in this research.

References

Adomi, E. E. (2005). Internet development and connectivity in Nigeria. Program: Electronic Library & Information Systems, 39(3), 257–268. https://doi.org/10.1108/00330330510610591

Adzharuddin, N. A., & Ling, L. H. (2013). Learning management system (LMS) among university students: Does it work. International Journal of E-Education, e-Business, e-Management and e-Learning, 3(3), 248–252.

Ahmad, S. A., Chinade, U. B., Gambaki, A. M., Ibrahim, S., & Ala, N. A. (2012). The need for moodle as a learning management system in Nigerian universities: Digesting university Utara Malaysia learning zone as a case study. Academic Research International, 2(3), 444.

Ajijola, E. M., Ogunlade, O. O. S., Abdulsalam, A., Buraimoh, O. F. A., & Gboyega, A. (2019). Perceived Usefulness and Perceived Ease of Use of Learning Management System Among Distance Learners'in South-West, Nigeria. Conference Proceedings of the AITIE 3rd International Conference and Workshop on Innovation, Technology and Education (ICWITE, Abuja 2019), 223.

Allier-Gagneur, Z., Chuang, R., McBurnie, C., & Haßler, B. (2020). Using Blended Learning to Support Marginalised Adolescent Girls' Education: A Review of the Evidence. EdTech Hub.

Aslam, S., & Sonkar, S. K. (2021). Platforms and Tools used for Online Learning all over the World during Covid-19: A Study. Library Philosophy and Practice, 0_1-18.

Aute, K. B. (2020). Tools for Digitalized/Online Teaching in the Wake of Pandemic Covid-19 Lockdown: An Overview. Mukt Shabd Journal, IX(IV), 2678–2683.

Damola, O., Adebimbo, A., & Alaba, S. O. (2016). Enhancing Students' Performance in Basic Science and Technology in Nigeria Using Moodle LMS. International Journal of Educational and Pedagogical Sciences, 10(5), 1657–1660.

Echezona, R., & Ugwuanyi, C. (2010). African university libraries and internet connectivity: Challenges and the way forward. Library Philosophy and Practice, 3(9), 1–13.

Emeka, A., Foluke, A., Jacob, O., & Olatunde-Aiyedun, T. (2021). Problems facing science teachers in public secondary schools in Nigeria and way forward. International Journal of Discoveries and Innovations in Applied Sciences, 1, 118–129.

Enyeneokpon, U. E., & Maureen, O. C. (2016). Teacher Quality Indicators as Correlates of Public Secondary School Physics Students' Achievement in Onitsha and Awka Educational Zones of Anambra State, Nigeria. Journal of Scientific Research and Reports, 1–9. https://doi.org/10.9734/JSRR/2016/28993

Eyyam, R., & Yaratan, H. S. (2014). Impact of use of technology in mathematics lessons on student achievement and attitudes. Social Behavior and Personality: An International Journal, 42(1), 31S-42S. https://doi.org/10.2224/sbp.2014.42.0.S31

Fatoba, J. O., Akinnodi, O. D., Adeleye, A. M., & Olofin, S. O. (2020, June 30). Teachers' Teaching Experience and Secondary School Students' Performance in Science Subjects in Ondo State, Nigeria. International Journal of Academic Research in Business, Arts & Science | IJARBAS. https://www.ijarbas.com/2020/06/30/teachers-teaching-experience-and-secondary-school-students-performance-in-science-subjects-in-ondo-state-nigeria/

Isman, A., Yaratan, H., & Caner, H. (2007). How Technology Is Integrated into Science Education in a Developing Country: North Cyprus Case. Turkish Online Journal of Educational Technology-TOJET, 6(3), 54–60.

Jacob, O. N., & Jegede, D. (2019). Challenges Facing Implementation of Science Program in FCT Secondary Schools, Abuja, Nigeria. 1, 13.

Mustapha, A. M., Yahaya, M. N. B., & Zakaria, M. A. Z. B. M. (2020). Performance of Learning Management System Moodle design in a Nigerian Higher Education. EasyChair Preprint, 3267.

Okediji, A. A. (2015). Effects of Case-Based and Observational Learning Strategy on Students' Attitude to and Achievement in Chemistry in Secondary Schools in Lagos State, Nigeria. [Unpublished Thesis]. University of Ibadan.

Olanrewaju, O. S., Kareem, I. A., & Adeshina, O. K. (2015). Development of Colour-Exploration in Learning Management System to Teach Students of Secondary Education in Creative Arts, Southwest. Journal of Educational Media and Technology (NAEMT) 19 (1) 120, 127.

Otamas, I. H., Anishchenko, V. O., Ovsiankina, L. A., Afanasieva, I. A., & Bieliatynskyi, A. (2021). COVID-19 Pandemic: Development of Digital Technologies that Provide Connection, Collaboration and Lifelong Learning. Studies of Applied Economics, 39(9). https://doi.org/10.25115/eea.v39i9.5770

Oyelaran-Oyeyinka, B., & Adeya, C. N. (2004). Internet access in Africa: Empirical evidence from Kenya and Nigeria. Telematics and Informatics, 21(1), 67–81. https://doi.org/10.1016/S0736-5853(03)00023-6

Patil, M. V. S. (n.d.). Distance Learning and Learning Management Systems Can Drive Online Teaching-Learning in Covid-19 Lockdown Duration. War Against COVID-19: An Alarm to Mankind (A Multidisciplinary Approach), 129.

Plaza, P., Sancristobal, E., Carro, G., Blazquez, M., Menacho, A., Castro, M., Perez, C., & García-Loro, F. (2018). Local MOOC Solution for Thight Budgets or Limited

Internet Access. 2018 Learning With MOOCS (LWMOOCS), 13–16.

Pontoh, G. T., Mediaty, M., Darmawati, D., Sadeli, Y., & Fadli, S. (2021). Does the Use of E-learning Media for Economic Disciplines Effective during the COVID 19 Pandemic? Accounting and Finance, 1, 115–121.

Ramadhani, R., Rofiqul, U., Abdurrahman, A., & Syazali, M. (2019). The effect of flipped-problem based learning model integrated with LMS-google classroom for senior high school students. Journal for the Education of Gifted Young Scientists, 7(2), 137–158. https://doi.org/10.17478/jegys.548350

Shaame, A. A., Anatory, J. R., Osaki, K. M., & Mrutu, S. I. (2020). Exploring a Learning Management System as a Way to Improve Students' Understanding of Geometry in Secondary Schools. Africa Education Review, 17(4), 17–40. https://doi.org/10.1080/18146627.2020.1868070

Teferra, D. M., Muchie, K. F., & Kidanu, G. P. (2015). Management Practice of School Closure During COVID-19 Outbreak for Ethiopia.

Toquero, C. M. (2021). Emergency remote education experiment amid COVID-19 pandemic. IJERI: International Journal of Educational Research and Innovation, 15, 162–176. https://doi.org/10.46661/ijeri.5113

Zaiontz, C. (2023, August 23). ANCOVA Light Basic Concepts | Real Statistics Using Excel. https://real-statistics.com/analysis-of-covariance-ancova/ancova-slopes-assumption-not-met/ancova-light-basic-concepts/