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Technology – Enhanced Pathology Education: Nigerian Medical Students Perspectives

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Abstract
Background: The delivery of pathology education traditionally through instructor centred didactic lectures, small group tutorials, and practical demonstrations using microscope glass slides, gross pot specimens and autopsy sessions, is paving way for electronic learner-centred methods. Successful adoption and implementation of rapidly advancing educational technologies in the resource-constrained environment obtainable in most of sub-Sahara Africa requires a comprehensive analysis of the learners' reflections on their use and effectiveness.**Aims:** This study aimed to evaluate the perspectives of medical students towards the ever-advancing ways of teaching and learning pathology in Nigeria.**Materials and methods:** Fifty-five fourth year medical students randomly selected from two universities were given survey questionnaire. The questionnaires enquired into opinions of the students on the various aspects of the use of ICT in pathology education.**Results:** Studying with microscope mounted glass slides was considered by the majority (33, 60%) of the 55 respondents to be the most effective method of learning pathology and 24 (43.6%) favoured the projection of the glass slide on a large screen using a camera-mounted microscope. Twenty-seven (49.1%) preferred projected computer based digital microscope images. Twenty students (36.4%) disagreed with the use of internet-based images during practical classes. Prior distribution of digital images to students' hand – held devices days before classes was agreed to by 19 (34.5%) and strongly agreed to by 15 (27.3%) students. Annotated digital images, instead of glass slides, were favoured by 50, (91%) students. Self-study with webinars was not supported by 26, (47.2%) students. Eleven (20%) students strongly agree, 25 (45.5%) agree, eight (14.5) are undecided, and 10 (18.2%) disagree that the use of digital microscope images reduces microscope handling proficiency. The use of digital images instead of mounted glass slides during objective structured practical examination was supported by 20, (36.4%) students. Forty-seven (85.5%) reported interrupted classes due to faulty equipment.**Conclusion:** The challenge of developing ways for better delivery of pathology curriculum content to future doctors compels medical educators to explore easier ways of teaching and learning. This study has demonstrated that medical students in Nigeria favour technology enhanced learning and the integration of new teaching methods into already existing frameworks.
Keywords: technology-enhanced learning, pathology, pathology education, student perspectives

1. Introduction

The rapidly advancing computer technology applications in biomedical research engendered the expansive sea of medical information available today. Technology is also changing the face of medical education as teachers, administrators and regulatory agencies have to keep pace with the needs of updating or developing new curriculum content and novel approaches for equipping medical students with critical competencies and dispositions for future practice in a society increasingly becoming dependent on advanced technology (Brass 2009, Badyal & Singh 2015). Technology-based learning, or e-learning, encompasses the use of multimedia, computer or internet based resources, digital tablets, phones or other applications of digital technologies to produce materials for learning, teaching and learning regulation (Fry 2001, Arkorful & Abaidoo 2015). Various computers, including laptops, portable hand held devices and internet based resources, some with intricately designed software have increasingly found an almost indispensible application in both healthcare and medical education (Luanrattana *et al.* 2007). The potential pedagogical application of information and computer technologies in pathology education includes supporting work performance, enhancing traditional teaching, facilitating learning and creating an innovative learning environment. Pathology, like radiology, is a specialty in medicine where sound knowledge of the basic sciences and clinical skills are combined for accurate image interpretation during patient management. Hence, technological advancements in medical imaging continuously change pathology practice and education (Weinstein *et al*. 2009, Hamilton *et al*. 2009). The traditional delivery of pathology education through instructor centred didactic lectures, small group tutorials, and practical demonstrations using microscope glass slides, gross pot specimens and autopsy sessions, is paving way for electronic learner-centred methods. Central to this transformation is the development of technological

pedagogical content knowledge base by medical educators, for effective implementation of an expanding curriculum content and measurement in the face of increasing number of medical students, myriads of learning resources, financial or administrative constraints and other barriers. Successful adoption and implementation of rapidly advancing educational technologies in the resource-constrained environment obtainable in most of sub-Sahara Africa requires a comprehensive analysis of the learners' reflections on their use and effectiveness. This work aimed to evaluate the perspectives of medical students towards new technology enhanced ways of teaching and learning currently employed for pathology education in Nigeria.

2. Materials and methods

Fifty-five fourth year medical students randomly selected from two universities; the government owned Benue State University, Makurdi and the private Bingham University, Jos, Nigeria voluntarily participated in this study. Selection criteria were based on the students having recently completed their postings in pathology and thus adjudged to be more inclined to give objective and vivid opinions. The students filled questionnaires, the contents of which consisted of enquiries into their perspective on selected parameters and experiences associated with the application of technology assisted teaching, learning and evaluation in pathology education. We graded the opinions of the respondents on a scale similar to the Likert scale. Statistical computations were performed using the Microsoft Excel 2007 edition.

3. Results

The results of this study show that out of the 55 respondents, 36 (65.5%) students found pathology to be interesting and 26 (47.3%) strongly agreed that the course has improved their diagnostic reasoning, but only seven (12.7%) are willing to take up the practice of pathology as a career (Table 1). Majority (14.5% - 58.2%) were of the opinion that normal lecture delivery, practical classes, small group tutorials, autopsies, and clinico-pathology meetings are the most effective methods of teaching pathology. Nineteen (34.5%) strongly favoured practical demonstrations (Table 2). The respondents opined that their teachers were approachable and had good communication skills (Table 3). Thirty-two (58.2%) students agreed to power point presentation of lectures, twenty-seven (49.1%) favoured oral lectures with board and marker, while 19 (34.5%) disagreed with dictation of lecture notes with provision of explanations (Table 4).

Studying with a glass slides mounted on a microscope was considered by the majority (33, 60%) to be the most effective method of learning pathology and twenty-four (43.6%) favoured the projection of the glass slide on a large screen using a camera-mounted microscope. Twenty-seven (49.1%) preferred projected computer based digital microscope images. Twenty students (36.4%) disagreed with the use of internet-based images during practical classes. The distribution of digital images to students' hand – held devices days before classes was agreed to by 19 (34.5%) and strongly agreed to by 15 (27.3%) students. Almost all (50, 91%) the students preferred the use of annotated digital images compared to glass slides. In contrast, self-study using downloaded webinars was not supported by most (26, 47.2%) of the students (Table 5).

In addition, on the perceptions about the use of digitized images for studying pathology of a disease, 23(41.8%) students agree and 15 (27.3%) strongly agree that microscope digital images are easier to understand when placed side by side with gross specimen and clinical appearance images. Nine students (16.4%) were undecided, seven (12.7%) disagree and only one (1.8%) student strongly disagrees with this.

Are there differences between the appearances of images viewed directly under the microscope and the digitized images? Nineteen (34.5%) students agree, 13 (23.6%) strongly agree, 18 (32.7%) were undecided; four (7.3%) disagreed while only one (1.8%) strongly disagreed.

Proficiency in the handling of the microscope is a fundamental aspect of the pathology course. Eleven (20%) students strongly agree, 25 (45.5%) agree, eight (14.5) undecided, and 10 (18.2%) disagree that the use of digital microscope images reduces the proficiency of medical students in the handling of the microscope (Table 6).

The use of digital images in multiple choice questions to test the interpretative skills and diagnostic reasoning was strongly agreed to by five (9.1%), agreed by 15(27.3%), disagreed by 11(20%) and 13 (23.6%) students strongly disagreed. Majority (20, 36.4%) agreed to the use of digital images instead of glass slides mounted on a microscope during the practical component of the objective structured practical examination (OSPE). The same proportion of students supported the use of digital images in the oral component of OSPE (Table 6).

Forty-seven (85.5%) of the students reported that classes were sometimes interrupted due to technical problems with equipment. Each student has at least an electronic device useful for studying pathology microscope images with the majority (39, 70.9%) owning a lap top computer; 23(41.8%) students owned an electronic tablet and the same proportion have mobile phones adequate for viewing digitised images. Four (7.3%) of the student never had internet connectivity on their devices, 21(38.2%) always had connectivity while 29(52.7%) sometimes had connectivity. Thirteen (23.6%) could access the internet through the institution provided internet services through their devices and personally paid subscriptions while the majority was only by personal subscription only. Forty-nine (90.7%) out of 54 respondents did not participate in any web based peer study group and only five (9.3%)

had joined such a group. Forty-one (78.8%) of 52 respondents opined that digital images have helped their understanding of gross pathology while 11(21.2%) said it made no difference. Ten (18.9%) of 53 students preferred learning with only gross specimens in pots but more of them, 43(81.1%) disagreed. The cost of access to the internet was rated by the students to be the most important factor adversely affecting the use of online – based resources for learning pathology.

Table 1: Perceptions About Pathology Course (n=55)

	Strongly Disagree	Disagree	Undecided/ Neutral	Agree	Strongly Agree
Interesting	1(1.8%)	4(7.3%)	5(9.1%)	36(65.5%)	9(16.4%)
Improves clinical diagnostic reasoning	0	1(1.8%)	2(3.6%)	26(47.3%)	26(47.3%)
Willingness to pursue career in pathology	8(14.5%)	19(34.5%)	21(38.2%)	7(12.7%)	0

Table 2: Most effective method of teaching pathology (n=55)

	Strongly Disagree	Disagree	Undecided/ Neutral	Agree	Strongly Agree
Normal lecture	1(1.8%)	4(7.3%)	7(12.7%)	32(58.2%)	10(18.2%)
Practical classes	0	3(5.5%)	1(1.8%)	32(58.2%)	19(34.5%)
Small group tutorials	1(1.8%)	5(9.1%)	8(14.5%)	25(45.5%)	16(29.1%)
Autopsy demonstrations	0	4(7.3%)	11(20%)	32(58.2%)	8(14.5%)
Clinico-pathologic conferences	0	3(5.5%)	13(23.6%)	24(43.6%)	15(27.3%)

Table 3: Students' opinion about lecturers (n=55)

	Strongly Disagree	Disagree	Undecided/ Neutral	Agree	Strongly Agree
Approachable	4(7.3%)	7(12.7%)	6(10.9%)	29(52.7%)	9(16.4%)
Have good communication skills	3(5.5%)	4(7.3%)	9(16.4%)	32(58.2%)	6(10.9%)
Make lectures interesting	6(10.9%)	8(14.5%)	14(25.5%)	20(36.4%)	6(10.9%)

Table 4: Medium of teaching (n=55)

Which medium do you think is better	Strongly Disagree	Disagree	Undecided/ Neutral	Agree	Strongly Agree
White board and marker	6(10.9%)	9(16.4%)	10(18.2%)	27(49.1%)	3(5.5%)
Power point presentation	1(1.8%)	0	2(3.6%)	32(58.2%)	20(36.4%)
Dictation of notes with explanation	14(25.5%)	19(34.5%)	3(5.5%)	11(20%)	7(12.7%)

Table 5: Perceptions about pathology images (n=55)

Select your choice of the most effective method of learning with microscope images	Strongly Disagree	Disagree	Undecided/ Neutral	Agree	Strongly Agree
Glass slides mounted on the microscope	0	2(3.6%)	5(9.1%)	33(60%)	15(27.3%)
Power point projected microscope images	0	2(3.6%)	10(18.2%)	27(49.1%)	16(29.1%)
Microscope image from glass slide mounted on a microscope with camera projected on large screen	0	0	0	24(43.6%)	31(56.4%)
Directly looking at internet based microscope images projected on large screen	8(14.5%)	20(36.4%)	14(25.5%)	8(14.5%)	4(7.3%)
Distributing the digital images of cases to students' mobile devices days before classes.	0	8(14.5%)	12(21.8%)	19(34.5%)	15(27.3%)
Use of digital images illustrated with arrows pointing to morphological features.	0	1(1.8%)	3(5.5%)	25(45.5%)	25(45.5%)
Microscope digital images are easier to understand when placed side by side with gross specimen and clinical appearance images.	1(1.8%)	7(12.7%)	9(16.4%)	23(41.8%)	15(27.3%)
Differences exist between digital images and what is seen directly under the microscope	1(1.8%)	4(7.3%)	18(32.7%)	19(34.5%)	13(23.6%)
Use downloadable online histopathology webinars for self study.	8(14.5%)	18(32.7%)	9(16.4%)	12(21.8%)	7(12.7%)

Table 6: Evaluation of student performance (n=55)					
	Strongly Disagree	Disagree	Undecided/ Neutral	Agree	Strongly Agree
Digital images may be used in MCQ	13(23.6%)	11(20%)	9(16.4%)	15(27.3%)	5(9.1%)
Prefer digital images to glass slides during practical component of summative examination	2(3.6%)	14(25.5%)	8(14.5%)	20(36.4%)	9(16.4%)
Digital images may be used in oral component of summative examination.	6(10.9%)	11(20%)	12(21.8%)	20(36.4%)	4(7.3%)
Use of digital images significantly reduces students' proficiency in handling the microscope	1(1.8%)	10(18.2%)	8(14.5%)	25(45.5%)	11(20%)
The use of digital images have facilitated achieving the overall objectives of the pathology course	2(3.6%)	8(14.5%)	16(29.1%)	21(38.2%)	8(14.5%)

4. Discussions

Pathology is the study of the causes, development, morphology and clinical manifestations of diseases (Mitchell 2015). The ability to understand the scientific foundations of disease, diagnosis and application to patient management distinguishes the training of physicians from other health care workers (Burton 2005). The majority of the students found pathology to be an interesting course and they are satisfied that the teachers are approachable and have good communication skills, but only a few students (7, 12.7%) are willing to take up a lifelong career in pathology. This is understandable because it equally reflects the fact that only a small minority of all doctors in practice actually examine pathological samples in their everyday work. Despite this, almost all the students are of the opinion that the pathology course has played a pivotal role in helping them to appreciate diagnostic reasoning. Expert reasoning is expected to be rapid, intuitive, and tacit (Eva 2005, Norman 2010). The fundamental knowledge of the aetiology, risk factors, pathogenesis, gross morphology and microscopic appearances of disease entities (and with emphasis on rapid image pattern recognition), are cardinal to training on clinical diagnostic reasoning (Mitchell 2015, Pelaccia *et al* 2011). This is consistent with the encapsulation theory of medical education which posits that the knowledge of the basic medical and clinical sciences becomes invariably embedded in and blends seamlessly into practical clinical experience of cases as training progresses (Schmidt & Rikers 2007, Rikers *et al* 2005). A good pathology knowledge base is therefore, one of the essential scaffolds required for developing diagnostic expertise.

The majority (43.6% -58%) of the students still supported the traditional methods of teaching enhanced by the use of power – point presentations instead of dictation of class notes. This suggests that adoption of new technologies in our environment is not so fast-paced, and thus, new technologies should blend seamlessly into old practices to minimise resistance (Overdijk *et al* 2012).

The landscape is indeed shifting in many medical schools, from the direct use of microscope glass slides and static computer-based images to virtual slides. In this survey, most of the students (31, 56.4%) strongly favoured the idea of a glass slide mounted on a microscope fitted with a digital camera and the image subsequently projected on a large screen for all to view simultaneously. Eight (14.5%) respondents strongly disagreed with teaching by directly projecting web-based images. Reasons for this include technical difficulties such as absent or slow network connections. Self-directed learning is characteristic of adult students, and has been described in the literature as the most pervasive and long lasting way of learning (Merriam *et al.* 2012). However, many students did not agree with the downloading of online resources for self-study of histopathology. In particular, online webinars lacked the primal element of a direct meaningful engagement with the microscope as obtains when the student is seated in a physical classroom, motivated by social stimulation from colleagues and the instructor (Arkorful & Abaidoo 2015). Besides, the increasing use of digital images may potentially reduce microscope handling proficiency by medical students. However, almost all the students chose learning with annotated digital images, which is consistent with the observation that visual cues effectively guide learners to rapidly identify morphological abnormalities, and develop a conceptual framework for accurate diagnosis (Crowley *et al.* 2001, Heiberg 2008).

A comprehensive adoption and implementation of information and communication technology (ICT) for education in Nigeria has been fraught with several barriers (Iloanusi *et al.* 2009). Technical faults, loss of power supply, poor or absent internet connection and lack of skilled work force are some of the impediments. In addition, internet access by students is mostly by personal, instead of institutional subscription. The cost of these devices and internet connection contribute to create an economic "technical divide" among the students. Participants in this research identified challenges such as administrative problems, poor learner motivation, and lack of technical skills, technical problems, lack of time, and lack of social interaction as the bottlenecks to full use of internet based

learning resources. In addition, the use of technology to generate microscope images to some extent expands the curriculum content because students may also be required to learn about the distortions induced by digital microscope image processing (Dikshit *et al.* 2005).

Although the study is limited by the relatively modest sample size, the authors believe that the opinions and experiences of the respondents faithfully represent those of the ever-enlarging population of medical students spread across Nigeria. Histopathology is the sub-specialty focus of this study and a sweeping generalisation may be impertinent because haematology, medical microbiology and chemical pathology sub-specialties, do not rely heavily on image interpretation.

Leadership and vision are essential ingredients of planning and managing change. Fry (2001) posited that universities, to be globally competitive, must embrace and strategically employ technological advancements to transform educational practices. In the context of Nigeria, incorporation of pedagogy into the existing framework of specialised content training during the postgraduate residency program and continuing medical education will enable medical teachers to acquire critical competencies and develop positive dispositions towards a technological pedagogical content knowledge base. Competence standards will also be required of students to enable them employ ICT positively to enhance learning, minimise technology-induced distractions and develop relevant skills for self-directed study. The high flux in both scientific research out-puts and medical educational paradigm imposes a challenge on teachers worldwide to keep adjusting the medical curriculum. For instance, pathology undergraduate education in Nigeria currently stands on the threshold of adopting more effective flexible pedagogies and computer-mediated objective structured assessment of critical competencies during examinations. The implementation of these innovations will be a success if institutional leaders create enabling institutional structures and induce lecturers and students to develop positive attitudes of "flexibility, openness in thinking, adaptiveness and responsibleness to change" (Mapuva 2010).

5. Conclusion

In the face of dwindling funds, increasing number of students and expanding wealth of learning resources, medical educators and administrators are required to confront the challenges of updating the current curriculum and developing new content adapted to emerging critical competencies to ensure that medical students are adequately equipped for future practice. This may require greater inventiveness on the part of teachers. This study has demonstrated that most Nigerian medical students are favourably inclined towards adopting and integrating emerging ways of teaching pathology into already existing frameworks for enhanced learning.

6. Conflicts of Interest

The authors do not have any conflict(s) of interest to declare.

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