

Original Research Article

Use of technology in undergraduate pharmacy education in selected universities in southern Nigeria

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Abstract

Purpose: To explore the technologies used in pharmacy education for teaching by lecturers and learning by students in selected universities in Southern Nigeria.

Methods: The study involved pharmacy lecturers and undergraduate students from four universities (two federal, one state, one private), selected through purposive and convenience sampling, respectively, using separate questionnaires for lecturers and students. Descriptive analysis, such as frequencies, percentages, and averages, was employed to organize and summarize the data. In contrast, inferential data analysis, including independent samples t-tests, ANOVA and Mann-Whitney U tests, was used to answer questions about differences between relevant variables at 5 % level of significance.

Results: Lecturers primarily used computers (83.3 %, avg = 3.7), multimedia projectors (72.7 %, avg = 3.2), Email (74.2 %, avg = 3.2), and WhatsApp (83.3 %, avg = 3.6) for teaching. Students mostly used WhatsApp (96.5 %, avg = 4.5), Wikipedia (86.6 %, avg = 3.9), and YouTube (91.9%, avg = 4.0) for learning. However, the overall adoption of educational technologies, especially Learning Management Systems, was low (avg = 2.6).

Conclusion: Technology adoption for teaching and learning in pharmacy education remains low. There is a need for faculty management and educational authorities to establish clear policies to promote effective integration of technology, thereby improving pharmacy education.

Keywords: Technology, Educational technology, Pharmacy education, Teaching, Learning

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INTRODUCTION

Advances in technology have changed the way teaching, learning, and communication are implemented. Information and communication technology (ICT) has permeated all forms of human endeavour, changing the way tasks are

accomplished. In education, ICT proficiency is now regarded as a vital skill and foundation for teaching and learning [1]. Several software applications, such as learning management systems (e.g., Moodle®, Blackboard Learn®, ATutor®) and e-learning platforms (e.g., Google Classroom®), along with interactive learning tools, have been developed for educational

purposes [2]. Adoption of technology, which has been defined as the sustained acceptance and use of technology, is a behavioural process involving the stages of pre-contemplation, contemplation, preparation, action, and maintenance [3]. At the maintenance stage, a user is considered to have fully adopted the technology [3].

Implementation of novel online educational technologies in pharmacy curricula has been recognised in developed countries such as, USA, Canada, Australia and European countries [4]. Tools such as podcasts, webinars, and internet-based LMS platforms like Moodle have improved interactive learning in pharmacy and medical education [5-7]. In Nigeria, the utilisation of Learning Management Systems (LMS) in pharmacy education has been advancing. At the University of Benin (UNIBEN), a federal university in southern Nigeria, the open-source LMS Docebo was introduced to pharmacy students enrolled in the Doctor of Pharmacy (PharmD) programme [8]. The objective of the study was to identify the technologies employed for teaching and learning by pharmacy faculty and undergraduate students at the selected universities in Southern Nigeria and evaluate the extent of educational technology adoption in undergraduate pharmacy education in the selected universities.

METHODS

Study design

The study was a cross-sectional survey of lecturers and students of pharmacy in selected universities in Southern Nigeria. The study was carried out in the University of Benin, Benin, Edo State, Igbinedion University, Okada, Edo State, Obafemi Awolowo University, Ile-Ife, Osun State and Olabisi Onabanjo University, Sagamu, Ogun State, which were purposefully selected to reflect the three major categories of university ownership in Southern Nigeria: private, federal and state.

Sources of data

Primary data were collected from the lecturers and students of the Faculties of Pharmacy in the four sampled schools, using a set of questionnaires for each group.

Population of the study

The population comprised 161 pharmacy lecturers and 1530 undergraduate pharmacy

students at the selected universities in Southern Nigeria.

Inclusion criteria

All lecturers and undergraduates in the professional classes (200 to 600 levels) in Pharmacy schools were included in the study.

Exclusion criteria

Students in 200 to 600 levels who were on academic leave, had deferred their studies, or were not present during the data collection period were excluded. Additionally, those who declined consent or submitted incomplete questionnaires were also excluded from the study. These exclusions were necessary to ensure that only actively enrolled and available students who provided valid responses were included in the final analysis.

Sampling method

A purposive sampling method was employed for the study to obtain a sample representative of the types of universities in Southern Nigeria. The schools were selected on the basis of the three types of ownership of universities in Nigeria, namely Federal (represented by Obafemi Awolowo University (OAU) and University of Benin (UNIBEN)), State (represented by Olabisi Onabanjo University (OOU)) and Private (represented by Igbinedion University). Furthermore, all other Pharmacy schools had four levels in the professional classes (that is, 200 to 500 levels), except the University of Benin, which had five levels (200 to 600 levels). This is because pharmacy education is in a state of transition in Nigeria, changing from the traditional curriculum to the more clinically oriented Doctor of Pharmacy (Pharm.D.) programme, and the University of Benin had already commenced the new programme with five levels of professional classes instead of four in the other schools.

The sample sizes for the lecturer and student populations were calculated to be 143 and 317, respectively (based on population sizes as at year 2020) using Taro Yamane's formula for finite population [9] with an error margin fixed at 0.05. The lecturers were purposively selected from the four university types to ensure a balanced representation across the different types of institutional ownership. Of the 66 respondents, 22 (33.3 %) were from OAU, 21 (31.8 %) from UNIBEN, 13 (19.7 %) from OOU, and 10 (15.2 %) from Igbinedion University. This

distribution aligns with the relative sizes and staffing structures of the institutions.

Questionnaire design

Two sets of questionnaires were employed for data collection, with one for each of the faculty members and students. They were designed in line with the specific objectives of the study, and their internal and content validity were achieved by adapting and collating items from various relevant literature [10-13] and through expert review by senior faculty members at OAU. Each of the questionnaires comprised three sections. The demographic section (Section A) was face-validated through expert review to ensure that all relevant demographic information was captured. The instruments were pre-tested for reliability using the test-retest method by administering the questionnaire twice to thirty pre-test samples, which consisted of population members who were not part of the study samples, with a two-week interval. Identified errors were also corrected before the administration of the questionnaire to the study samples. Cronbach's alpha values of 0.90 and 0.81 were obtained for the lecturers' and students' questionnaires, respectively.

Methods of data collection

Google Forms and paper questionnaires were administered to students and lecturers of OAU, UNIBEN, OOU and Igbinedion University. Google Forms were sent to participants through WhatsApp and Email. Hard print (paper version) copies of the questionnaires were later administered to participants who had not filled out the Google Forms. Students were first briefed on the purpose and voluntary nature of the study, after which only those who gave informed consent were given the questionnaires during class. A quota-convenience sampling approach was employed for the students, and completed questionnaires were retrieved immediately. Each of the lecturers who consented was also given a lecturer's questionnaire, which was retrieved on the same day.

Data analysis and presentation

Data collected through Google Forms was automatically entered into spreadsheets by the software. This was then exported to Statistical Package for Social Sciences version 21 (SPSS). Data collected through a paper questionnaire were entered by hand into SPSS. All collated data were coded, screened for errors, cleaned and analysed using SPSS. Descriptive statistics such as frequencies, percentages, medians,

weighted averages, and mean of weighted averages were used to summarise, organise and present the demographic and other data collected. The median was employed as the measure of central tendency since the participant responses were obtained on ordinal scales and presented as Median $\pm$ interquartile range (Mdn $\pm$ IR). Weighted averages were also presented as weighted average $\pm$ standard deviation (WA $\pm$ SD). The weighted averages act as a useful tool in comparing medians that are tied. Inferential statistics, including independent samples t-test, analysis of variance and Mann-Whitney U tests, were employed in answering questions between relevant variables at 5 % level of significance.

Ethical approval

Ethical clearance for this study was obtained from the Health Research Ethics Committee of the Institute of Public Health, Obafemi Awolowo University, Ile-Ife, Nigeria, with approval number IPHOAU/12/1471.

RESULTS

A total of 29 lecturers and 255 students responded to the online Google form. This response rate was below expectations; thus, a paper questionnaire was introduced. This was administered by hand to available students and lecturers who had not previously filled out the online questionnaire and agreed to participate. Selection was done informally and at random, by approaching individuals present during class sessions or departmental activities without following a predefined list, ensuring voluntary participation and avoiding duplication. Fifty lecturer questionnaires and 560 student questionnaires were distributed. Out of those sampled using paper questionnaires, 37 lecturers and 524 students returned them. A total of 779 students and 66 lecturers responded to the students' and faculty questionnaires, respectively. The demographic data collected show that out of the 66 lecturer-respondents, about a third each were from OAU (33.3 %) and UNIBEN (31.8 %). There were more male (41, 62.1 %) than female (25, 37.9 %) respondents. About three-quarters have at least an MSc (50, 75.8 %). For the student-respondents, about a third (300, 38.5 %) were students of OAU, about a quarter (207, 26.6 %) were students of OOU, and the rest were from UNIBEN and Igbinedion University (132, 16.9% and 140, 18.0 % respectively). Majority of student-respondents were between the ages of 16 to 25 years (712, 91.4 %), and there were more female than male respondents (421, 54.0 % to 358, 46.0 %).

Technologies employed for teaching

Table 1 presents the audio-visual technologies employed for teaching by lecturer-respondents and shows that computer for lecture delivery (CLD) (Median 4; WA 3.7 ± 1.2) and multimedia projector for lecture delivery (MPLD) (Median 3; 3.7 ± 1.2) were the most commonly employed audio-visual technologies employed for teaching by lecturer-respondents. Other technologies, such as audio recording of lectures (ARL) (Median 1; WA 1.9 ± 1.1), television for teaching (TFT) (Median 1; WA 1.3 ± 0.9), were hardly employed. In addition, a few lecturers reported using Epocrates, Manikin, Medscape, UpToDate and Zoom for teaching purposes.

Internet-based technologies employed by the pharmacy lecturers

Table 2 presents data on internet-based technologies used by pharmacy lecturers for teaching. WhatsApp (Mdn 4, WA 3.62 ± 1.0) and

Email (Mdn 3, WA 3.24 ± 2.0) for communicating with students were the most used.

Lecturer-respondents also reported using various technologies for general purposes beyond teaching (Table 3). They include WhatsApp (Median 5; WA 4.6 ± 0.9), Google Scholar (Median 4; WA 3.9 ± 0.9) and YouTube (Median 4; WA 3.8 ± 1.0), which were the most commonly employed. Twitter (Median 1; WA 1.9 ± 1.2), Telegram (Median 2; WA 2.5 ± 1.3), and LinkedIn (Median 3; WA 2.7 ± 1.1) were the least employed in that order.

Technologies employed for learning

The technologies most frequently employed by students for learning are presented in Table 4, and they include WhatsApp (Median 5, WA 4.5), YouTube (Median 4, WA 4.0) and Wikipedia (Median 4, WA 3.9). The least employed were BlackBerry Messenger (Median 1, WA 1.2), LinkedIn (Median 1, WA 2.0) and Skype (Median 2, WA 2.3).

Table 1: Audio-visual technologies employed for teaching by lecturer-respondents

Variable (n = 66)	Never f (%)	Rarely f (%)	Occasionally f (%)	Often f (%)	Routinely f (%)	Mdn±IR	WA
CLD	6(9.09)	5(7.58)	13(19.70)	22(33.33)	20(30.30)	4.0±2.0	3.68
MPLD	12(18.18)	6(9.09)	19(28.79)	12(18.18)	17(25.76)	3.0±3.0	3.24
IWLD	28(42.42)	12(18.18)	8(12.12)	8(12.12)	10(15.15)	2.0±3.0	2.39
VLD	27(40.91)	16(24.24)	20(30.30)	1(1.52)	2(3.03)	2.0±2.0	2.02
ARL	35(53.03)	12(18.18)	14(21.21)	4(6.06)	1(1.52)	1.0±2.0	1.85
TFT	49(74.24)	15(22.73)	1(1.52)	1(1.52)	-	1.0±1.0	1.30
MWA							2.41

Note: Mdn = Median; WA =Weighted Average; SD = Standard Deviation; IR = interquartile range; CLD: Computer for lecture Delivery; MPLD: Multimedia projector (e.g., PowerPoint) for lecture delivery; IWLD: Interactive whiteboard for lecture delivery; ARL: Audio recording of lectures; VLD: Video for lecture Delivery; TFT: Television for Teaching

Table 2: Internet-based technologies employed for teaching by lecturer-respondents

Variable (n = 66)	Never f (%)	Rarely f (%)	Occasionally f (%)	Often f (%)	Routinely f (%)	Mdn±IR	WA
WCS	5(7.58)	6(9.09)	13(19.70)	27(40.91)	15(22.72)	4.0±1.0	3.62
ECS	7(10.61)	10(15.15)	22(33.33)	14(21.21)	13(19.70)	3.0±2.0	3.24
GWI	12(18.18)	7(10.61)	32(48.48)	14(21.21)	1(1.52)	3.0±1.0	2.77
OSA	22(33.33)	12(18.18)	21(31.82)	8(12.12)	3(4.55)	2.0±2.0	2.36
OTS	38(57.58)	9(13.64)	13(19.70)	4(6.06)	2(3.03)	1.0±2.0	1.83
DC	33(50.00)	16(24.24)	13(19.70)	4(6.06)	-	2.0±2.0	1.82
LMS	39(62.90)	8(12.90)	8(12.90)	3(4.84)	4(6.45)	1.0±1.0	1.76
VWT	45(68.18)	10(15.15)	5(7.58)	5(7.58)	1(1.52)	1.0±1.0	1.59
VPT	49(74.24)	10(15.15)	2(3.03)	4(6.06)	1(1.52)	1.0±1.0	1.45
MWA							3.25

Note: Mdn = Median; WA =Weighted Average; SD = Standard Deviation; IR = interquartile range; OTS: Online testing of students; OSA: Online submission of assignments; GWI: Giving students web links to get more information; LMS: Learning Management Systems (LMS) e.g. Docebo®, Edmodo®, Moodle®, schoology®, etc. DC: Document collaboration, e.g., Google Docs for group work/assignment collaboration, e.g., Google Docs for group work/assignment; ECS: Email for communicating with students; WCS: WhatsApp for communicating with students; VSRP: Videotape for situational role play in teaching VWT: Virtual Worlds for teaching; VPT: Virtual patient technology for teaching

Table 3: Frequency of use of internet-based technologies by the pharmacy lecturers for general purposes

Variable (n = 66)	Never f (%)	Rarely f (%)	Occasionally f (%)	Often f (%)	Routinely f (%)	Mdn±IR	WA
WhatsApp	2(3.03)	1(1.51)	2(3.03)	14(21.21)	47(71.21)	5.0±1.0	4.56
Google Scholar	-	4(6.06)	16(24.24)	26(39.39)	20(30.30)	4.0±2.0	3.94
YouTube	3(4.55)	3(4.55)	15(22.73)	28(42.42)	17(25.76)	4.0±1.0	3.80
Wikipedia	1(1.51)	6(9.09)	35(37.88)	21(31.82)	13(19.70)	4.0±1.0	3.59
Google Docs	5(7.58)	11(16.67)	12(18.18)	25(37.88)	13(19.70)	4.0±1.0	3.45
Facebook	12(18.18)	12(18.18)	19(28.79)	18(27.27)	5(7.58)	3.0±2.0	2.88
LinkedIn	10(15.15)	17(25.76)	27(40.91)	8(12.12)	4(6.06)	3.0±1.0	2.68
Telegram	22(33.33)	12(18.18)	14(21.21)	14(21.21)	4(6.06)	2.0±3.0	2.48
Twitter	36(54.55)	12(18.18)	10(15.15)	5(7.58)	3(4.55)	1.0±2.0	1.89
MWA							3.25

Note: Mdn = Median; WA =Weighted Average; MWA = Mean of Weighted Averages; SD = Standard Deviation; IR = interquartile range

Table 4: Internet-based technologies employed by student-respondents for learning

Variable (n = 66)	Never f (%)	Rarely f (%)	Occasionally f (%)	Often f (%)	Routinely f (%)	Mdn±IR	WA
WhatsApp	17(2.18)	10(1.28)	55(7.06)	208(26.70)	489(62.77)	5.0±1.0	4.47
YouTube	19(2.44)	44(5.65)	139(17.84)	280(35.94)	297(38.13)	4.0±2.0	4.02
Wikipedia	48(6.16)	56(7.19)	119(15.28)	243(31.19)	313(40.18)	4.0±2.0	3.92
Email	60(7.70)	135(17.33)	242(31.07)	239(30.68)	103(13.22)	3.0±2.0	3.24
Google Scholar	140(17.97)	112(14.38)	142(18.23)	191(24.52)	194(24.90)	3.0±3.0	3.24
Instagram	162(20.80)	138(17.72)	149(19.13)	202(25.93)	128(16.43)	3.0±2.0	2.99
Twitter	228(29.27)	136(17.46)	134(17.20)	149(19.13)	132(16.94)	3.0±3.0	2.77
Facebook	168(21.57)	201(25.80)	160(20.54)	171(21.95)	79(10.14)	3.0±2.0	2.73
Telegram	259(33.25)	175(22.46)	158(20.28)	133(17.07)	54(6.93)	2.0±2.0	2.42
Skype/Voice call	278(35.69)	172(22.07)	158(20.28)	125(16.05)	46(5.91)	2.0±2.0	2.34
Blogs	268(34.40)	191(24.52)	213(27.34)	79(10.14)	28(3.59)	2.0±2.0	2.24
LinkedIn	400(51.35)	163(20.92)	110(14.12)	68(8.73)	38(4.88)	1.0±2.0	1.95
BlackBerry							
Messenger	679(87.16)	70(8.99)	19(2.44)	7(0.90)	4(0.51)	1.0±0.0	1.19
MWA							2.89

KMdn = Median; WA =Weighted Average; SD = Standard Deviation; IR = interquartile range

Level of adoption of technologies for teaching and learning

Table 5 presents the data on the adoption of technologies for teaching with summary value of MWA 2.6. Audio-visual technologies such as computers and multimedia projectors have been adopted in teaching by lecturers (Median 5, WA 4.0 and Median 5, WA 3.7 respectively). Internet-based technologies such as Email (Median 5, WA 3.9) and WhatsApp (Median 5, WA 4.1) have also been adopted for teaching. However, other technologies such as virtual worlds (Median 1, WA 1.9) and virtual patient technology (Median 1, WA 1.7) for teaching were not yet adopted in teaching. The data on adoption of technologies for learning, as presented in Table 6, with summary value of MWA 2.8, shows that majority of students have not yet adopted most educational technologies. However, the use of internet to obtain more information on topics taught (Median 5, WA 4.0) and online group discussions with other classmates (Median 4,

WA 3.6) has been adopted for use by a majority of students.

Adoption stages

Stage 1 – Pre-contemplation (x = 1); Stage 2 – Contemplation (x = 2); Stage 3 – Preparation (x = 3); Stage 4 – Action (x = 4); Stage 5 – Maintenance (x = 5).

DISCUSSION

This study has aimed to investigate the technologies used in pharmacy education in Southern Nigeria. Of the various types of technologies deployable, presentation technologies, that is, computers and multimedia projectors, which combine text with graphics and sometimes, audio and video, have been proven to enhance knowledge transfer and improve learning [14]. WhatsApp, which is reported as the most used technology by students, has been demonstrated to be a useful educational tool in previous studies [15].

Table 5: Level of adoption of educational technologies employed for teaching as reported by lecturer-respondents

Variable (n=66)	Stage 1 f (%)	Stage 2 f (%)	Stage 3 f (%)	Stage 4 f (%)	Stage 5 f (%)	Mdn±IR	WA
Audio-visual technologies							
CLD	8(12.12)	7(10.61)	2(3.03)	10(15.15)	39(59.09)	5.0±2.0	3.98
MPLD	7(10.61)	13(19.70)	5(7.58)	8(12.12)	33(50.00)	5.0±3.0	3.71
IWLD	28(42.42)	13(19.70)	6(9.09)	3(4.55)	16(24.24)	2.0±3.0	2.48
OTS	31(46.97)	13(19.70)	4(6.06)	8(12.12)	10(15.15)	2.0±3.0	2.29
VLD	25(37.88)	21(31.82)	6(9.09)	6(9.09)	8(12.12)	2.0±2.0	2.26
ARL	36(54.55)	16(24.24)	4(6.06)	8(12.12)	2(3.03)	1.0±1.0	1.85
TFT	49(74.24)	12(18.18)	2(3.03)	-	3(4.55)	1.0±1.0	1.42
Internet-based technologies							
WCS	7(10.61)	3(4.55)	8(12.12)	7(10.61)	41(62.12)	5.0±2.0	4.09
ECS	7(10.61)	7(10.61)	8(12.12)	8(12.12)	36(54.55)	5.0±2.0	3.89
GWI	8(12.12)	17(25.76)	8(12.12)	6(9.09)	27(40.91)	4.0±3.0	3.41
OSA	20(30.30)	12(18.18)	8(12.12)	9(13.64)	17(25.76)	3.0±4.0	2.86
LMS	31(46.97)	14(21.21)	5(7.58)	7(10.61)	9(13.64)	2.0±2.0	2.23
DC	29(43.94)	18(27.27)	9(13.64)	4(6.06)	6(9.09)	2.0±2.0	2.09
VSRP	33(50.00)	17(25.76)	9(13.64)	4(6.06)	3(4.55)	2.0±1.0	1.89
VWT	37(56.06)	14(21.21)	7(10.61)	3(4.55)	5(7.58)	1.0±1.0	1.86
VPT	41(62.12)	12(18.18)	6(9.09)	3(4.55)	4(6.06)	1.0±1.0	1.74
MWA							2.63

Table 6: Level of adoption of educational technologies employed for learning as reported by student-respondents

Variable (n=779)	Stage 1 f (%)	Stage 2 f (%)	Stage 3 f (%)	Stage 4 f (%)	Stage 5 f (%)	Mdn±IR	WA
Audio-visual technology							
ARL	386(49.55)	93(11.94)	75(9.63)	134(17.20)	91(11.68)	2.0±3.0	2.30
Internet-based technologies							
INT	60(7.70)	85(10.91)	70(8.99)	119(15.28)	445(57.12)	5.0±2.0	4.03
OGD	101(12.97)	117(15.02)	97(12.45)	143(18.36)	321(41.21)	4.0±3.0	3.64
RPL	196(25.16)	98(12.58)	101(12.97)	136(17.46)	248(31.84)	3.0±4.0	3.18
DC	254(32.61)	125(16.05)	99(12.71)	136(17.46)	165(21.18)	3.0±3.0	2.79
WCL	297(38.13)	106(13.61)	105(13.48)	128(16.43)	143(18.36)	2.0±3.0	2.63
OSA	320(41.08)	91(11.68)	83(10.65)	125(16.05)	160(20.54)	2.0±3.0	2.63
LMS	338(43.39)	105(13.48)	89(11.42)	123(15.79)	124(15.92)	2.0±3.0	2.47
ECL	367(47.11)	97(12.45)	93(11.94)	135(17.33)	87(11.17)	2.0±3.0	2.37
OT	432(55.46)	88(11.30)	74(9.50)	91(11.68)	94(12.07)	1.0±2.0	2.14
MWA							2.82

Note: Mdn = Median; WA =Weighted Average; MWA = Mean of Weighted Averages; SD = Standard Deviation; IR = interquartile range; CLD: Computer for lecture Delivery; MPLD: Multimedia projector (e.g., PowerPoint) for lecture delivery; IWLD: Interactive whiteboard for lecture delivery; ARL: Audio recording of lectures; VLD: Video for lecture Delivery; OTS: Online testing of Students; GWI: Giving students web links to get more information; LMS: Learning/Course Management Systems (LMS/CMS) e.g. Docebo®, Edmodo®, Moodle®, schoology®, etc.; DC: Document collaboration e.g. Google Docs for group assignments; ECS: Email for communicating with students; WCS: WhatsApp for communicating with students; VSRP: Videotape for situational roleplay in teaching; VWT: Virtual worlds for teaching; VPT: Virtual patient Technology for teaching; TFT: Television for Teaching; ARL: Audio recording of Lectures; OSA: Online submission of assignments; INT: Internet to get more information on topics taught; LMS: Learning/Course Management Systems e.g. Docebo®, Edmodo®, Moodle®, schoology®, etc.; DC: Document collaboration e.g. Google Docs for group work or assignments; ECL: Email for communicating with lecturers; WCL: WhatsApp for communicating with lecturers; OSA: Online submission of assignments; OT: Other technologies for communicating with lecturers (Zoom, Microsoft Teams); OGD: Online group discussions with other classmates; RPL: Role play in learning with other classmates.

Being an instant messaging application that allows sending of not only text, but also documents, audio and video files, it has enormous potential for being an important educational tool for virtual teaching and learning. The fact that it works on mobile phones also means that learning takes place on the go.

YouTube, which students also reported using as a learning technology, is a video-sharing platform. Videos are potential enhancers of teaching, and YouTube provides free access to a wide array of educational videos, which students also use for learning [16]. Thus, this study shows that pharmacy students are taking advantage of

this. Students also reported using Wikipedia as a learning tool. Wikipedia is a type of encyclopaedia; however, students should be instructed to use it with caution, as it often does not provide authoritative information, because its content is editable by anyone, thus making it unreliable [17]. Google Scholar was reported as less used by students, even though its use has been reported in previous studies [18]. Its low patronage may be because undergraduate students do not have knowledge of its usefulness as a source of information.

Computer and multimedia projectors, which are presentations as well as demonstration technologies, have been adopted for use by the majority of the lecturers. Their use of these technologies for more than 6 months shows that they are in the maintenance stage (stage 5) of adoption. This means that they are most likely to continue using these technologies for teaching. Technologies such as Email and WhatsApp have also been adopted for use at the maintenance stage, having been used for more than 6 months. These technologies could be used for presentation and demonstration (when used to send lecture notes and/or other educational materials). They are also useful as interaction and collaboration technologies, as they are internet-based and provide an opportunity for communication and feedback [15].

Technologies such as virtual worlds, virtual patient technology, and online testing of students are still being contemplated by the majority as they plan to use them in the future (planned for 6 months). This means they have considered them for use but have yet to make the decision to make use of these technologies. The reason may be that it requires substantial investment in infrastructure, both hardware and software, and organizational readiness for its implementation. Students are more in tune with technology than their lecturers and seem to use it more. The technologies that have been effectively adopted by students for learning (up to the maintenance stage) are technologies that are initiated independently by students and include the use of the internet to get more information and online group discussions with other classmates. Other technologies need to be introduced by the lecturers before they are adopted by students. Furthermore, students may be ignorant of the possibility of employing some technologies for learning, for example, audio recording of lectures, which the students initiate independently. As audio recordings provide an opportunity for playback, they provide students the opportunity to hear a lecture more than once

and should be promoted as a possible technology for enhancing the learning process.

Limitations of this study

With respect to the lecturers' sample, the 66 participants ultimately surveyed have increased the actual margin of error to approximately 9.3 %, exceeding the acceptable threshold for statistical generalization. The purposive sampling approach provided valuable context-specific insights, although the low sample size and reliance on self-reported data introduce a potential for non-response bias and reduce the statistical power of the study, restricting the generalizability of the findings. Thus, future studies using longitudinal or mixed methods may provide deeper insights.

Although the lecturers' response was relatively low compared to the total lecturer population, no formal assessment was conducted to determine the reasons for the low response. This may be attributed to factors such as lecturers' limited availability, competing academic responsibilities, or reluctance to engage in survey-based studies.

CONCLUSION

Technologies employed for teaching by Pharmacy faculties and for learning by undergraduate pharmacy students are mainly audio-visual and internet-based technologies. Adoption of technology for teaching and learning was low on average. However, lecturers have adopted technologies such as computers, multimedia projectors, Email and WhatsApp for teaching, while students have adopted technologies such as WhatsApp, Wikipedia, YouTube and Google for learning, assessing information, online group discussion with other classmates, and role play with other classmates as self-initiated ways of learning. Other useful technologies are yet to be effectively adopted, and thus, there is still room for improvement in the adoption of technologies to enhance teaching and learning in order to make pharmacy education better.

DECLARATIONS

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Ethical approval

Ethical approval for the project was obtained from the Institute of Public Health, Obafemi Awolowo University, with the Health Research Ethics Committee Certificate (HREC) no. IPHOAU/12/1471.

Use of artificial intelligence/large language models

We also declare that we did not use Generative artificial intelligence (AI) and/or AI-assisted technologies in the writing of this manuscript.

Availability of data and materials

The data collected and used for this study are available from the corresponding author on reasonable request.

Conflict of interest

No conflicts of interest are associated with this study.

Contribution of authors

We declare that this work was done by the authors named in this article, and all liabilities pertaining to claims relating to the content of this article will be borne by the authors. Enitan Oluwatomisin Irenitemi and Omoniyi Joseph Ola-Olorun conceptualized and designed the study. Enitan Oluwatomisin Irenitemi, Uchenna Helen Eze and Timothy Olugbenga Fajemirokun collected the data. Enitan Oluwatomisin Irenitemi and Omoniyi Joseph Ola-Olorun carried out the data analysis. Enitan Oluwatomisin Irenitemi did the initial drafting of the manuscript. Omoniyi Joseph Ola-Olorun, Ayodapo O. Jegede and Stella Folajole Usifoh carried out the critical analysis, and all co-authors approved the final draft.

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