'Anytime, Anywhere': Tablet technology in medical education

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TITLE PAGE

Title : ‘Anytime, Anywhere’: Tablet technology in medical education

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ABSTRACT

Objective: The purpose of this exploratory study was to establish the use of mobile devices by learners at a selected medical school. The distribution of the mobile devices was an inaugural initiative implemented by the College.

Design: A quasi-mixed methodology research design was chosen to guide our enquiry. A questionnaire comprising both open and close ended questions was analysed from 179 second year medical students registered for the Anatomy course.

Setting and participants: Second year medical students at a medical school in South Africa.

Results: Three main themes emerged from the data analysis viz. mobile devices as learning tools, advantages of mobile devices and challenges affecting use of mobile devices. Findings revealed that the majority of learners accessed their tablets for lecture notes. Females were more inclined to access these mobile devices than males. Participants experienced challenges such as poor wifi connectivity on and off the University campus whilst some students were not keen on the idea of mobile devices and preferred the traditional methods of teaching anatomy.

Conclusions: Mobile computing devices have been rapidly adopted by medical learners at our Institution and it seems likely that their presence will soon be ubiquitous. Integrating tablets into Higher Education anatomy classes had a positive effect on student access to course material.

Strengths and limitations of this study

- The findings add to the literature that students engage with tablets as a learning tool.
- Sampling was purposive and research was limited to a single cohort of MBChB second year students. Additional research is necessary to isolate disciplinary strengths and weaknesses.
• Further studies are required to determine if tablets have an impact on academic performance and whether they encourage self-directed learning.

• It is recommended that university administrators ensure that provisions are made for technological support to students.
INTRODUCTION

The last decade has seen the introduction of new technology which has transformed many aspects of our culture, commerce, communication and education\(^1\). Mobile computing devices such as tablets, iPhones and the iPad have been swiftly implemented in many countries resulting in access to information in ways that were not possible before \(^2\). This article begins with a brief description of mobile learning and it is proposed that the growing use of mobile technology at universities is the most current trend forcing educators to evaluate its merits.

Mobile learning is defined as “any type of learning that takes place in learning environments and spaces that take account of the mobility of technology, mobility of learners and mobility of learning.” As mobile technology develops, it creates new opportunities for enhancing the learning experience of students at all levels of education \(^3\). Cobcroft \textit{et al.} (2006)\(^4\) reported that “mobile technologies are able to support learners’ engagement in creative, collaborative, critical and communicative learning activities.” Traxler (2007)\(^5\) further emphasized that mobile learning offers a unique opportunity to support learning that is personalized, authentic and situated thus facilitating a wide variety of teaching methods. The growing use of mobile technology at Colleges and Universities is the most current trend forcing educators to evaluate its merits and

The College of Health Sciences (CHS) at the selected University has implemented a Visual Learning Project and over 1400 health science students have received new Proline Tablet PCs. This technology was the first in South Africa to provide such a platform to stream live lectures, and record lectures for later on-demand viewing. According to the Information Technology Department at the Institution, “the live lecture streaming incorporates an interactive classroom, where students can ask the lecturer questions electronically, and students can respond to
questions, surveys and polls from their seats in the lecture room, or from a remote location. College management said this new solution opened up exciting opportunities that could even allow international lecturers to lecture to the student population. The new technology would allow lecturers to reach the more remote areas of the university community; proving especially beneficial to CHS students when fulfilling the clinical service requirements of their degrees.” (UKZN website; accessed 21 July 2016). Mobile learning presents students and faculty with a unique opportunity to access information instantaneously, regardless of location.

The main advantages of using tablet technology embrace the following perceptions viz. using software applications to enhance creativity, critical thinking and encouraging greater interaction among students and faculty. The benefits of using the tablet have also included a reduction in the amount of paper used and a reduction in textbook costs as students have opted for electronic versions of the text. Engagement with tablet-pcs in academic programmes creates a positive educational experience. Miller (2012) reported that not only do tablet-pcs have applications that serve as study aides and productivity tools for students, but students are also able to use “apps” to help create flashcards for studying, including retrieving and editing documents on “Google Docs” for assignments. Further, some authors elaborate that the design of tablet-pcs combines e-reading capabilities with web-browsing, plus an assortment of applications that facilitate the integration of information by making information conveniently available, including creating a richer set of course notes.

**Anatomy in Higher Education**

Anatomy is an integral part of any medical degree. Within anatomy programmes, students are required to construct a comprehensive and sophisticated understanding of basic anatomy, and
then apply that information to clinical care. Anatomy requires students to learn a large volume of Latin terminology and functions including muscle names, origins, insertions, joint, connective tissue and cellular, micro and gross anatomy. Traditionally, students use a rote or surface learning approach and have stated that anatomy is “boring, hard, dull” in previous literature.

Anatomy teaching in medical schools has been traditionally based around the use of human cadaveric specimens, either taking the whole body specimens for complete dissection or as prosected specimens. The debate on teaching via the conventional pedagogy of cadaveric dissection versus the computer and more innovative modalities has raged on for the last decade.

Those who advocate retaining this traditional learning exercise (the so called “traditionalists”) cite the value of the cadaver experience. Those who see the practice as redundant defend their position by pointing to recent technological advancements (the so called “modernists”).

At our Institution cadaver-based learning includes the actual dissection of cadavers by medical students under the supervision of qualified instructors and the study of prosected specimens where individual structures in the human body have been dissected and displayed by skilled dissectors.

Theoretical approaches

Lave and Wengers’ (1991) theoretical lens of Situated Learning and Lev Vygotsky’s social constructivist theory (Vygotsky, 1978) will assist us to explore student perceptions of tablet use within our Institution. It does this through an analysis of the use of tablet technology in a specific context viz. the anatomy course within the second year medical curriculum. Situated Learning theory is a valuable lens through which to explore social forms of learning. It is a theory which declares that “learning is not merely situated in practice”; rather it is influenced by the social
environment in which it takes place\textsuperscript{24}. Social constructivist theory defines learning as a “collaborative social process involving the co-construction of knowledge among a community of learners.” The importance of the context in which learning occurs renders situations and events significant and applicable to the student by providing opportunities to construct new knowledge from genuine experience. A constructivist view of learning describes learning as a process of knowledge production\textsuperscript{26}. This theory emphasizes learner autonomy and personal involvement in learning and fosters learners’ natural curiosity. It also considers learners’ beliefs, attitudes and motivation\textsuperscript{26}.

It is with this literature review in mind that the research questions addressed in this study are:

- What is the extent to which medical trainees use their mobile devices?
- What kinds of information are being accessed generally and specifically with reference to anatomical education?

**AIM**

The purpose of this exploratory study was to establish how learners at a selected medical school use their mobile devices since this was a unique initiative implemented by the College.

**MATERIALS AND METHODS**

*Design*

A quasi-mixed methodology research design integrating both quantitative and qualitative findings was chosen to guide our enquiry to generate the data required to meet the aims of this study.
Participants

A total of 179 second year medical students registered for the Anatomy course at the selected Institution chose to participate in this study. Students were informed about the study and their consent was duly taken for their voluntary and anonymous participation. Any chance of participant bias was eliminated by clearly explaining the objective of the study while obtaining their informed consent. There were no specific exclusion criteria and no participants withdrew from the study. Ethical approval was obtained from the Institutional Ethics Committee (BE386/15).

Instrumentation (Appendix A)

A survey questionnaire containing structured and free response items was utilized in this study to obtain both quantitative and qualitative information regarding student use of their mobile device. Questions 1 and 2 asked all respondents about their prior exposure to mobile devices. Question 3 focused on student knowledge of participation in the College project. Questions 4-9 concentrated on type, frequency and location of usage of the tablets, including the preferred method of learning anatomy. Question 10 covered internet connectivity. Questions 11-13 and 15 asked respondents about their views pertaining to the use of the tablet in accessing anatomy content. Question 14 asked a general question related to applications accessed by students.

Data Analysis
The questionnaire was administered to students before class and they were allocated twenty minutes for completion. The close ended questions were statistically analysed using the SPSS version 21.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data for comparison of categorical variables was tested using the Pearson’s Chi-square test to compute frequency tables and descriptive statistics. A p value of <0.05 was considered to be statistically significant.

The open ended questions were analysed by two of the authors (LL and RS) using a thematic approach to identify emergent ideas and concepts expressed by participants. Key words, phrases and/or descriptions from the participants were documented, as the authors reflexively engaged with the data. Convergence and divergence of data were noted, leading to the development of preliminary emergent themes. The themes were further interrogated and developed with reference to participants’ original words while also including the authors’ collective interpretations.

RESULTS

a) Sample demographics

There were 179 respondents with a gender distribution of 60 male and 119 female students and a racial organization of 137 Black, 26 Indian, 6 White and 9 Coloured participants. Students also indicated their socio-economic background viz. urban 62, peri-urban 46 and rural 71 (Table 1). The average age of respondents was 20.2 years with a range between 18-28 years.

b) Quantitative results

Significant p-values (highlighted) were recorded for the different categorical variables according
to gender, race and socio-economic status (Table 2). The majority of students came from a rural background (39.7%) and these students indicated that they had no prior exposure to a tablet device prior to receiving the current one as part of their course (38%). Statistically significant results were obtained when gender (p<0.020), race (p<0.000) and socio-economic (p<0.000) status were compared to students having prior access to a tablet. The majority of Black students were not aware of the Visual Learning Project (43.6%) and a statistically significant result (p<0.024) was obtained when race was correlated with academic activities of the College. Female students indicated that they utilized the tablet for both academic and personal reasons (35.8%). It was also shown that females tend to access their tablets twice a week (16.8%) to obtain anatomy related content when compared to males (7.8%). Statistically significant results (p<0.017) were obtained between gender and the frequency of tablet usage to access anatomical information. The majority of students (37.4%) with rural backgrounds utilized the tablet to access lecture notes and a statistically significant value of p<0.000 was obtained when socio-economic status was correlated with the latter parameter. A total of 24% of male students reported that they found physical dissection more beneficial in the study of anatomy as opposed to female students who preferred visual aids (15.1%). An overwhelmingly large number of female students (62%) reported that they accessed the tablets for lecture notes. Female students also indicated that they accessed their tablets whilst on campus (36.3%). However, 17.4% of African students reported a lack of internet access at home (p<0.000 when race was correlated with internet availability). A total of 43% of female students indicated that the tablet made accessing anatomy-related content more convenient for them. A majority of female students (33.5%) reported that they found physical attendance of lectures and practical’s and access to anatomy-related study material i.e. lecture notes via the tablet beneficial to them. Despite having
the tablet, female students still recorded lecture notes during classroom time (43.6%). Statistically significant correlates were recorded for gender (p<0.032) and race (p<0.014) versus traditional note taking. Students indicated that provision of the tablet did not affect their attendance (57.5%).

c) Qualitative results

The following themes emerged from the data analysed viz.

i. Mobile devices as learning tools

ii. Advantages of mobile devices

iii. Challenges affecting use of mobile devices

iv. Miscellaneous use

i. Mobile devices as learning tools

Students turn their mobile devices into learning tools through the use of mobile applications or “apps”. Students reported the use of the tablet to access E-books (3.4%) such as Netter’s interactive and Drake’s Grey’s Anatomy. Students also accessed databases such as Medscapes (1.1%), UKZN Tube (16.2%) for notes and software programmes (10.1%) such as Essential Anatomy 2, Visual Anatomy Free Videos and Quiz Up. Students also mentioned that the tablet allowed them to learn at their own pace (21.2%); whilst others felt that they learnt better by watching videos on the tablet as anatomical specimens are clearer in the videos and enabled them to understand the content (42.5%).

“I am able to replay the videos in my own time; hence making learning easier.”
“I have downloaded certain books and videos using my tablet and so it has made accessing anatomy related content more convenient.”

“The visual part, the one I use with the tablet enables me to combine what I learn in the class with what I see and it makes me able to know the exact locations of certain important structures.”

ii. Advantages of mobile devices

Participants listed a number of advantages associated with the use of mobile tablets such as portability (6.7%) allowing students the opportunity of accessing information on campus and allowing them to revise at home, access to information on the internet (22.9%) and research areas of course content that were not covered in the lectures (9.5%).

“Since the tablet is portable, I am able to view lecture slides more frequently”

Respondents also mentioned the value of utilizing dissection as well as visual aids in the learning of anatomy (17.3%).

“Tablet enables one to combine what is learnt in lectures with structures in the DH”

iii. Challenges affecting use of mobile devices

Respondents reported on some of the challenges they experienced with the use of the tablet such as having no wifi access outside of campus (64.2%) as well as poor wifi access on campus (12.3%).

“Because I am staying at residence and there is no wifi”

“I do not have access to the internet at home”
Some also considered that learning from the tablet did not improve their understanding of anatomy (3.4%) and felt that learning from the cadaver was easier (60.3%) as opposed to the tablet.

“I prefer physical dissection and viewing of prospected specimens because you learn how to dissect and it is much easier to learn and understand.”

Respondents also reported on the lack of anatomy related content being posted on the Institutional website (3.4%).

“There are no resources for Anatomy in the UKZN Tube.”

iv. Miscellaneous use

Participants also used their devices for private use such as a recorder (6.7%), as a camera (3.9%), gaming (9.5%), social media such as Facebook (1.7%), as a media player (8.4%), software applications (18.3%) and for non-course related academic purposes (6.7%). Some respondents stated that the tablet has no effect on their leaning at all (11.2%).

DISCUSSION

In conducting this exploratory investigation into student perceptions of Tablet usage, it was found that there are many issues to consider when using this technology in practice. The results from this study reveal that students are using mobile devices for both academic as well as private purposes outside of the classroom. According to Yau and Leung (2016)\textsuperscript{27}, gender differences account for one of the factors affecting students’ use of technology. In this study, females were
inclined to use their tablets more often than males which was statistically significant (Question 5, Table 2). These results concur with that reported by Yau and Leung (2016) but differ from Kekkonen-Moneta and Moneta (2002); the latter authors suggested that tablet technology use is a more dominant activity for male students. McNulty (2006) and (2009) demonstrated that although students may be familiar with Web based educational resources, medical student usage of Web-based computer aided instruction is related to gender, learning styles and personality.

A large majority of students (91.6%) accessed their tablets for lecture notes. These “online lectures” define a range of content available for Web access, ranging from text files to audio or video-enhanced presentations to captured video lectures. According to Chan and Pawlina (2015), lecture capture records an instructor’s presentation as it is delivered live in the classroom, as is the scenario at our Institution. Lecture capture is regarded as an effective review tool for students provided that the lecture is well presented.

The use of mobile learning enables students to collaborate and create knowledge and to interact with a larger range of content, thus supporting a social constructivist view of learning as it enhances students’ ability to learn and apply course content. More than any previous mobile learning technology, tablets provide students with immediate and far reaching access to information, course resources and real world application of knowledge. The qualitative data in this study corroborates the views expressed by Rossing et al. (2012) particularly student responses in the themes of mobile devices as learning tools and advantages of mobile devices.

Students reported that the immediate access to information enhanced in-class understanding of content (“….the tablet enables me to combine what I learn in the class with what I see and it makes me able to know the exact locations of certain important structures”).
The growing number of websites and databases further facilitate the ease with which students can “download certain books and videos using my tablet and so it has made accessing anatomy related content more convenient.” Some students were motivated enough to access additional anatomical content via web-based learning such as E-books, Medscapes, Essential Anatomy 2, Visual Anatomy Free Videos and Quiz Up supporting the social constructivist instructional strategy. Sharing common principles with the constructive learning, situated learning depends on knowledge and skills being learned in social interactions in practical working contexts. According to Chan and Pawlina (2015), constructive and situated learning can be found in modern anatomy curricula including anatomy laboratories where students access their tablets. The aforementioned applications that are downloaded to these tablets provide students with interactive visual representation of the information. The touch screen capabilities of the tablet allows students to enlarge or rotate images with ease, thereby making learning more hands on. Further, they provide visual representations of anatomy that more closely resemble the structures in the human body. This is especially beneficial in those programs in the field of health sciences that do not possess anatomy laboratories as a component of their curriculum; hence anatomy applications may be a useful resource for augmenting student learning.

This study’s findings (“…since the tablet is portable, I am able to view lecture slides more frequently”) support the literature that recommends that today’s students desire and benefit from “anywhere, anytime” learner participation. The literature suggests that mobile learners desire the ability and flexibility to choose their location and time for learning. As reported by this study, learners were allocated their own tablets; therefore they had the option of using it for personal purposes; thus allowing them greater opportunities to collaborate with others and construct knowledge of real world experiences in their daily lives. The majority of students
accessed their tablets on campus; therefore it can be concluded that the use of these mobile devices encourages sharing and collaboration among students. Students are able to work cooperatively with each other by creating online communities such as e-mail and Facebook to facilitate learning “anywhere, anytime.”

The largest impediments to learning and the strongest challenge to the convenience of the tablet appeared to be wireless connectivity. Failure of wifi connectivity leads to disenchantment with mobile devices (“…there is no wifi”) and severely hampers the learning process.

Some learners also felt that physical dissection provided the best method of learning anatomy (30.9%), corroborating the views of authors such as McLachlan et al. (2004)\textsuperscript{33} and McLachlan and Patten (2006)\textsuperscript{34} despite the implementation of the newer technology; whilst some students felt that the provision of the tablet had no effect at all on their learning (6.7%).

CONCLUSION

Mobile computing devices have been rapidly adopted by medical learners worldwide, including those at our Institution as illustrated by this pilot study and it seems likely that their presence will soon be ubiquitous. This study offers a unique South African perspective which has the possibility to enhance learning, but also has potential problems associated with its use. We can conclude from our study that integrating tablets into Higher Education anatomy classes had a positive effect on student access to course material. In a subject already utilising active learning through traditional methods the addition of technology via quizzes, 3D visual material and access to the internet could be an alternative method of engaging students in the learning process. Students are seizing opportunities of learning anywhere, anytime due to the portability of their mobile devices.
Limitations and implications for future research

Firstly, this study is limited by the exclusive use of the Proline 7” android tablet. Additional research is necessary to incorporate the use of other branded technological devices such as the Apple iPad.

Secondly, as this study used purposive sampling, the results may be limited by the nature of the population and cannot be generalized to account for student experiences with other academic courses offered. Additional research is necessary to isolate disciplinary strengths and weaknesses.

Thirdly, students in graduate programs such as MBChB are expected to be self-directed learners who have the ability to locate resources to supplement their learning. This could be a motivating factor for students to use their tablets for learning outside of the classroom. Further studies are necessary to determine whether mobile devices such as the tablet have an impact on academic performance, assessments and whether they encourage self-directed learning. Additional studies are warranted to determine the effect of tablet technology on examination performance.

Fourthly, there should be no compromise in students having access to the material they are promised; university administrators should ensure that provisions are made for technological support in places such a living residences have wifi access points for students to utilize at their convenience. As mobile technology continues to grow and develop, universities cannot be caught with a wireless infrastructure incapable of handling the demand for connectivity.

Fifthly, in order to maximize the benefit of mobile tablets, educators must carefully adapt the technology to specific learning goals and outcomes.
Sixthly, educators must not assume that students are prepared for new technologies and need to
gauge student’s level of knowledge and comfort with new technological devices. It is essential to
devote classroom time to students to acclimate to these new devices.
# TABLES

Table 1: Demographic profile of the study respondents (n=179)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>60 (33.5)</td>
</tr>
<tr>
<td>Female</td>
<td>119 (66.5)</td>
</tr>
<tr>
<td><strong>Race</strong></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>138 (77.1)</td>
</tr>
<tr>
<td>Indian</td>
<td>26 (14.5)</td>
</tr>
<tr>
<td>White</td>
<td>6 (3.4)</td>
</tr>
<tr>
<td>Coloured</td>
<td>9 (5.0)</td>
</tr>
<tr>
<td><strong>Socio-economic status</strong></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>62 (34.6)</td>
</tr>
<tr>
<td>Peri-urban</td>
<td>46 (25.7)</td>
</tr>
<tr>
<td>Rural</td>
<td>71 (39.7)</td>
</tr>
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</table>
Table 2: Responses to close ended questions according to gender, race and socio-economic status

<table>
<thead>
<tr>
<th>Question</th>
<th>Incidence of Demographic factor (%)</th>
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<tbody>
<tr>
<td></td>
<td>Sex</td>
</tr>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>2. Did you have access to a tablet prior to receiving the current one?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td><strong>P Value</strong></td>
<td>0.020</td>
</tr>
<tr>
<td>3. Were you familiar with the visual learning programme prior to the provision of the tablet?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td><strong>P Value</strong></td>
<td>0.665</td>
</tr>
<tr>
<td>4. What do you frequently use the tablet for?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No Comment</td>
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<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Personal</td>
</tr>
<tr>
<td></td>
<td>Academic &amp; Personal</td>
</tr>
<tr>
<td></td>
<td>Other</td>
</tr>
<tr>
<td><strong>P Value</strong></td>
<td>0.342</td>
</tr>
<tr>
<td>5. How often do you use the tablet to access anatomy-related content?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No Comment</td>
</tr>
<tr>
<td></td>
<td>Everyday</td>
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<tr>
<td></td>
<td>Twice a week</td>
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<tr>
<td></td>
<td>More than 3 times week</td>
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<tr>
<td></td>
<td>Once in two weeks</td>
</tr>
<tr>
<td></td>
<td>Other</td>
</tr>
<tr>
<td><strong>P Value</strong></td>
<td>0.017</td>
</tr>
<tr>
<td>6. Which of the following do you most frequently access via your tablet?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No Comment</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
</tr>
<tr>
<td></td>
<td>Actual lecture</td>
</tr>
<tr>
<td></td>
<td>Demo &amp; Practical</td>
</tr>
<tr>
<td><strong>P Value</strong></td>
<td>0.701</td>
</tr>
<tr>
<td>7. Which method of studying anatomy do you find most beneficial to you?</td>
<td></td>
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<tr>
<td></td>
<td>No effect</td>
</tr>
<tr>
<td></td>
<td>Visual aid</td>
</tr>
<tr>
<td></td>
<td>Physical dissection</td>
</tr>
<tr>
<td><strong>P Value</strong></td>
<td>0.938</td>
</tr>
<tr>
<td>9. Where do you generally use your tablet?</td>
<td></td>
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<tr>
<td></td>
<td>On Campus</td>
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<tr>
<td></td>
<td>Home</td>
</tr>
<tr>
<td></td>
<td>Hospital</td>
</tr>
<tr>
<td></td>
<td>Campus &amp; Home</td>
</tr>
<tr>
<td><strong>P Value</strong></td>
<td>0.093</td>
</tr>
<tr>
<td>10. Do you have internet access at home?</td>
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<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td><strong>P Value</strong></td>
<td>0.064</td>
</tr>
<tr>
<td>11. Has the tablet made accessing anatomy-related content more convenient for you?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No Comment</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td><strong>P Value</strong></td>
<td>0.339</td>
</tr>
<tr>
<td>12. What do you consider most beneficial to you?</td>
<td>No Comment</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>A : Live streaming of lectures and practical's only</td>
<td>1.1</td>
</tr>
<tr>
<td>B : Physical attendance to lectures and practical's only</td>
<td>0.6</td>
</tr>
<tr>
<td>C : Live streaming of lectures AND physical attendance to lectures and practical's</td>
<td>11.7</td>
</tr>
<tr>
<td>D : Access of anatomy-related study material only, i.e. lecture notes</td>
<td>1.1</td>
</tr>
<tr>
<td>E : Live streaming of lectures AND access of anatomy-related study material, i.e. lecture notes</td>
<td>2.8</td>
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<tr>
<td>F: Physical attendance of lectures and practical's AND access of anatomy-related study material i.e. lecture notes</td>
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| P Value | 0.708 | 0.320 | 0.000 |

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<th>1.7</th>
<th>0.6</th>
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| P Value | 0.032 | 0.014 | 0.116 |

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<th>4.5</th>
<th>2.2</th>
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| P Value | 0.144 | 0.752 | 0.867 |

*Questions numbered according to Questionnaire (Appendix A)
Contributors

All three authors are justifiably credited with authorship, according to the authorship criteria. In detail: LL collection, analysis and interpretation of data, drafting the article and final approval of the version to be published. RS: analysis and thematic development, revising the article and final approval of the version to be published. KSS: revising the article and final approval of the version to be published.

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Competing Interests

We have read and understood BMJ policy on declaration of interests and declare that we have no competing interests.

Ethical approval

Ethics approval was obtained from the Biomedical Research and Ethics Committee of the University of KwaZulu Natal (Ethics number BE386/15).

Data Sharing statement

No additional data are available.
References


APPENDIX

TABLET TECHNOLOGY IN MEDICAL EDUCATION

The purpose of this survey is to provide faculty with information about whether you utilize mobile devices as they relate to your studies in the Anatomy Program. This survey is for general program development and is voluntary. However, your participation is greatly appreciated and will be useful in course planning, development and improvement. Please mark with a tick where appropriate

Age: ____________

Sex:  M  F

Race:  Black African  White  Indian  Coloured

Socio-Economic Background  Urban  Peri-urban  Rural

1. When did you receive your tablet? _______________________________________________

2. Did you have access to a tablet prior to receiving the current one?
   Yes   No

3. Were you familiar with the visual learning programme prior to the provision of the tablet?
   Yes   No

4. What do you frequently use the tablet for? (Please cross the most applicable option)
   Academic
   Personal
   Academic and personal
   Other

5. How often do you use the tablet to access anatomy-related content? (Please cross the most applicable option)
   Everyday
   Twice a week
   More than three times a week
   Once in two weeks
   Other

6. Which of the following do you most frequently access via your tablet? (Please cross the most applicable option)
   Lecture notes
   The actual lecture
   Demonstration of prosected specimens

7. Which method of studying anatomy do you find most beneficial to you? (Please cross the most applicable option)
   Visual aid (learning via the tablet)
   Physical dissection and viewing of prosected specimens

7.1 Please explain your preferred choice:

_______________________________________________________________________
_______________________________________________________________________
8. How does the use of the tablet for the access of anatomy-related content assist with your clinical skills?
___________________________________________________________________________
___________________________________________________________________________

9. Where do you generally use your tablet? (Please cross the most applicable option)
At campus
At home
At hospital during ward rounds
9.1 Please explain the reason for the selected location?
___________________________________________________________________________

10. Do you have internet access at home?
Yes
No
10.1 How does this affect the usage of your tablet to access anatomy-related content?
___________________________________________________________________________

11. Has the tablet made accessing anatomy-related content more convenient for you?
Yes
No
11.1 Please elaborate about your choice
___________________________________________________________________________

12. What do you consider most beneficial to you? (Please cross the most applicable option)
Live streaming of lectures and practical’s only
Physical attendance to lectures and practical’s only
Live streaming of lectures AND physical attendance to lectures and practical’s
Access of anatomy-related study material only, i.e. lecture notes
Live streaming of lectures AND access of anatomy-related study material, i.e. lecture notes
Physical attendance to lectures and practical’s AND access of anatomy-related study material, i.e. lecture notes

13. In addition to the provision of the tablet, do you still record notes during the lecture?
Yes
No

14. What applications do you most frequently use on your tablet? (Please list in order of preference)
1. ____________________________
2. ____________________________
3. ____________________________

15. Does the provision of the tablet affect your attendance to lectures and practical’s?
Yes
No
# ‘Anytime, Anywhere’: Tablet technology in medical education

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| Complete List of Authors: | Lazarus, Lelika; University of KwaZulu-Natal College of Health Sciences, Clinical Anatomy
Sookrajh, Reshma; University of KwaZulu Natal, Department of Curriculum Studies, School of Education, College of Humanities
Satyapal, Kapil; University of KwaZulu-Natal College of Health Sciences, Clinical Anatomy; University of KwaZulu-Natal College of Health Sciences, Clinical Anatomy |
| Primary Subject Heading: | Medical education and training |
| Secondary Subject Heading: | Medical education and training, Qualitative research, Communication |
| Keywords: | communication, tablet, Information technology < BIOTECHNOLOGY & BIOINFORMATICS, Anatomy < BASIC SCIENCES, MEDICAL EDUCATION & TRAINING, electronic devices |
TITLE PAGE

Title : ‘Anytime, Anywhere’: Tablet technology in medical education

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Total number of figures : 0

Total number of tables : 2

Type of article : Original communication

Running headline : The use of tablet technology in medical education

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ABSTRACT

Objective: The purpose of this study was to establish the use of mobile devices by learners at a selected medical school. Distribution of mobile devices was an inaugural initiative implemented by our College.

Design: A mixed methodology design using a questionnaire comprising both open and close ended questions was analysed from 179 (60 male; 119 female) second year medical students registered for the Anatomy course. Open-ended questions were analysed using a thematic approach by identifying emergent ideas and concepts. Close-ended questions were analysed using SPSS version 21.0.

Setting and participants: Second year medical students at a medical school in South Africa.

Results: Three main themes emerged viz. (i) mobile device engagement, (ii) advantages and (iii) challenges affecting use of mobile devices. A majority of learners accessed their tablets for lecture notes; more females were inclined to access these devices than males. Challenges experienced included poor wifi connectivity on and off University campus; some students were not keen on the idea of mobile devices and preferred traditional methods of teaching.

Conclusions: Mobile devices have been adopted by learners at our University. Uses of technology outlined are related to Eraut’s intentions of informal learning. Integrating tablets into classes had a positive effect on student access to course material.

Strengths and limitations of this study

- Findings reveal that students engage with tablets for learning and miscellaneous use unrelated to the discipline
Sampling was purposive; research was limited to a single cohort of second year medical degree students. We cannot exclude an element of response bias as a large part of the sample comprised of female respondents.

Further, quantitative and qualitative studies are necessary to determine if tablets have an impact on academic performance and whether they encourage self-directed learning.

University administrators are recommended to ensure that provisions are made for technological support to students.
INTRODUCTION

The last decade has seen the introduction of new technology which has transformed many aspects of our culture, commerce, communication and education. Mobile computing devices such as tablets, iPhones and the iPad have been swiftly implemented in many countries resulting in access to information in ways that were not possible before. This article begins with a brief description of mobile learning and it is proposed that the growing use of mobile technology at universities is the most current trend forcing educators to evaluate its merits.

Mobile learning is defined as “any type of learning that takes place in learning environments and spaces that take account of the mobility of technology, mobility of learners and mobility of learning.” As mobile technology develops, it creates new opportunities for enhancing the learning experience of students at all levels of education. Cobcroft et al. (2006) reported that “mobile technologies are able to support learners’ engagement in creative, collaborative, critical and communicative learning activities.” Traxler (2007) further emphasized that mobile learning offers a unique opportunity to support learning that is personalized, authentic and situated thus facilitating a wide variety of teaching methods. The growing use of mobile technology at Colleges and Universities is the most current trend forcing educators to evaluate its merits and The College of Health Sciences (CHS) at our University has implemented a Visual Learning Project and over 1400 health science students have received new Proline Tablet PCs. This technology was the first in South Africa to provide such a platform to stream live lectures, and record lectures for later on-demand viewing. According to the Information Technology Department at the university, “the live lecture streaming incorporates an interactive classroom, where students can ask the lecturer questions electronically, and students can respond to
questions, surveys and polls from their seats in the lecture room, or from a remote location. College management said this new solution opened up exciting opportunities that could even allow international lecturers to lecture to the student population. The new technology would allow lecturers to reach the more remote areas of the university community; proving especially beneficial to CHS students when fulfilling the clinical service requirements of their degrees.” (UKZN website; accessed 21 July 2016). Mobile learning presents students and faculty with a unique opportunity to access information instantaneously, regardless of location.

The main advantages of using tablet technology embrace the following perceptions viz. using software applications to enhance creativity, critical thinking and encouraging greater interaction among students and faculty. The benefits of using the tablet have also included a reduction in the amount of paper used and a reduction in textbook costs as students have opted for electronic versions of the text. Engagement with tablet-pcs in academic programmes creates a positive educational experience. Miller (2012) reported that not only do tablet-pcs have applications that serve as study aides and productivity tools for students, but students are also able to use “apps” to help create flashcards for studying, including retrieving and editing documents on “Google Docs” for assignments. There are hundreds and thousands of applications, some free and some requiring paid subscriptions. These applications are available in a wide range of categories and are tailored for specific medical disciplines such as Medscape, Medical Tools, Gray’s Anatomy-Atlas, Medical Abbreviations, Harrison’s Manual of Medicine, Anatomy Learning-3D Atlas, MediApp, Resuscitation, iGyno and O&G App. Further, some authors elaborate that the design of tablet-pcs combines e-reading capabilities with web-browsing, plus an assortment of applications that facilitate the integration of information by making information conveniently available, including creating a richer set of course notes.
Ellaway (2014) categorized mobile use by medical learners into four groups viz. (i) *logistics* (when learners use their devices for personal information management such as email and texting); (ii) *personal* (when learners use their devices for social and entertainment purposes such as social media and gaming; (iii) *learning tools* (when learners use their devices for undertaking learning tasks such as note taking and (iv) *learning content* (when learners use their devices as a source of information such as checking drug interactions. This categorization will used a framework to represent data later on in this paper.

**Anatomy in Higher Education**

Anatomy is an integral part of any medical degree. Within anatomy programmes, students are required to construct a comprehensive and sophisticated understanding of basic anatomy, and then apply that information to clinical care. Anatomy requires students to learn a large volume of Latin terminology and functions including muscle names, origins, insertions, joint, connective tissue and cellular, micro and gross anatomy. Traditionally, students use a rote or surface learning approach and have stated that anatomy is “boring, hard, dull” in previous literature.

The nature of anatomical education has transformed substantially over the past decade due to both a new generation of students who learn differently from those of the past and the explosion of advances in anatomical imaging and programing. Medical students of today are products of the “interactive generation”. Millennial generation learners (sometimes referred to as digital natives) are defined as individuals whose development has been infused with technology and these individuals possess extensive experience with digital exploration, gaming and communication and are claimed to be adept with user-friendly digital devices.
Anatomy teaching in medical schools has been traditionally based around the use of human cadaveric specimens, either taking the whole body specimens for complete dissection or as prosected specimens\(^{20}\). The debate on teaching via the conventional pedagogy of cadaveric dissection versus the computer and more innovative modalities has raged on for the last decade\(^{21}\). Those who advocate retaining this traditional learning exercise (the so called “traditionalists”) cite the value of the cadaver experience\(^{22-24}\). Those who see the practice as redundant defend their position by pointing to recent technological advancements (the so called “modernists”)\(^{25-27}\).

At our University cadaver-based learning includes the actual dissection of cadavers by medical students under the supervision of qualified instructors and the study of prosected specimens where individual structures in the human body have been dissected and displayed by skilled dissectors.

It is with this literature review in mind that the research questions addressed in this study are:

- What is the extent to which medical trainees use their mobile devices?
- What kinds of information are being accessed generally and specifically with reference to anatomical education?

**AIM**

The purpose of this exploratory study was to establish how learners at a selected medical school use their mobile devices since this was a unique initiative implemented by the College.
MATERIALS AND METHODS

Design

A mixed methodology research design integrating both quantitative and qualitative approaches was chosen to guide our enquiry to generate the data required to meet the aims of this study.

Context and Participants

The study sought to explore how learners at a selected medical school use their mobile devices. The second year class was comprised of a total of 257 medical students registered for the Anatomy course. Of these only 179 students (60 male; 119 female) chose to participate in this study (69.6% response rate). Teaching sessions are comprised of lectures in various anatomical structural themes (x 5 per annum), for example, Cardiovascular System. Each of these themes are conducted over an 8-week period comprising approximately 11 one-hour lecture and 29 two-hour practical sessions per theme.

Students were informed about the study and their consent was duly taken for their voluntary and anonymous participation. Any chance of participant bias was eliminated by clearly explaining the objective of the study while obtaining their informed consent. There were no specific exclusion criteria and no participants withdrew from the study. Ethical approval was obtained from the University Biomedical Research Ethics Committee (BE386/15).

Instrumentation (Appendix A)

A survey questionnaire containing structured and free response items was used in this study to obtain both quantitative and qualitative information regarding student use of their mobile device.
Questions 1 and 2 asked all respondents about their prior exposure to mobile devices. Question 3 focused on student knowledge of participation in the College project. Questions 4-9 concentrated on type, frequency and location of usage of the tablets, including the preferred method of learning anatomy. Question 10 covered internet connectivity. Questions 11-13 and 15 asked respondents about their views pertaining to the use of the tablet in accessing anatomy content. Question 14 asked a general question related to applications accessed by students.

**Data Analysis**

The questionnaire was administered to students before class and they were allocated twenty minutes for completion. The open ended questions were analysed by two of the authors (LL and RS) using a thematic approach to identify emergent ideas and concepts expressed by participants. Key words, phrases and/or descriptions from the participants were documented, as the authors reflexively engaged with the data. Convergence and divergence of data were noted, leading to the development of preliminary emergent themes. The themes were further interrogated and developed with reference to participants’ original words while also including the authors’ collective interpretations. The close ended questions were statistically analysed using the SPSS version 21.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data for comparison of categorical variables was tested using the Pearson’s Chi-squared test ($\chi^2$) to compute frequency tables and descriptive statistics. A $p$ value of $<0.05$ was considered to be statistically significant.
RESULTS

a) Sample demographics

There were 179 respondents with a gender distribution of 60 male and 119 female students and a racial organization of 137 Black, 26 Indian, 6 White and 9 Coloured participants. Students also indicated their socio-economic background viz. urban 62, peri-urban 46 and rural 71 (Table 1). The average age of respondents was 20.2 years with a range between 18-28 years.

b) Quantitative results

Significant p-values (highlighted) were recorded for the different categorical variables according to gender, population groups, and socio-economic status (Table 2). The majority of students came from a rural background (39.7%) and these students indicated that they had no prior exposure to a tablet device prior to receiving the current one as part of their course (38%). Statistically significant results were obtained between the sexes (p<0.020) when gender was compared to students having prior access to a tablet. Comparisons for the different population groups (p<0.000) and socio-economic status (p<0.000) also yielded statistically significant results when this parameter was compared to students having prior access to a tablet. The majority (43.6%) of Black students were not aware of the Visual Learning Project and a statistically significant result (p<0.024) was obtained when population groups were compared with the level of student awareness of the Visual Learning Project. A total of 35.8% of female students indicated that they used the tablet for both academic and personal reasons compared to 21.2% of male students. Overall, females tended to access their tablets for anatomy related content more often when compared to their male counterparts (Table 2) which yielded a statistically significant p value (p<0.017). A total of 37.4% of students from rural backgrounds used the tablet to access lecture notes and a statistically significant value of p<0.000 was obtained when
socio-economic status was compared with the latter parameter. A total of 24% of male students reported that they found physical dissection more beneficial in the study of anatomy as opposed to female students who preferred visual aids (15.1%). A total of 62% of female students reported that they accessed the tablets for lecture notes; these students also indicated that they accessed their tablets whilst on campus (36.3%). However, 17.4% of African students reported a lack of internet access at home (p<0.000 when population groups were correlated with internet availability). A total of 43% of female students indicated that the tablet made accessing anatomy-related content more convenient for them. A majority of female students (33.5%) reported that they found access to anatomy-related study material i.e. lecture notes via the tablet beneficial to them versus 29.6% of male students who accessed the tablet for a similar purpose. Despite having the tablet, female students still recorded lecture notes during classroom time (43.6%). Statistically significant correlates were recorded for gender (p<0.032) and population groups (p<0.014) versus traditional note taking. A total of 83.8% of students indicated that provision of the tablet did not affect their attendance (57.5% female and 26.3% male) (Table 2).

c) Qualitative results

The following themes emerged from the data viz.

i. Mobile device engagement

ii. Advantages of mobile devices

iii. Challenges affecting use of mobile devices

iv. Miscellaneous use
i. Mobile device engagement

Learners listed a number of uses in their engagement with mobile devices. These uses have been categorised according to Ellaway’s (2014) four activity groups as outlined in the Introduction of this paper (Table 3) as follows:

- **Logistics:** Students reported the use of the tablet to access emails (16.2%) and browse the web (77%) using internet sites such as Firefox and Google, supporting

- **Personal:** Students also accessed social media such as Facebook (1.7%), social videos (8.4%) and games (7.3%).

- **Learning tools:** A large majority of the students accessed the tablet for lecture notes (91.6%) whilst 26.3% of learners used applications such as WPS Office to alter documents.

- **Learning content:** Students also accessed sites for drug guidelines such as Medscapes (1.7%) and 6.2% accessed Anatomy e-books such as Netter’s Interactive, Drake’s Grey’s Anatomy and software applications such as Essential Anatomy 2 and Visual Anatomy for learning content and expressed that they learnt better by watching anatomy videos on the tablet as anatomical specimens are clearer in the videos and enabled them to understand the content.

Students also mentioned that the tablet allowed them to learn at their own pace (21.2%).

“The visual part, the one I use with the tablet enables me to combine what I learn in the class with what I see and it makes me able to know the exact locations of certain important structures.” (Participant 1; male) (Count =31)
ii. Advantages of mobile devices

Participants listed a number of advantages associated with the use of mobile tablets such as portability (6.7%) allowing students the opportunity of accessing information on campus and allowing them to revise at home, access to information on the internet (22.9%) and research areas of course content that were not covered in the lectures (9.5%).

“With visual aids, I can access the slides and videos anytime” (Participant 33; female) (Count=63)

Respondents also mentioned the value of utilizing dissection as well as visual aids in the learning of anatomy (17.3%).

“Tablet enables one to combine what is learnt in lectures with structures in the DH” (Participant 21; female) (Count=6)

iii. Challenges affecting use of mobile devices

Respondents reported on some of the challenges they experienced with the use of the tablet such as having no wifi access outside of campus (64.2%) as well as poor wifi access on campus (12.3%).

“I do not have access to the internet at home” (Participant 4; female) (Count=122)

Some also considered that learning from the tablet did not improve their understanding of anatomy (3.4%) and felt that learning from the cadaver was easier (60.3%) as opposed to the tablet.
“The tablet does not provide visual aids of real specimens, just lecture slides. Looking at real specimens helps orientate oneself and get a three dimensional understanding.” (Participant 70; female) (Count=103)

Respondents also reported on the lack of anatomy related content being posted on the university website (3.4%).

“There are no resources for Anatomy in the UKZN Tube.” (Participant 2; male) (Count=4)

iv. Miscellaneous use

Participants also used their devices for private use such as a camera (3.4%) and as a media player (6.1%). Some respondents stated that the tablet has no effect on their leaning at all (11.2%).

DISCUSSION

In conducting this exploratory investigation into student perceptions of Tablet usage, it was found that there are many issues to consider when using this technology in practice. The results from this study reveal that students are using mobile devices for both academic as well as private purposes outside of the classroom. According to Yau and Leung (2016), gender differences account for one of the factors affecting students’ use of technology. In this study, females were inclined to use their tablets more often than males which was statistically significant (Question 5, Table 2). These results concur with that reported by Yau and Leung (2016) but differ from Kekkonen-Moneta and Moneta (2002); the latter authors suggested that tablet technology use is a more dominant activity for male students. McNulty (2006) and (2009) demonstrated that although students may be familiar with Web-based educational resources, medical student usage of Web-based computer aided instruction is related to gender, learning styles and personality.
The majority of students (91.6%) accessed their tablets for lecture notes. These lectures define a range of content available for Web access, ranging from text files to audio or video-enhanced presentations to captured video lectures. According to Chan and Pawlina (2015), lecture capture records an instructor’s presentation as it is delivered live in the classroom, as is the scenario at our university. Lecture capture is regarded as an effective review tool for students provided that the lecture is well presented. More than any previous mobile learning technology, tablets provide students with immediate and far reaching access to information, course resources and real world application of knowledge.

The educational practice of technology can be associated with learning theories. The various uses of mobile learning can be associated with the different stages in Kolb’s learning cycle. For example, accessing the tablet for related lecture notes in the dissecting hall provides an opportunity to practice skills, social media (such as YouTube videos and Wikipedia) can assist in maintaining learners’ reflections on experiences and apps can offer access to knowledge which can assist abstract conceptualization.

Bullock and Webb (2015) further cite the impact of technology on Eraut’s theory of informal learning in the work-place as being either implicit, reactive or deliberative. In this study, the so-called work-place refers to the University environment. Learning from social media is regarded as being implicit learning; reactive learning is opportunistic, often occurring in the middle of an action such as accessing the tablet “to view content and determine anatomical positions realistically (Participant 3; female).” Deliberate learning is regarded as having a goal and a set time (Eraut, 2004) where the learner clearly thinks about their actions such as accessing lecture notes for study purposes. Students reported that the immediate access to information enhanced in-class understanding of content ("...the tablet enables me to combine what I learn in the class..."
with what I see and it makes me able to know the exact locations of certain important structures”).

The qualitative data in this study corroborates the views expressed by Rossing et al. (2012) particularly student responses in the themes of mobile device engagement and advantages of mobile devices.

The growing number of websites and databases further facilitate the ease with which students can “download certain books and videos using my tablet and so it has made accessing anatomy related content more convenient.” Some students were motivated enough to access additional anatomical content via web-based learning such as E-books, Drug Guides, Essential Anatomy 2, Visual Anatomy supporting the deliberative aspect of informal learning.

Hafferty (1998) defines the informal mobile curriculum as those practices that “targets learning at the level of interpersonal interactions.” Such interpersonal interactions can be found in modern anatomy curricula in learning spaces such as anatomy laboratories where students access their tablets. The deliberate engagement with the tablets in this setting allows students to access notes, videos, e-books and software applications which provide interactive visual information to augment their learning. The touch screen capabilities of the tablet allows students to enlarge or rotate images with ease, thereby making learning more hands on. Further, they provide visual representations of anatomy that more closely resemble the structures in the human body. This is especially beneficial in those programs in the field of health sciences that do not possess anatomy laboratories as a component of their curriculum; hence anatomy applications may be a useful resource for augmenting student learning.
This study’s findings (“…since the tablet is portable, I am able to view lecture slides more frequently”) support the literature that recommends that today’s students desire and benefit from “anywhere, anytime” learner participation. The literature suggests that mobile learners desire the ability and flexibility to choose their location and time for learning. As reported by this study, learners were allocated their own tablets; therefore they had the option of using it for personal purposes; thus supporting Ellaway’s (2014) logistical category of mobile device activity. Students largely accessed their tablets on campus as they experienced problems accessing wireless connectivity at home. The Failure of wifi connectivity leads to disenchantment with mobile devices (“…there is no wifi”) and severely hampers the learning process.

Some learners also felt that physical dissection provided the best method of learning anatomy (30.9%), corroborating the views of authors such as McLachlan et al. (2004) and McLachlan and Patten (2006) despite the implementation of the newer technology; whilst some students felt that the provision of the tablet had no effect at all on their learning (6.7%).

In order to maximize the benefit of mobile tablets, educators must carefully adapt the technology to specific learning goals and outcomes. Educators must not assume that students are prepared for new technologies and need to gauge student’s level of knowledge and comfort with new technological devices. It is essential to devote classroom time to students to acclimate to these new devices.

CONCLUSION

Mobile computing devices have been rapidly adopted by medical learners worldwide, including those at our university as illustrated by this pilot study and it seems likely that their presence will
soon be ubiquitous. This study offers a unique South African perspective which has the possibility to enhance learning, but also has potential problems associated with its use. We can conclude from our study that integrating tablets into Higher Education anatomy classes had a positive effect on student access to course material. In a subject already utilising active learning through traditional methods the addition of technology via quizzes, 3D visual material and access to the internet could be an alternative method of engaging students in the learning process. Students are seizing opportunities of learning anywhere, anytime due to the portability of their mobile devices.

Limitations and implications for future research

Firstly, this study is limited by the exclusive use of the Proline 7” android tablet. Additional research is necessary to incorporate the use of other branded technological devices such as the Apple iPad.

Secondly, as this study used purposive sampling, the results may be limited by the nature of the population and cannot be generalized to account for student experiences with other academic courses offered. Additional research is necessary to isolate disciplinary strengths and weaknesses.

Thirdly, students in graduate programs such as those registered for medical degrees are expected to be self-directed learners who have the ability to locate resources to supplement their learning. This could be a motivating factor for students to use their tablets for learning outside of the classroom. Further studies are necessary to determine whether mobile devices such as the tablet have an impact on academic performance, assessments and whether they encourage self-directed
learning. Additional studies are warranted to determine the effect of tablet technology on examination performance.

Fourthly, there should be no compromise in students having access to the material they are promised; university administrators should ensure that provisions are made for technological support in places such as living residences have wifi access points for students to utilize at their convenience. As mobile technology continues to grow and develop, universities cannot be caught with a wireless infrastructure incapable of handling the demand for connectivity.

TABLES

Table 1: Demographic profile of the study respondents (n=179)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>60 (33.5)</td>
</tr>
<tr>
<td>Female</td>
<td>119 (66.5)</td>
</tr>
<tr>
<td>Population Groups</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>138 (77.1)</td>
</tr>
<tr>
<td>Indian</td>
<td>26 (14.5)</td>
</tr>
<tr>
<td>White</td>
<td>6 (3.4)</td>
</tr>
<tr>
<td>Coloured</td>
<td>9 (5.0)</td>
</tr>
<tr>
<td>Socio-economic status</td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>62 (34.6)</td>
</tr>
<tr>
<td>Peri-urban</td>
<td>46 (25.7)</td>
</tr>
<tr>
<td>Rural</td>
<td>71 (39.7)</td>
</tr>
</tbody>
</table>
Table 2: Responses to close ended questions according to gender, population groups and socio-economic status

<table>
<thead>
<tr>
<th>*Question</th>
<th>No Comment</th>
<th>Yes</th>
<th>No</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Did you have access to a tablet prior to receiving the current one?</td>
<td>0.6, 0.6, 0.6, 0.6</td>
<td>4.3, 20.1, 9.5, 9.5</td>
<td>28.5, 46.4, 66.5, 5.0</td>
<td>0.020, 0.000, 0.000, 0.000</td>
</tr>
<tr>
<td>P Value</td>
<td>0.065</td>
<td></td>
<td></td>
<td>0.024</td>
</tr>
<tr>
<td>3. Were you familiar with the visual learning programme prior to the provision of the tablet?</td>
<td>0.6, 1.1, 1.8</td>
<td>14.5, 33.5, 31.3, 11.7</td>
<td>18.4, 31.8, 43.6, 2.8</td>
<td>0.017, 0.001, 0.001, 0.001</td>
</tr>
<tr>
<td>P Value</td>
<td>0.701</td>
<td></td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td>4. What do you frequently use the tablet for?</td>
<td>0.6, 0.6, 1.1, 0.6</td>
<td>10.6, 26.8, 29.1, 6.1</td>
<td>1.1, 2.8, 2.2, 1.1</td>
<td>0.342</td>
</tr>
<tr>
<td>P Value</td>
<td>0.938</td>
<td></td>
<td></td>
<td>0.412</td>
</tr>
<tr>
<td>5. How often do you use the tablet to access anatomy-related content?</td>
<td>0.6, 0.6, 1.1, 0.6</td>
<td>6.1, 15.6, 18.4, 1.1</td>
<td>7.8, 16.8, 17.3, 4.5</td>
<td>0.099</td>
</tr>
<tr>
<td>P Value</td>
<td>0.938</td>
<td></td>
<td></td>
<td>0.328</td>
</tr>
<tr>
<td>6. Which of the following do you most frequently access via your tablet?</td>
<td>1.1, 1.1, 1.1, 0</td>
<td>29.6, 62.0, 71.5, 11.7</td>
<td>1.7, 1.7, 2.2, 1.1</td>
<td>0.093</td>
</tr>
<tr>
<td>P Value</td>
<td>0.938</td>
<td></td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td>7. Which method of studying anatomy do you find most beneficial to you?</td>
<td>2.2, 4.5, 0.6, 0.6</td>
<td>6.7, 15.1, 3.4</td>
<td>24.0, 6.9, 10.6, 2.2</td>
<td>0.093</td>
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<tr>
<td>P Value</td>
<td>0.938</td>
<td></td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td>8. Where do you generally use your tablet?</td>
<td>24.6, 36.3, 60.0, 5.6</td>
<td>7.8, 27.4, 21.2, 8.9</td>
<td>0, 1.1, 0.6</td>
<td>0.093</td>
</tr>
<tr>
<td>P Value</td>
<td>0.938</td>
<td></td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td>9. Do you have internet access at home?</td>
<td>5.6, 35.5, 6.1, 12.3</td>
<td>27.9, 19.6, 17.4, 2.2</td>
<td>7.8, 17.9, 19.6, 5.0</td>
<td>0.093</td>
</tr>
<tr>
<td>P Value</td>
<td>0.938</td>
<td></td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td>10. Has the tablet made accessing anatomy-related content more convenient for you?</td>
<td>1.1, 5.6, 5.6, 0.6</td>
<td>24.6, 43.0, 51.4, 8.9</td>
<td>7.8, 17.9, 19.6, 5.0</td>
<td>0.093</td>
</tr>
<tr>
<td>P Value</td>
<td>0.938</td>
<td></td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td>12. What do you consider most beneficial to you?</td>
<td>No Comment</td>
<td>3.4</td>
<td>5.6</td>
<td>6.7</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>-----------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>A : Live streaming of lectures and practical's only</td>
<td>1.1</td>
<td>0.6</td>
<td>1.7</td>
<td>0</td>
</tr>
<tr>
<td>B : Physical attendance to lectures and practical's only</td>
<td>0.6</td>
<td>1.1</td>
<td>1.1</td>
<td>0.6</td>
</tr>
<tr>
<td>C : Live streaming of lectures AND physical attendance to lectures and practical's</td>
<td>11.7</td>
<td>19.6</td>
<td>27.9</td>
<td>2.8</td>
</tr>
<tr>
<td>D : Access of anatomy-related study material only, i.e. lecture notes</td>
<td>1.1</td>
<td>1.1</td>
<td>1.7</td>
<td>0.6</td>
</tr>
<tr>
<td>E : Live streaming of lectures AND access of anatomy-related study material, i.e. lecture notes</td>
<td>2.8</td>
<td>5.0</td>
<td>3.4</td>
<td>2.8</td>
</tr>
<tr>
<td>F : Physical attendance of lectures and practical's AND access of anatomy-related study material i.e. lecture notes</td>
<td>12.8</td>
<td>33.5</td>
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<td>6.1</td>
</tr>
<tr>
<td><strong>P Value</strong></td>
<td>0.708</td>
<td>0.320</td>
<td>0.000</td>
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</table>

<table>
<thead>
<tr>
<th>13. In addition to the provision of the tablet, do you still record notes during the lecture?</th>
<th>No Comment</th>
<th>1.7</th>
<th>0.6</th>
<th>1.7</th>
<th>0.6</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>1.1</th>
<th>0</th>
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</thead>
<tbody>
<tr>
<td>Yes</td>
<td>16.2</td>
<td>43.6</td>
<td>14.2</td>
<td>12.8</td>
<td>2.8</td>
<td>3.9</td>
<td>0</td>
<td>25.1</td>
<td>14.5</td>
<td>20.1</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>15.6</td>
<td>22.3</td>
<td>34.6</td>
<td>1.1</td>
<td>0.6</td>
<td>1.1</td>
<td>0.6</td>
<td>8.4</td>
<td>11.2</td>
<td>17.9</td>
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<tr>
<td><strong>P Value</strong></td>
<td>0.032</td>
<td>0.014</td>
<td>0.116</td>
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<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>15. Does the provision of the tablet affect your attendance to lectures and practical's?</th>
<th>No Comment</th>
<th>4.5</th>
<th>2.8</th>
<th>4.5</th>
<th>2.2</th>
<th>0.6</th>
<th>0</th>
<th>0</th>
<th>3.4</th>
<th>1.7</th>
<th>2.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>2.8</td>
<td>5.6</td>
<td>7.3</td>
<td>0.6</td>
<td>0</td>
<td>0.6</td>
<td>0</td>
<td>2.2</td>
<td>3.4</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>26.3</td>
<td>57.5</td>
<td>64.2</td>
<td>11.7</td>
<td>2.8</td>
<td>4.5</td>
<td>0.6</td>
<td>28.5</td>
<td>20.7</td>
<td>34.1</td>
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<td>0.752</td>
<td>0.867</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Questions numbered according to Questionnaire (Appendix A)
Table 3: User engagement of learners with tablets by gender groups (n=179)

<table>
<thead>
<tr>
<th>Activity Group</th>
<th>Male (%)</th>
<th>Female (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Email</td>
<td>5.0</td>
<td>11.2</td>
<td>16.2</td>
</tr>
<tr>
<td>Web-browsing</td>
<td>26.2</td>
<td>50.8</td>
<td>77</td>
</tr>
<tr>
<td>Time-keeping</td>
<td>0.6</td>
<td>-</td>
<td>0.6</td>
</tr>
<tr>
<td>Personal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Media</td>
<td>0.6</td>
<td>1.1</td>
<td>1.7</td>
</tr>
<tr>
<td>Social Videos</td>
<td>3.4</td>
<td>5.0</td>
<td>8.4</td>
</tr>
<tr>
<td>Gaming</td>
<td>1.7</td>
<td>5.6</td>
<td>7.3</td>
</tr>
<tr>
<td>Learning Tools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accessing notes</td>
<td>29.6</td>
<td>62.0</td>
<td>91.6</td>
</tr>
<tr>
<td>Alteration of Documents</td>
<td>10.1</td>
<td>16.2</td>
<td>26.3</td>
</tr>
<tr>
<td>Learning content</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug guides</td>
<td>1.1</td>
<td>0.6</td>
<td>1.7</td>
</tr>
<tr>
<td>Anatomy E-books&amp; software applications</td>
<td>1.7</td>
<td>4.5</td>
<td>6.2</td>
</tr>
</tbody>
</table>
Contributors

All three authors are justifiably credited with authorship, according to the authorship criteria. In detail: LL collection, analysis and interpretation of data, drafting the article and final approval of the version to be published. RS: analysis and thematic development, revising the article and final approval of the version to be published. KSS: revising the article and final approval of the version to be published.

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Competing Interests

We have read and understood BMJ policy on declaration of interests and declare that we have no competing interests.

Ethical approval

Ethics approval was obtained from the Biomedical Research and Ethics Committee of the University of KwaZulu Natal (Ethics number BE386/15).

Data Sharing statement

No additional data are available.
References


APPENDIX
TABLET TECHNOLOGY IN MEDICAL EDUCATION

The purpose of this survey is to provide faculty with information about whether you utilize mobile devices as they relate to your studies in the Anatomy Program. This survey is for general program development and is voluntary. However, your participation is greatly appreciated and will be useful in course planning, development and improvement. Please mark with a tick where appropriate

Age: ____________

Sex:  M  F

<table>
<thead>
<tr>
<th>Population Group:</th>
<th>Black African</th>
<th>White</th>
<th>Indian</th>
<th>Coloured</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Socio-Economic Background</th>
<th>Urban</th>
<th>Peri-urban</th>
<th>Rural</th>
</tr>
</thead>
</table>

1. When did you receive your tablet? _______________________________________________

2. Did you have access to a tablet prior to receiving the current one?
   Yes
   No

3. Were you familiar with the visual learning programme prior to the provision of the tablet?
   Yes
   No

4. What do you frequently use the tablet for? (Please cross the most applicable option)
   Academic
   Personal
   Academic and personal
   Other

5. How often do you use the tablet to access anatomy-related content? (Please cross the most applicable option)
   Everyday
   Twice a week
   More than three times a week
   Once in two weeks
   Other

6. Which of the following do you most frequently access via your tablet? (Please cross the most applicable option)
   Lecture notes
   The actual lecture
   Demonstration of prosected specimens

7. Which method of studying anatomy do you find most beneficial to you? (Please cross the most applicable option)
   Visual aid (learning via the tablet)
   Physical dissection and viewing of prosected specimens

7.1 Please explain your preferred choice:
_____________________________________________________________________
_____________________________________________________________________

29
8. How does the use of the tablet for the access of anatomy-related content assist with your clinical skills?
_________________________________________________________________________
_________________________________________________________________________

9. Where do you generally use your tablet? (Please cross the most applicable option)
   At campus
   At home
   At hospital during ward rounds
9.1 Please explain the reason for the selected location?
________________________________________________________________________________

10. Do you have internet access at home?
    Yes
    No
10.1 How does this affect the usage of your tablet to access anatomy-related content?
________________________________________________________________________________

11. Has the tablet made accessing anatomy-related content more convenient for you?
    Yes
    No
11.1 Please elaborate about your choice
________________________________________________________________________________

12. What do you consider most beneficial to you? (Please cross the most applicable option)
    Live streaming of lectures and practical's only
    Physical attendance to lectures and practical's only
    Live streaming of lectures AND physical attendance to lectures and practical's
    Access of anatomy-related study material only, i.e. lecture notes
    Live streaming of lectures AND access of anatomy-related study material, i.e. lecture notes
    Physical attendance to lectures and practical's AND access of anatomy-related study material, i.e. lecture notes

13. In addition to the provision of the tablet, do you still record notes during the lecture?
    Yes
    No

14. What applications do you most frequently use on your tablet? (Please list in order of preference)
    1. _______________________________
    2. _______________________________
    3. _______________________________

15. Does the provision of the tablet affect your attendance to lectures and practical’s?
    Yes
    No
**Tablet technology in medical education in South Africa: a mixed methods study**

<table>
<thead>
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<th>Journal:</th>
<th>BMJ Open</th>
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<td>Date Submitted by the Author:</td>
<td>25-Jan-2017</td>
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| Complete List of Authors: | Lazarus, Lelika; University of KwaZulu-Natal College of Health Sciences, Clinical Anatomy  
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 Satyapal, Kapil; University of KwaZulu-Natal College of Health Sciences, Clinical Anatomy; University of KwaZulu-Natal College of Health Sciences, Clinical Anatomy |
| **Primary Subject Heading:** | Medical education and training |
| **Secondary Subject Heading:** | Medical education and training, Qualitative research, Communication |
| **Keywords:** | communication, tablet, Information technology < BIOTECHNOLOGY & BIOINFORMATICS, Anatomy < BASIC SCIENCES, MEDICAL EDUCATION & TRAINING, electronic devices |
# TITLE PAGE

**Title**: Tablet technology in medical education in South Africa: a mixed methods study

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**Total number of figures**: 0

**Total number of tables**: 2

**Type of article**: Original communication

**Running headline**: The use of tablet technology in medical education

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ABSTRACT

Objective: The purpose of this study was to establish the use of mobile devices by learners at a selected medical school. Distribution of mobile devices was an inaugural initiative implemented by our College.

Design: A mixed methodology design using a questionnaire comprising both open and close ended questions was analysed from 179 (60 male; 119 female) second year medical students registered for the Anatomy course. Open-ended questions were analysed using a thematic approach by identifying emergent ideas and concepts. Close-ended questions were analysed using SPSS version 21.0.

Setting and participants: Second year medical students at a medical school in South Africa.

Results: Three main themes emerged viz. (i) mobile device engagement, (ii) advantages and (iii) challenges affecting use of mobile devices. A majority of learners accessed their tablets for lecture notes; more females were inclined to access these devices than males. Challenges experienced included poor wifi connectivity on and off University campus; some students were not keen on the idea of mobile devices and preferred traditional methods of teaching.

Conclusions: Mobile devices have been adopted by learners at our University. Uses of technology outlined are related to Eraut’s intentions of informal learning. Integrating tablets into classes had a positive effect on student access to course material.

Strengths and limitations of this study

- The adoption of innovative technology into University classrooms has changed several features of our teaching approaches.
• This study examined the use of mobile devices by learners at a selected medical school.

• Sampling was purposive; research was limited to a single cohort of second year medical degree students. An element of response bias cannot be excluded as a large part of the sample was comprised of female respondents.

• Students engage with tablets for learning and uses unrelated to the discipline.

• University administrators should make provisions for technological support to students.
TEXT

INTRODUCTION

The last decade has seen the introduction of new technology which has transformed many aspects of our culture, commerce, communication and education. Mobile computing devices such as tablets, iPhones and the iPad have been swiftly implemented in many countries resulting in access to information in ways that were not possible before. This article begins with a brief description of mobile learning and it is proposed that the growing use of mobile technology at universities is the most current trend forcing educators to evaluate its merits.

Mobile learning is defined as “any type of learning that takes place in learning environments and spaces that take account of the mobility of technology, mobility of learners and mobility of learning.” As mobile technology develops, it creates new opportunities for enhancing the learning experience of students at all levels of education. Cobcroft et al. (2006) reported that “mobile technologies are able to support learners’ engagement in creative, collaborative, critical and communicative learning activities.” Traxler (2007) further emphasized that mobile learning offers a unique opportunity to support learning that is personalized, authentic and situated thus facilitating a wide variety of teaching methods. The growing use of mobile technology at Colleges and Universities is the most current trend forcing educators to evaluate its merits and the College of Health Sciences (CHS) at our University has implemented a Visual Learning Project and over 1400 health science students have received new Proline Tablet PCs. This technology was the first in South Africa to provide such a platform to stream live lectures, and record lectures for later on-demand viewing. According to the Information Technology Department at the university, “the live lecture streaming incorporates an interactive classroom, where students can ask the lecturer questions electronically, and students can respond to
questions, surveys and polls from their seats in the lecture room, or from a remote location. College management said this new solution opened up exciting opportunities that could even allow international lecturers to lecture to the student population. The new technology would allow lecturers to reach the more remote areas of the university community; proving especially beneficial to CHS students when fulfilling the clinical service requirements of their degrees.” (UKZN website; accessed 21 July 2016)\(^6\). Mobile learning presents students and faculty with a unique opportunity to access information instantaneously, regardless of location\(^7\).

The main advantages of using tablet technology embrace the following perceptions viz. using software applications to enhance creativity, critical thinking and encouraging greater interaction among students and faculty\(^8\). The benefits of using the tablet have also included a reduction in the amount of paper used and a reduction in textbook costs as students have opted for electronic versions of the text. Engagement with tablet-pcs in academic programmes creates a positive educational experience\(^9\). Miller (2012)\(^10\) reported that not only do tablet-pcs have applications that serve as study aides and productivity tools for students, but students are also able to use “apps” to help create flashcards for studying, including retrieving and editing documents on “Google Docs” for assignments. There are hundreds and thousands of applications, some free and some requiring paid subscriptions. These applications are available in a wide range of categories and are tailored for specific medical disciplines such as Medscape, Medical Tools, Gray’s Anatomy-Atlas, Medical Abbreviations, Harrison’s Manual of Medicine, Anatomy Learning-3D Atlas, MediApp, Resuscitation, iGyno and O&G App. Further, some authors elaborate that the design of tablet-pcs combines e-reading capabilities with web-browsing, plus an assortment of applications that facilitate the integration of information by making information conveniently available, including creating a richer set of course notes\(^11\,12\).
Ellaway (2014) categorized mobile use by medical learners into four groups viz. (i) logistics (when learners use their devices for personal information management such as email and texting); (ii) personal (when learners use their devices for social and entertainment purposes such as social media and gaming; (iii) learning tools (when learners use their devices for undertaking learning tasks such as note taking and (iv) learning content (when learners use their devices as a source of information such as checking drug interactions. This categorization will used a framework to represent data later on in this paper.

Anatomy in Higher Education

Anatomy is an integral part of any medical degree. Within anatomy programmes, students are required to construct a comprehensive and sophisticated understanding of basic anatomy, and then apply that information to clinical care. Anatomy requires students to learn a large volume of ancient languages and functions including muscle names, origins, insertions, joint, connective tissue and cellular, micro and gross anatomy. Traditionally, students use a rote or surface learning approach and have stated that anatomy is “boring, hard, dull” in previous literature.

The nature of anatomical education has transformed substantially over the past decade due to both a new generation of students who learn differently from those of the past and the explosion of advances in anatomical imaging and programing. Medical students of today are products of the “interactive generation”. Millennial generation learners (sometimes referred to as digital natives) are defined as individuals whose development has been infused with technology and these individuals possess extensive experience with digital exploration, gaming and communication and are claimed to be adept with user-friendly digital devices.
Anatomy teaching in medical schools has been traditionally based around the use of human cadaveric specimens, either taking the whole body specimens for complete dissection or as prosected specimens\textsuperscript{20}. The debate on teaching via the conventional pedagogy of cadaveric dissection versus the computer and more innovative modalities has raged on for the last decade\textsuperscript{21}. Those who advocate retaining this traditional learning exercise (the so called “traditionalists”) cite the value of the cadaver experience\textsuperscript{22-24}. Those who see the practice as redundant defend their position by pointing to recent technological advancements (the so called “modernists”)\textsuperscript{25-27}.

At our University cadaver-based learning includes the actual dissection of cadavers by medical students under the supervision of qualified instructors and the study of prosected specimens where individual structures in the human body have been dissected and displayed by skilled dissectors.

It is with this literature review in mind that the research questions addressed in this study are:

- What is the extent to which medical trainees use their mobile devices?

- What kinds of information are being accessed generally and specifically with reference to anatomical education?

\textbf{AIM}

The purpose of this exploratory study was to establish how learners at a selected medical school use their mobile devices since this was a unique initiative implemented by the College.
MATERIALS AND METHODS

Design

A mixed methodology research design integrating both quantitative and qualitative approaches was chosen to guide our enquiry to generate the data required to meet the aims of this study.

Context and Participants

The study sought to explore how learners at a selected medical school use their mobile devices. The second year class was comprised of a total of 257 medical students registered for the Anatomy course. Of these only 179 students (60 male; 119 female) chose to participate in this study (69.6% response rate). Teaching sessions are comprised of lectures in various anatomical structural themes (x 5 per annum), each of which are conducted over an 8-week period, comprising a total of 49 hours of lectures and 197 hours of practical sessions.

Students were informed about the study and their consent was duly taken for their voluntary and anonymous participation. Any chance of participant bias was eliminated by clearly explaining the objective of the study while obtaining their informed consent. There were no specific exclusion criteria and no participants withdrew from the study. Ethical approval was obtained from the University Biomedical Research Ethics Committee (BE386/15).

Instrumentation (Appendix A)

A survey questionnaire containing structured and free response items was used in this study to obtain both quantitative and qualitative information regarding student use of their mobile device. Questions 1 and 2 asked all respondents about their prior exposure to mobile devices. Question 3
focused on student knowledge of participation in the College project. Questions 4-9 concentrated on type, frequency and location of usage of the tablets, including the preferred method of learning anatomy. Question 10 covered internet connectivity. Questions 11-13 and 15 asked respondents about their views pertaining to the use of the tablet in accessing anatomy content. Question 14 asked a general question related to applications accessed by students.

Data Analysis

The questionnaire was administered to students before class and they were allocated twenty minutes for completion. The open ended questions were analysed by two of the authors (LL and RS) using a thematic approach to identify emergent ideas and concepts expressed by participants. Key words, phrases and/or descriptions from the participants were documented, as the authors reflexively engaged with the data. Convergence and divergence of data were noted, leading to the development of preliminary emergent themes. The themes were further interrogated and developed with reference to participants’ original words while also including the authors’ collective interpretations. The close ended questions were statistically analysed using the SPSS version 21.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data for comparison of categorical variables was tested using the Pearson’s Chi-squared test ($X^2$) to compute frequency tables and descriptive statistics. A $p$ value of $<0.05$ was considered to be statistically significant.
RESULTS

a) Sample demographics

There were 179 respondents with a sex distribution of 60 male and 119 female students and a population grouping of 137 Black, 26 Indian, 6 White and 9 Coloured participants [The term “Coloured” is an historical throwback from the apartheid racial classification which remains in the post-1994 democratic era to assist the current government in seeking restitution for various disadvantaged groupings. The term “Coloured” refers to a group of heterogeneous people, who may be more or less accurately described as ‘mixed-race’ (https://welections.wordpress.com28; Accessed 24 January 2017)]. Students also indicated their socio-economic background viz. urban 62, peri-urban 46 and rural 71 (Table 1). The average age of respondents was 20.2 years with a range between 18-28 years.

b) Quantitative results

Significant p-values (highlighted) were recorded for the different categorical variables according to sex, population groups, and socio-economic status (Table 2). The majority of students came from a rural background (39.7%) and these students indicated that they had no prior exposure to a tablet device prior to receiving the current one as part of their course (38%). A statistically significant difference (p<0.020) was obtained for the comparison of sex with students having prior access to a tablet. Comparisons for the different population groups (p<0.000) and socio-economic status (p<0.000) also yielded statistically significant results when this parameter was compared to students having prior access to a tablet. The majority (43.6%) of Black students were not aware of the Visual Learning Project and a statistically significant result (p<0.024) was obtained when population groups were compared with the level of student awareness of the
Visual Learning Project. A total of 35.8% of female students indicated that they used the tablet for both academic and personal reasons compared to 21.2% of male students. Overall, females tended to access their tablets for anatomy related content more often when compared to their male counterparts (Table 2) which yielded a statistically significant p value (p<0.017). A total of 37.4% of students from rural backgrounds used the tablet to access lecture notes and a statistically significant value of p<0.000 was obtained when socio-economic status was compared with the latter parameter. A total of 24% of male students reported that they found physical dissection more beneficial in the study of anatomy as opposed to female students who preferred visual aids (15.1%). A total of 62% of female students reported that they accessed the tablets for lecture notes; these students also indicated that they accessed their tablets whilst on campus (36.3%). However, 17.4% of African students reported a lack of internet access at home (p<0.000 when population groups were correlated with internet availability). A total of 43% of female students indicated that the tablet made accessing anatomy-related content more convenient for them. A majority of female students (33.5%) reported that they found access to anatomy-related study material i.e. lecture notes via the tablet beneficial to them versus 29.6% of male students who accessed the tablet for a similar purpose. Despite having the tablet, female students still recorded lecture notes during classroom time (43.6%). Statistically significant correlates were recorded for sex (p<0.032) and population groups (p<0.014) versus traditional note taking. A total of 83.8% of students indicated that provision of the tablet did not affect their attendance (57.5% female and 26.3% male) (Table 2).

c) Qualitative results

The following themes emerged from the data viz.

i. Mobile device engagement
ii. Advantages of mobile devices

iii. Challenges affecting use of mobile devices

iv. Miscellaneous use

i. Mobile device engagement

Learners listed a number of uses in their engagement with mobile devices. These uses have been categorised according to Ellaway’s (2014) four activity groups as outlined in the Introduction of this paper (Table 3) as follows:

- **Logistics:** Students reported the use of the tablet to access emails (16.2%) and browse the web (77%) using internet sites such as Firefox and Google, supporting

- **Personal:** Students also accessed social media such as Facebook (1.7%), social videos (8.4%) and games (7.3%).

- **Learning tools:** A large majority of the students accessed the tablet for lecture notes (91.6%) whilst 26.3% of learners used applications such as WPS Office to alter documents.

- **Learning content:** Students also accessed sites for drug guidelines such as Medscapes (1.7%) and 6.2% accessed Anatomy e-books such as Netter’s Interactive, Drake’s Grey’s Anatomy and software applications such as Essential Anatomy 2 and Visual Anatomy for learning content and expressed that they learnt better by watching anatomy videos on the tablet as anatomical specimens are clearer in the videos and enabled them to understand the content.

Students also mentioned that the tablet allowed them to learn at their own pace (21.2%).
“*The visual part, the one I use with the tablet enables me to combine what I learn in the class with what I see and it makes me able to know the exact locations of certain important structures.*” (Participant 1; male) (Count =31)

**ii. Advantages of mobile devices**

Participants listed a number of advantages associated with the use of mobile tablets such as portability (6.7%) allowing students the opportunity of accessing information on campus and allowing them to revise at home, access to information on the internet (22.9%) and research areas of course content that were not covered in the lectures (9.5%).

“*With visual aids, I can access the slides and videos anytime*” (Participant 33; female) (Count=63)

Respondents also mentioned the value of utilizing dissection as well as visual aids in the learning of anatomy (17.3%).

“*Tablet enables one to combine what is learnt in lectures with structures in the DH*” (Participant 21; female) (Count=6)

**iii. Challenges affecting use of mobile devices**

Respondents reported on some of the challenges they experienced with the use of the tablet such as having no wifi access outside of campus (64.2%) as well as poor wifi access on campus (12.3%).

“I do not have access to the internet at home” (Participant 4; female) (Count=122)

Some also considered that learning from the tablet did not improve their understanding of anatomy (3.4%) and felt that learning from the cadaver was easier (60.3%) as opposed to the tablet.
“The tablet does not provide visual aids of real specimens, just lecture slides. Looking at real specimens helps orientate oneself and get a three dimensional understanding.” (Participant 70; female) (Count=103)

Respondents also reported on the lack of anatomy related content being posted on the university website (3.4%).

“There are no resources for Anatomy in the UKZN Tube.” (Participant 2; male) (Count=4)

iv. Miscellaneous use

Participants also used their devices for private use such as a camera (3.4%) and as a media player (6.1%). Some respondents stated that the tablet has no effect on their leaning at all (11.2%).

DISCUSSION

In conducting this exploratory investigation into student perceptions of Tablet usage, it was found that there are many issues to consider when using this technology in practice. The results from this study reveal that students are using mobile devices for both academic as well as private purposes outside of the classroom. According to Yau and Leung (2016) sex differences account for one of the factors affecting students’ use of technology. In this study, females were inclined to use their tablets more often than males which was statistically significant (Question 5, Table 2). These results concur with that reported by Yau and Leung (2016) but differ from Kekkonen-Moneta and Moneta (2002); the latter authors suggested that tablet technology use is a more dominant activity for male students. McNulty (2006) and (2009) demonstrated that although students may be familiar with Web-based educational resources, medical student usage of Web-based computer aided instruction is related to sex, learning styles and personality.
The majority of students (91.6%) accessed their tablets for lecture notes. These lectures define a range of content available for Web access, ranging from text files to audio or video-enhanced presentations to captured video lectures. According to Chan and Pawlina (2015)\textsuperscript{33}, lecture capture records an instructor’s presentation as it is delivered live in the classroom, as is the scenario at our university. Lecture capture is regarded as an effective review tool for students provided that the lecture is well presented. More than any previous mobile learning technology, tablets provide students with immediate and far reaching access to information, course resources and real world application of knowledge\textsuperscript{12}. 

The educational practice of technology can be associated with learning theories\textsuperscript{34}. The various uses of mobile learning can be associated with the different stages in Kolb’s learning cycle\textsuperscript{35}. For example, accessing the tablet for related lecture notes in the dissecting hall provides an opportunity to practice skills, social media (such as YouTube videos and Wikipedia) can assist in maintaining learners’ reflections on experiences and apps can offer access to knowledge which can assist abstract conceptualization\textsuperscript{34}. 

Bullock and Webb (2015)\textsuperscript{34} further cite the impact of technology on Eraut’s theory of informal learning in the work-place as being either implicit, reactive or deliberative. In this study, the so-called work-place refers to the University environment. Learning from social media is regarded as being implicit learning; reactive learning is opportunistic, often occurring in the middle of an action such as accessing the tablet “to view content and determine anatomical positions realistically (Participant 3; female).” Deliberate learning is regarded as having a goal and a set time (Eraut, 2004)\textsuperscript{36} where the learner clearly thinks about their actions such as accessing lecture notes for study purposes. Students reported that the immediate access to information enhanced in-class understanding of content (“….the tablet enables me to combine what I learn in the class
with what I see and it makes me able to know the exact locations of certain important structures”).

The qualitative data in this study corroborates the views expressed by Rossing et al. (2012) particularly student responses in the themes of mobile device engagement and advantages of mobile devices.

The growing number of websites and databases further facilitate the ease with which students can “download certain books and videos using my tablet and so it has made accessing anatomy related content more convenient.” Some students were motivated enough to access additional anatomical content via web-based learning such as E-books, Drug Guides, Essential Anatomy 2, Visual Anatomy supporting the deliberative aspect of informal learning.

Hafferty (1998) defines the informal mobile curriculum as those practices that “targets learning at the level of interpersonal interactions.” Such interpersonal interactions can be found in modern anatomy curricula in learning spaces such as anatomy laboratories where students access their tablets. The deliberate engagement with the tablets in this setting allows students to access notes, videos, e-books and software applications which provide interactive visual information to augment their learning. The touch screen capabilities of the tablet allows students to enlarge or rotate images with ease, thereby making learning more hands on. Further, they provide visual representations of anatomy that more closely resemble the structures in the human body. This is especially beneficial in those programs in the field of health sciences that do not possess anatomy laboratories as a component of their curriculum; hence anatomy applications may be a useful resource for augmenting student learning.
This study’s findings (“…since the tablet is portable, I am able to view lecture slides more frequently”) support the literature that recommends that today’s students desire and benefit from “anywhere, anytime” learner participation. The literature suggests that mobile learners desire the ability and flexibility to choose their location and time for learning. As reported by this study, learners were allocated their own tablets; therefore they had the option of using it for personal purposes; thus supporting Ellaway’s (2014) logistical category of mobile device activity. Students largely accessed their tablets on campus as they experienced problems accessing wireless connectivity at home. The Failure of wifi connectivity leads to disenchantment with mobile devices (“…there is no wifi”) and severely hampers the learning process.

Some learners also felt that physical dissection provided the best method of learning anatomy (30.9%), corroborating the views of authors such as McLachlan et al. (2004) and McLachlan and Patten (2006) despite the implementation of the newer technology; whilst some students felt that the provision of the tablet had no effect at all on their learning (6.7%).

In order to maximize the benefit of mobile tablets, educators must carefully adapt the technology to specific learning goals and outcomes. Educators must not assume that students are prepared for new technologies and need to gauge student’s level of knowledge and comfort with new technological devices. It is essential to devote classroom time to students to acclimate to these new devices.

CONCLUSION

Mobile computing devices have been rapidly adopted by medical learners worldwide, including those at our university as illustrated by this pilot study and it seems likely that their presence will
soon be ubiquitous. This study offers a unique South African perspective which has the possibility to enhance learning, but also has potential problems associated with its use. We can conclude from our study that integrating tablets into Higher Education anatomy classes had a positive effect on student access to course material. In a subject already utilising active learning through traditional methods the addition of technology via quizzes, 3D visual material and access to the internet could be an alternative method of engaging students in the learning process. Students are seizing opportunities of learning anywhere, anytime due to the portability of their mobile devices.

**Limitations and implications for future research**

Firstly, this study is limited by the exclusive use of the Proline 7” android tablet. Additional research is necessary to incorporate the use of other branded technological devices such as the Apple iPad.

Secondly, as this study used purposive sampling, the results may be limited by the nature of the population and cannot be generalized to account for student experiences with other academic courses offered. Additional research is necessary to isolate disciplinary strengths and weaknesses.

Thirdly, students in graduate programs such as those registered for medical degrees are expected to be self-directed learners who have the ability to locate resources to supplement their learning. This could be a motivating factor for students to use their tablets for learning outside of the classroom. Further studies are necessary to determine whether mobile devices such as the tablet have an impact on academic performance, assessments and whether they encourage self-directed
learning. Additional studies are warranted to determine the effect of tablet technology on examination performance.

Fourthly, there should be no compromise in students having access to the material they are promised; university administrators should ensure that provisions are made for technological support in places such as living residences have wifi access points for students to utilize at their convenience. As mobile technology continues to grow and develop, universities cannot be caught with a wireless infrastructure incapable of handling the demand for connectivity.
### TABLES

#### Table 1: Demographic profile of the study respondents (n=179)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>60 (33.5)</td>
</tr>
<tr>
<td>Female</td>
<td>119 (66.5)</td>
</tr>
<tr>
<td><strong>Population Groups</strong></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>138 (77.1)</td>
</tr>
<tr>
<td>Indian</td>
<td>26 (14.5)</td>
</tr>
<tr>
<td>White</td>
<td>6 (3.4)</td>
</tr>
<tr>
<td>Coloured</td>
<td>9 (5.0)</td>
</tr>
<tr>
<td><strong>Socio-economic status</strong></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>62 (34.6)</td>
</tr>
<tr>
<td>Peri-urban</td>
<td>46 (25.7)</td>
</tr>
<tr>
<td>Rural</td>
<td>71 (39.7)</td>
</tr>
</tbody>
</table>
Table 2: Responses to close ended questions according to sex, population groups and socio-economic status

<table>
<thead>
<tr>
<th>Question</th>
<th>Incidence of Demographic factor (%)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Did you have access to a tablet prior to receiving the current one?</td>
<td>No Comment</td>
<td>0.020</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>0.000</td>
</tr>
<tr>
<td>3. Were you familiar with the visual learning programme prior to the provision of the tablet?</td>
<td>No Comment</td>
<td>0.065</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>0.096</td>
</tr>
<tr>
<td>4. What do you frequently use the tablet for?</td>
<td>No Comment</td>
<td>0.342</td>
</tr>
<tr>
<td></td>
<td>Academic</td>
<td>0.425</td>
</tr>
<tr>
<td></td>
<td>Personal</td>
<td>0.835</td>
</tr>
<tr>
<td>5. How often do you use the tablet to access anatomy-related content?</td>
<td>No Comment</td>
<td>0.017</td>
</tr>
<tr>
<td></td>
<td>Everyday</td>
<td>0.728</td>
</tr>
<tr>
<td></td>
<td>Twice a week</td>
<td>0.164</td>
</tr>
<tr>
<td></td>
<td>More than 3 times week</td>
<td>0.701</td>
</tr>
<tr>
<td></td>
<td>Once in two weeks</td>
<td>0.412</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>0.000</td>
</tr>
<tr>
<td>6. Which of the following do you most frequently access via your tablet?</td>
<td>No Comment</td>
<td>0.701</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td>0.412</td>
</tr>
<tr>
<td></td>
<td>Actual lecture</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Demo &amp; Practical</td>
<td>0.000</td>
</tr>
<tr>
<td>7. Which method of studying anatomy do you find most beneficial to you?</td>
<td>No effect</td>
<td>0.938</td>
</tr>
<tr>
<td></td>
<td>Visual aid</td>
<td>0.212</td>
</tr>
<tr>
<td></td>
<td>Physical dissection</td>
<td>0.491</td>
</tr>
<tr>
<td>9. Where do you generally use your tablet?</td>
<td>On Campus</td>
<td>0.093</td>
</tr>
<tr>
<td></td>
<td>Home</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>Hospital</td>
<td>0.082</td>
</tr>
<tr>
<td></td>
<td>Campus &amp; Home</td>
<td>0.000</td>
</tr>
<tr>
<td>10. Do you have internet access at home?</td>
<td>Yes</td>
<td>0.064</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>0.000</td>
</tr>
<tr>
<td>11. Has the tablet made accessing anatomy-related content more convenient for you?</td>
<td>No Comment</td>
<td>0.339</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>0.540</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>0.712</td>
</tr>
</tbody>
</table>
12. What do you consider most beneficial to you?

<table>
<thead>
<tr>
<th>Option</th>
<th>No Comment</th>
<th>3.4</th>
<th>5.6</th>
<th>6.7</th>
<th>1.7</th>
<th>0.6</th>
<th>0</th>
<th>0</th>
<th>2.8</th>
<th>1.1</th>
<th>5.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Live streaming of lectures and practical's only</td>
<td>1.1</td>
<td>0.6</td>
<td>1.7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.6</td>
<td>0</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>B: Physical attendance to lectures and practical's only</td>
<td>0.6</td>
<td>1.1</td>
<td>1.1</td>
<td>0.6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.6</td>
<td>1.1</td>
</tr>
<tr>
<td>C: Live streaming of lectures AND physical attendance to lectures and practical's</td>
<td>11.7</td>
<td>19.6</td>
<td>27.9</td>
<td>2.8</td>
<td>0</td>
<td>0.6</td>
<td>0</td>
<td>0</td>
<td>10.1</td>
<td>10.1</td>
<td>11.2</td>
</tr>
<tr>
<td>D: Access of anatomy-related study material only, i.e. lecture notes</td>
<td>1.1</td>
<td>1.1</td>
<td>1.7</td>
<td>0.6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.1</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>E: Live streaming of lectures AND access of anatomy-related study material, i.e. lecture notes</td>
<td>2.8</td>
<td>5.0</td>
<td>3.4</td>
<td>2.8</td>
<td>0.6</td>
<td>1.1</td>
<td>0</td>
<td>5.6</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>F: Physical attendance of lectures and practical's AND access of anatomy-related study material i.e. lecture notes</td>
<td>12.8</td>
<td>33.5</td>
<td>34.1</td>
<td>6.1</td>
<td>2.2</td>
<td>3.4</td>
<td>0</td>
<td>15.1</td>
<td>11.7</td>
<td>19.6</td>
<td></td>
</tr>
</tbody>
</table>

| P Value | 0.708 | 0.320 | 0.000 |

13. In addition to the provision of the tablet, do you still record notes during the lecture?

<table>
<thead>
<tr>
<th>Option</th>
<th>No Comment</th>
<th>1.7</th>
<th>0.6</th>
<th>1.7</th>
<th>0.6</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>1.1</th>
<th>0</th>
<th>1.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>16.2</td>
<td>43.6</td>
<td>14.2</td>
<td>12.8</td>
<td>2.8</td>
<td>3.9</td>
<td>0</td>
<td>25.1</td>
<td>14.5</td>
<td>20.1</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>15.6</td>
<td>22.3</td>
<td>34.6</td>
<td>1.1</td>
<td>0.6</td>
<td>1.1</td>
<td>0.6</td>
<td>8.4</td>
<td>11.2</td>
<td>17.9</td>
<td></td>
</tr>
</tbody>
</table>

| P Value | 0.032 | 0.014 | 0.116 |

15. Does the provision of the tablet affect your attendance to lectures and practical's?

<table>
<thead>
<tr>
<th>Option</th>
<th>No Comment</th>
<th>4.5</th>
<th>2.8</th>
<th>4.5</th>
<th>2.2</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>3.4</th>
<th>1.7</th>
<th>2.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>2.8</td>
<td>5.6</td>
<td>7.3</td>
<td>0.6</td>
<td>0</td>
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<td>2.2</td>
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<td>No</td>
<td>26.3</td>
<td>57.5</td>
<td>64.2</td>
<td>11.7</td>
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<td>20.7</td>
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| P Value | 0.144 | 0.752 | 0.867 |

*Questions numbered according to Questionnaire (Appendix A)
Table 3: User engagement of learners with tablets (n=179)

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<thead>
<tr>
<th>Activity Group</th>
<th>Male (%)</th>
<th>Female (%)</th>
<th>Total (%)</th>
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<tr>
<td><strong>Logistical</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Email</td>
<td>5.0</td>
<td>11.2</td>
<td>16.2</td>
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<tr>
<td>• Web-browsing</td>
<td>26.2</td>
<td>50.8</td>
<td>77</td>
</tr>
<tr>
<td>• Time-keeping</td>
<td>0.6</td>
<td>-</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Personal</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Social Media</td>
<td>0.6</td>
<td>1.1</td>
<td>1.7</td>
</tr>
<tr>
<td>• Social Videos</td>
<td>3.4</td>
<td>5.0</td>
<td>8.4</td>
</tr>
<tr>
<td>• Gaming</td>
<td>1.7</td>
<td>5.6</td>
<td>7.3</td>
</tr>
<tr>
<td><strong>Learning Tools</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Accessing notes</td>
<td>29.6</td>
<td>62.0</td>
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<tr>
<td>• Alteration of Documents</td>
<td>10.1</td>
<td>16.2</td>
<td>26.3</td>
</tr>
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<td><strong>Learning content</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Drug guides</td>
<td>1.1</td>
<td>0.6</td>
<td>1.7</td>
</tr>
<tr>
<td>• Anatomy E-books &amp; software applications</td>
<td>1.7</td>
<td>4.5</td>
<td>6.2</td>
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Contributors

All three authors are justifiably credited with authorship, according to the authorship criteria. In detail: LL collection, analysis and interpretation of data, drafting the article and final approval of the version to be published. RS: analysis and thematic development, revising the article and final approval of the version to be published. KSS: revising the article and final approval of the version to be published.

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Competing Interests

We have read and understood BMJ policy on declaration of interests and declare that we have no competing interests.

Ethical approval

Ethics approval was obtained from the Biomedical Research and Ethics Committee of the University of KwaZulu Natal (Ethics number BE386/15).

Data Sharing statement

No additional data are available.
References


APPENDIX

TABLET TECHNOLOGY IN MEDICAL EDUCATION

The purpose of this survey is to provide faculty with information about whether you utilize mobile devices as they relate to your studies in the Anatomy Program. This survey is for general program development and is voluntary. However, your participation is greatly appreciated and will be useful in course planning, development and improvement. Please mark with a tick where appropriate

Age: ____________

Sex:  M  F

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<tr>
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<th>White</th>
<th>Indian</th>
<th>Coloured</th>
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<table>
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<tr>
<th>Socio-Economic Background</th>
<th>Urban</th>
<th>Peri-urban</th>
<th>Rural</th>
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1. When did you receive your tablet? _______________________________________________

2. Did you have access to a tablet prior to receiving the current one?

   Yes

   No

3. Were you familiar with the visual learning programme prior to the provision of the tablet?

   Yes

   No

4. What do you frequently use the tablet for? (Please cross the most applicable option)

   Academic

   Personal

   Academic and personal

   Other

5. How often do you use the tablet to access anatomy-related content? (Please cross the most applicable option)

   Everyday

   Twice a week

   More than three times a week

   Once in two weeks

   Other

6. Which of the following do you most frequently access via your tablet? (Please cross the most applicable option)

   Lecture notes

   The actual lecture

   Demonstration of prosected specimens

7. Which method of studying anatomy do you find most beneficial to you? (Please cross the most applicable option)

   Visual aid (learning via the tablet)

   Physical dissection and viewing of prosected specimens

7.1 Please explain your preferred choice:

___________________________________________________________________________

___________________________________________________________________________
8. How does the use of the tablet for the access of anatomy-related content assist with your clinical skills?
___________________________________________________________________________
___________________________________________________________________________

9. Where do you generally use your tablet? (Please cross the most applicable option)
   - At campus
   - At home
   - At hospital during ward rounds
9.1 Please explain the reason for the selected location?
___________________________________________________________________________

10. Do you have internet access at home?
   - Yes
   - No
10.1 How does this affect the usage of your tablet to access anatomy-related content?
___________________________________________________________________________

11. Has the tablet made accessing anatomy-related content more convenient for you?
   - Yes
   - No
11.1 Please elaborate about your choice
___________________________________________________________________________

12. What do you consider most beneficial to you? (Please cross the most applicable option)
   - Live streaming of lectures and practical’s only
   - Physical attendance to lectures and practical’s only
   - Live streaming of lectures AND physical attendance to lectures and practical’s
   - Access of anatomy-related study material only, i.e. lecture notes
   - Live streaming of lectures AND access of anatomy-related study material, i.e. lecture notes
   - Physical attendance to lectures and practical’s AND access of anatomy-related study material, i.e. lecture notes

13. In addition to the provision of the tablet, do you still record notes during the lecture?
   - Yes
   - No

14. What applications do you most frequently use on your tablet? (Please list in order of preference)
1. __________________________________________
2. __________________________________________
3. __________________________________________

15. Does the provision of the tablet affect your attendance to lectures and practical’s?
   - Yes
   - No
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<td>22-Feb-2017</td>
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<td>Lazarus, Lelika; University of KwaZulu-Natal College of Health Sciences, Clinical Anatomy  Sookrajh, Reshma; University of KwaZulu Natal, Department of Curriculum Studies, School of Education, College of Humanities  Satyapal, Kapil; University of KwaZulu-Natal College of Health Sciences, Clinical Anatomy; University of KwaZulu-Natal College of Health Sciences, Clinical Anatomy</td>
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TITLE PAGE

Title : Tablet technology in medical education in South Africa: a mixed methods study

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ABSTRACT

Objective: The purpose of this study was to establish the use of mobile devices by learners at a selected medical school. Distribution of mobile devices was an inaugural initiative implemented by our College.

Design: A mixed methodology design using a questionnaire comprising both open and close ended questions was analysed from 179 (60 male; 119 female) second year medical students registered for the Anatomy course. Open-ended questions were analysed using a thematic approach by identifying emergent ideas and concepts. Close-ended questions were analysed using SPSS version 21.0.

Setting and participants: Second year medical students at a medical school in South Africa.

Results: Three main themes emerged viz. (i) mobile device engagement, (ii) advantages and (iii) challenges affecting use of mobile devices. A majority of learners accessed their tablets for lecture notes; more females were inclined to access these devices than males. Challenges experienced included poor wifi connectivity on and off University campus; some students were not keen on the idea of mobile devices and preferred traditional methods of teaching.

Conclusions: Mobile devices have been adopted by learners at our University. Uses of technology outlined are related to Eraut’s intentions of informal learning. Integrating tablets into classes had a positive effect on student access to course material.
Strengths and limitations of this study

- This paper demonstrates the use of mobile technology, and describes how it created new opportunities to enable positive student learning experiences in a selected university classroom.

- The use of this software application was novel in the discipline of anatomy education and was designed to enhance creativity, critical thinking and promote increased interaction among students and faculty.

- The research sample was purposive and limited to a single cohort of second year medical degree students, which comprised largely of female students.
INTRODUCTION

The last decade has seen the introduction of new technology which has transformed many aspects of our culture, commerce, communication and education\(^1\). Mobile computing devices such as tablets, iPhones and the iPad have been swiftly implemented in many countries resulting in access to information in ways that were not possible before\(^2\). This article begins with a brief description of mobile learning and it is proposed that the growing use of mobile technology at universities is the most current trend forcing educators to evaluate its merits.

Mobile learning is defined as “any type of learning that takes place in learning environments and spaces that take account of the mobility of technology, mobility of learners and mobility of learning.” As mobile technology develops, it creates new opportunities for enhancing the learning experience of students at all levels of education\(^3\). Cobcroft \(et\ al.\) (2006)\(^4\) reported that “mobile technologies are able to support learners’ engagement in creative, collaborative, critical and communicative learning activities.” Traxler (2007)\(^5\) further emphasized that mobile learning offers a unique opportunity to support learning that is personalized, authentic and situated thus facilitating a wide variety of teaching methods. The growing use of mobile technology at Colleges and Universities is the most current trend forcing educators to evaluate its merits and The College of Health Sciences (CHS) at our University has implemented a Visual Learning Project and over 1400 health science students have received new Proline Tablet PCs. This technology was the first in South Africa to provide such a platform to stream live lectures, and record lectures for later on-demand viewing. According to the Information Technology Department at the university, “the live lecture streaming incorporates an interactive classroom, where students can ask the lecturer questions electronically, and students can respond to
questions, surveys and polls from their seats in the lecture room, or from a remote location.

College management said this new solution opened up exciting opportunities that could even allow international lecturers to lecture to the student population. The new technology would allow lecturers to reach the more remote areas of the university community; proving especially beneficial to CHS students when fulfilling the clinical service requirements of their degrees.” (UKZN website; accessed 21 July 2016)⁶. Mobile learning presents students and faculty with a unique opportunity to access information instantaneously, regardless of location⁷.

The main advantages of using tablet technology embrace the following perceptions viz. using software applications to enhance creativity, critical thinking and encouraging greater interaction among students and faculty⁸. The benefits of using the tablet have also included a reduction in the amount of paper used and a reduction in textbook costs as students have opted for electronic versions of the text. Engagement with tablet-pcs in academic programmes creates a positive educational experience⁹. Miller (2012)¹⁰ reported that not only do tablet-pcs have applications that serve as study aides and productivity tools for students, but students are also able to use “apps” to help create flashcards for studying, including retrieving and editing documents on “Google Docs” for assignments. There are hundreds and thousands of applications, some free and some requiring paid subscriptions. These applications are available in a wide range of categories and are tailored for specific medical disciplines such as Medscape, Medical Tools, Gray’s Anatomy-Atlas, Medical Abbreviations, Harrison’s Manual of Medicine, Anatomy Learning-3D Atlas, MediApp, Resuscitation, iGyno and O&G App. Further, some authors elaborate that the design of tablet-pcs combines e-reading capabilities with web-browsing, plus an assortment of applications that facilitate the integration of information by making information conveniently available, including creating a richer set of course notes¹¹¹².
Ellaway (2014) categorized mobile use by medical learners into four groups viz. (i) logistics (when learners use their devices for personal information management such as email and texting); (ii) personal (when learners use their devices for social and entertainment purposes such as social media and gaming; (iii) learning tools (when learners use their devices for undertaking learning tasks such as note taking and (iv) learning content (when learners use their devices as a source of information such as checking drug interactions. This categorization will used a framework to represent data later on in this paper.

**Anatomy in Higher Education**

Anatomy is an integral part of any medical degree. Within anatomy programmes, students are required to construct a comprehensive and sophisticated understanding of basic anatomy, and then apply that information to clinical care. Anatomy requires students to learn a large volume of ancient languages based on terminology including muscle names, origins, insertions, joint, connective tissue and cellular, micro and gross anatomy. Traditionally, students use a rote or surface learning approach and have stated that anatomy is “boring, hard, dull” in previous literature.

The nature of anatomical education has transformed substantially over the past decade due to both a new generation of students who learn differently from those of the past and the explosion of advances in anatomical imaging and programing. Medical students of today are products of the “interactive generation”. Millennial generation learners (sometimes referred to as digital natives) are defined as individuals whose development has been infused with technology and these individuals possess extensive experience with digital exploration, gaming and communication and are claimed to be adept with user-friendly digital devices.
Anatomy teaching in medical schools has been traditionally based around the use of human cadaveric specimens, either taking the whole body specimens for complete dissection or as prosected specimens\textsuperscript{20}. The debate on teaching via the conventional pedagogy of cadaveric dissection versus the computer and more innovative modalities has raged on for the last decade\textsuperscript{21}. Those who advocate retaining this traditional learning exercise (the so called “traditionalists”) cite the value of the cadaver experience\textsuperscript{22-24}. Those who see the practice as redundant defend their position by pointing to recent technological advancements (the so called “modernists”)\textsuperscript{25-27}. At our University cadaver-based learning includes the actual dissection of cadavers by medical students under the supervision of qualified instructors and the study of prosected specimens where individual structures in the human body have been dissected and displayed by skilled dissectors.

It is with this literature review in mind that the research questions addressed in this study are:

- What is the extent to which medical trainees use their mobile devices?
- What kinds of information are being accessed generally and specifically with reference to anatomical education?

**AIM**

The purpose of this exploratory study was to establish how learners at a selected medical school use their mobile devices since this was a unique initiative implemented by the College.
MATERIALS AND METHODS

Design

A mixed methodology research design integrating both quantitative and qualitative approaches was chosen to guide our enquiry to generate the data required to meet the aims of this study.

Context and Participants

The study sought to explore how learners at a selected medical school use their mobile devices. The second year class was comprised of a total of 257 medical students registered for the Anatomy course. Of these only 179 students (60 male; 119 female) chose to participate in this study (69.6% response rate). The mode of anatomy instruction is comprised of both lectures and practical sessions in various regional anatomical themes. There are five such themes per annum, each of which is conducted over an 8-week period. There are a total of approximately 49 hours of lectures and 197 hours of practical sessions per theme.

Students were informed about the study and their consent was duly taken for their voluntary and anonymous participation. Any chance of participant bias was eliminated by clearly explaining the objective of the study while obtaining their informed consent. There were no specific exclusion criteria and no participants withdrew from the study. Ethical approval was obtained from the University Biomedical Research Ethics Committee (BE386/15).

Instrumentation (Appendix A)

A survey questionnaire containing structured and free response items was used in this study to obtain both quantitative and qualitative information regarding student use of their mobile device. Questions 1 and 2 asked all respondents about their prior exposure to mobile devices. Question 3
focused on student knowledge of participation in the College project. Questions 4-9 concentrated on type, frequency and location of usage of the tablets, including the preferred method of learning anatomy. Question 10 covered internet connectivity. Questions 11-13 and 15 asked respondents about their views pertaining to the use of the tablet in accessing anatomy content. Question 14 asked a general question related to applications accessed by students.

**Data Analysis**

The questionnaire was administered to students before class and they were allocated twenty minutes for completion. The open ended questions were analysed by two of the authors (LL and RS) using a thematic approach to identify emergent ideas and concepts expressed by participants. Key words, phrases and/or descriptions from the participants were documented, as the authors reflexively engaged with the data. Convergence and divergence of data were noted, leading to the development of preliminary emergent themes. The themes were further interrogated and developed with reference to participants’ original words while also including the authors’ collective interpretations. The close ended questions were statistically analysed using the SPSS version 21.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data for comparison of categorical variables was tested using the Pearson’s Chi-squared test ($X^2$) to compute frequency tables and descriptive statistics. A $p$ value of $<0.05$ was considered to be statistically significant.
RESULTS

a) Sample demographics

There were 179 respondents with a sex distribution of 60 male and 119 female students and a population grouping of 137 Black, 26 Indian, 6 White and 9 Coloured participants [The term “Coloured” is an historical throwback from the apartheid racial classification which remains in the post-1994 democratic era to assist the current government in seeking restitution for various disadvantaged groupings. The term “Coloured” refers to a group of heterogeneous people, who may be more or less accurately described as ‘mixed-race’ (https://welections.wordpress.com; Accessed 24 January 2017)]. Students also indicated their socio-economic background viz. urban 62, peri-urban 46 and rural 71 (Table 1). The average age of respondents was 20.2 years with a range between 18-28 years.

b) Quantitative results

Significant p-values (highlighted) were recorded for the different categorical variables according to sex, population groups, and socio-economic status (Table 2). The majority of students came from a rural background (39.7%) and these students indicated that they had no prior exposure to a tablet device prior to receiving the current one as part of their course (38%). A majority of female students (46.4%) indicated that they had no prior access to a tablet device - these results are statistically significant (p<0.020) when this parameter was investigated in the sexes. Comparisons for the different population groups (p<0.000) and socio-economic status (p<0.000) also yielded statistically significant results when this parameter was compared to students having prior access to a tablet. The majority (43.6%) of Black students were not aware of the Visual Learning Project and a statistically significant result (p<0.024) was obtained when population
groups were compared with the level of student awareness of the Visual Learning Project. A total of 35.8% of female students indicated that they used the tablet for both academic and personal reasons compared to 21.2% of male students. Overall, females tended to access their tablets for anatomy related content more often when compared to their male counterparts (Table 2) which yielded a statistically significant p value (p<0.017). A total of 37.4% of students from rural backgrounds used the tablet to access lecture notes and a statistically significant value of p<0.000 was obtained when socio-economic status was compared with the latter parameter. A total of 24% of male students reported that they found physical dissection more beneficial in the study of anatomy as opposed to female students who preferred visual aids (15.1%). A total of 62% of female students reported that they accessed the tablets for lecture notes; these students also indicated that they accessed their tablets whilst on campus (36.3%). However, 17.4% of African students reported a lack of internet access at home (p<0.000 when population groups were correlated with internet availability). A total of 43% of female students indicated that the tablet made accessing anatomy-related content more convenient for them. A majority of female students (33.5%) reported that they found access to anatomy-related study material i.e. lecture notes via the tablet beneficial to them versus 29.6% of male students who accessed the tablet for a similar purpose. Despite having the tablet, female students still recorded lecture notes during classroom time (43.6%). Statistically significant correlates were recorded for sex (p<0.032) and population groups (p<0.014) versus traditional note taking. A total of 83.8% of students indicated that provision of the tablet did not affect their attendance (57.5% female and 26.3% male) (Table 2).

c) Qualitative results
The following themes emerged from the data viz.
i. Mobile device engagement

ii. Advantages of mobile devices

iii. Challenges affecting use of mobile devices

iv. Miscellaneous use

i. Mobile device engagement

Learners listed a number of uses in their engagement with mobile devices. These uses have been categorised according to Ellaway’s (2014)\textsuperscript{13} four activity groups as outlined in the Introduction of this paper (Table 3) as follows:

- **Logistics:** Students reported the use of the tablet to access emails (16.2\%) and browse the web (77\%) using internet sites such as Firefox and Google, supporting

- **Personal:** Students also accessed social media such as Facebook (1.7\%), social videos (8.4\%) and games (7.3\%).

- **Learning tools:** A large majority of the students accessed the tablet for lecture notes (91.6\%) whilst 26.3\% of learners used applications such as WPS Office to alter documents.

- **Learning content:** Students also accessed sites for drug guidelines such as Medscapes (1.7\%) and 6.2\% accessed Anatomy e-books such as Netter’s Interactive, Drake’s Grey’s Anatomy and software applications such as Essential Anatomy 2 and Visual Anatomy for learning content and expressed that they learnt better by watching anatomy videos on the tablet as anatomical specimens are clearer in the videos and enabled them to understand the content.

Students also mentioned that the tablet allowed them to learn at their own pace (21.2\%).
“The visual part, the one I use with the tablet enables me to combine what I learn in the class with what I see and it makes me able to know the exact locations of certain important structures.” (Participant 1; male) (Count =31)

ii. Advantages of mobile devices

Participants listed a number of advantages associated with the use of mobile tablets such as portability (6.7%) allowing students the opportunity of accessing information on campus and allowing them to revise at home, access to information on the internet (22.9%) and research areas of course content that were not covered in the lectures (9.5%).

“With visual aids, I can access the slides and videos anytime” (Participant 33; female) (Count=63)

Respondents also mentioned the value of utilizing dissection as well as visual aids in the learning of anatomy (17.3%).

“Tablet enables one to combine what is learnt in lectures with structures in the DH” (Participant 21; female) (Count=6)

iii. Challenges affecting use of mobile devices

Respondents reported on some of the challenges they experienced with the use of the tablet such as having no wifi access outside of campus (64.2%) as well as poor wifi access on campus (12.3%).

“I do not have access to the internet at home” (Participant 4; female) (Count=122)

Some also considered that learning from the tablet did not improve their understanding of anatomy (3.4%) and felt that learning from the cadaver was easier (60.3%) as opposed to the tablet.
“**The tablet does not provide visual aids of real specimens, just lecture slides. Looking at real specimens helps orientate oneself and get a three dimensional understanding.**” (Participant 70; female) (Count=103)

Respondents also reported on the lack of anatomy related content being posted on the university website (3.4%).

“**There are no resources for Anatomy in the UKZN Tube.**” (Participant 2; male) (Count=4)

iv. **Miscellaneous use**

Participants also used their devices for private use such as a camera (3.4%) and as a media player (6.1%). Some respondents stated that the tablet has no effect on their leaning at all (11.2%).

**DISCUSSION**

In conducting this exploratory investigation into student perceptions of Tablet usage, it was found that there are many issues to consider when using this technology in practice. The results from this study reveal that students are using mobile devices for both academic as well as private purposes outside of the classroom. According to Yau and Leung (2016)\(^\text{29}\), sex differences account for one of the factors affecting students’ use of technology. In this study, females were inclined to use their tablets more often than males which was statistically significant (Question 5, Table 2). These results concur with that reported by Yau and Leung (2016)\(^\text{29}\) but differ from Kekkonen-Moneta and Moneta (2002)\(^\text{30}\); the latter authors suggested that tablet technology use is a more dominant activity for male students. McNulty (2006)\(^\text{31}\) and (2009)\(^\text{32}\) demonstrated that although students may be familiar with Web-based educational resources, medical student usage of Web-based computer aided instruction is related to sex, learning styles and personality.
The majority of students (91.6%) accessed their tablets for lecture notes. These lectures define a range of content available for Web access, ranging from text files to audio or video-enhanced presentations to captured video lectures. According to Chan and Pawlina (2015)\textsuperscript{33}, lecture capture records an instructor’s presentation as it is delivered live in the classroom, as is the scenario at our university. Lecture capture is regarded as an effective review tool for students provided that the lecture is well presented. More than any previous mobile learning technology, tablets provide students with immediate and far reaching access to information, course resources and real world application of knowledge\textsuperscript{12}.

The educational practice of technology can be associated with learning theories\textsuperscript{34}. The various uses of mobile learning can be associated with the different stages in Kolb’s learning cycle\textsuperscript{35}. For example, accessing the tablet for related lecture notes in the dissecting hall provides an opportunity to practice skills, social media (such as YouTube videos and Wikipedia) can assist in maintaining learners’ reflections on experiences and apps can offer access to knowledge which can assist abstract conceptualization\textsuperscript{34}.

Bullock and Webb (2015)\textsuperscript{34} further cite the impact of technology on Eraut’s theory of informal learning in the work-place as being either implicit, reactive or deliberative. In this study, the so called work-place refers to the University environment. Learning from social media is regarded as being implicit learning; reactive learning is opportunistic, often occurring in the middle of an action such as accessing the tablet “to view content and determine anatomical positions realistically (Participant 3; female).” Deliberate learning is regarded as having a goal and a set time (Eraut, 2004)\textsuperscript{36} where the learner clearly thinks about their actions such as accessing lecture notes for study purposes. Students reported that the immediate access to information enhanced in-class understanding of content (“...the tablet enables me to combine what I learn in the class...”\textsuperscript{36}).
with what I see and it makes me able to know the exact locations of certain important structures").

The qualitative data in this study corroborates the views expressed by Rossing et al. (2012) particularly student responses in the themes of mobile device engagement and advantages of mobile devices.

The growing number of websites and databases further facilitate the ease with which students can “download certain books and videos using my tablet and so it has made accessing anatomy related content more convenient.” Some students were motivated enough to access additional anatomical content via web-based learning such as E-books, Drug Guides, Essential Anatomy 2, Visual Anatomy supporting the deliberative aspect of informal learning.

Hafferty (1998) defines the informal mobile curriculum as those practices that “targets learning at the level of interpersonal interactions.” Such interpersonal interactions can be found in modern anatomy curricula in learning spaces such as anatomy laboratories where students access their tablets. The deliberate engagement with the tablets in this setting allows students to access notes, videos, e-books and software applications which provide interactive visual information to augment their learning. The touch screen capabilities of the tablet allows students to enlarge or rotate images with ease, thereby making learning more hands on. Further, they provide visual representations of anatomy that more closely resemble the structures in the human body. This is especially beneficial in those programs in the field of health sciences that do not possess anatomy laboratories as a component of their curriculum; hence anatomy applications may be a useful resource for augmenting student learning.
This study’s findings ("…since the tablet is portable, I am able to view lecture slides more frequently") support the literature that recommends that today’s students desire and benefit from “anywhere, anytime” learner participation. The literature suggests that mobile learners desire the ability and flexibility to choose their location and time for learning. As reported by this study, learners were allocated their own tablets; therefore they had the option of using it for personal purposes; thus supporting Ellaway’s (2014) logistical category of mobile device activity. Students largely accessed their tablets on campus as they experienced problems accessing wireless connectivity at home. The Failure of wifi connectivity leads to disenchantment with mobile devices ("...there is no wifi") and severely hampers the learning process.

Some learners also felt that physical dissection provided the best method of learning anatomy (30.9%), corroborating the views of authors such as McLachlan et al. (2004) and McLachlan and Patten (2006) despite the implementation of the newer technology; whilst some students felt that the provision of the tablet had no effect at all on their learning (6.7%).

In order to maximize the benefit of mobile tablets, educators must carefully adapt the technology to specific learning goals and outcomes. Educators must not assume that students are prepared for new technologies and need to gauge student’s level of knowledge and comfort with new technological devices. It is essential to devote classroom time to students to acclimate to these new devices.

CONCLUSION

Mobile computing devices have been rapidly adopted by medical learners worldwide, including those at our university as illustrated by this pilot study and it seems likely that their presence will
soon be ubiquitous. This study offers a unique South African perspective which has the possibility to enhance learning, but also has potential problems associated with its use. We can conclude from our study that integrating tablets into Higher Education anatomy classes had a positive effect on student access to course material. In a subject already utilising active learning through traditional methods the addition of technology via quizzes, 3D visual material and access to the internet could be an alternative method of engaging students in the learning process. Students are seizing opportunities of learning anywhere, anytime due to the portability of their mobile devices.

Limitations and implications for future research

Firstly, this study is limited by the exclusive use of the Proline 7” android tablet. Additional research is necessary to incorporate the use of other branded technological devices such as the Apple iPad.

Secondly, as this study used purposive sampling, the results may be limited by the nature of the population and cannot be generalized to account for student experiences with other academic courses offered. Additional research is necessary to isolate disciplinary strengths and weaknesses.

Thirdly, students in graduate programs such as those registered for medical degrees are expected to be self-directed learners who have the ability to locate resources to supplement their learning. This could be a motivating factor for students to use their tablets for learning outside of the classroom. Further studies are necessary to determine whether mobile devices such as the tablet have an impact on academic performance, assessments and whether they encourage self-directed
learning. Additional studies are warranted to determine the effect of tablet technology on examination performance.

Fourthly, there should be no compromise in students having access to the material they are promised; university administrators should ensure that provisions are made for technological support in places such a living residences have wifi access points for students to utilize at their convenience. As mobile technology continues to grow and develop, universities cannot be caught with a wireless infrastructure incapable of handling the demand for connectivity.
### Table 1: Demographic profile of the study respondents (n=179)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>60 (33.5)</td>
</tr>
<tr>
<td>Female</td>
<td>119 (66.5)</td>
</tr>
<tr>
<td><strong>Population Groups</strong></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>138 (77.1)</td>
</tr>
<tr>
<td>Indian</td>
<td>26 (14.5)</td>
</tr>
<tr>
<td>White</td>
<td>6 (3.4)</td>
</tr>
<tr>
<td>Coloured</td>
<td>9 (5.0)</td>
</tr>
<tr>
<td><strong>Socio-economic status</strong></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>62 (34.6)</td>
</tr>
<tr>
<td>Peri-urban</td>
<td>46 (25.7)</td>
</tr>
<tr>
<td>Rural</td>
<td>71 (39.7)</td>
</tr>
</tbody>
</table>
Table 2: Responses to close ended questions according to sex, population groups and socio-economic status

<table>
<thead>
<tr>
<th>Question</th>
<th>Incidence of Demographic factor (%)</th>
<th>Sex</th>
<th>Population Groups</th>
<th>Socio-economic status</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Did you have access to a tablet prior to receiving the current one?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Comment</td>
<td>Male: 0.6 Female: 0</td>
<td></td>
<td>Black: 0.6</td>
<td>White: 0</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>Male: 4.3 Female: 20.1</td>
<td></td>
<td>Indian: 9.5</td>
<td>White: 28.8</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Male: 28.5 Female: 46.4</td>
<td></td>
<td>Coloured: 5.0</td>
<td>White: 2.2</td>
<td>0.020</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Urban: 17.9</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Peri-urban: 22.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rural: 38.0</td>
<td></td>
</tr>
<tr>
<td>3. Were you familiar with the visual learning programme prior to the provision of the tablet?</td>
<td>No Comment: 0.6 Male: 1.1 Female: 1.1</td>
<td></td>
<td></td>
<td></td>
<td>0.665</td>
</tr>
<tr>
<td>Yes</td>
<td>Male: 14.5 Female: 33.5</td>
<td></td>
<td>Indian: 31.3</td>
<td>White: 28.8</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Male: 18.4 Female: 31.8</td>
<td></td>
<td>Coloured: 43.6</td>
<td>White: 2.8</td>
<td>0.000</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Urban: 12.8</td>
<td>0.000</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Peri-urban: 15.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rural: 22.3</td>
<td></td>
</tr>
<tr>
<td>4. What do you frequently use the tablet for?</td>
<td>No Comment: 0.6 Male: 1.1 Female: 1.1</td>
<td></td>
<td></td>
<td></td>
<td>0.017</td>
</tr>
<tr>
<td>Academic</td>
<td>Male: 10.6 Female: 26.8</td>
<td></td>
<td>Indian: 29.1</td>
<td>White: 1.7</td>
<td></td>
</tr>
<tr>
<td>Personal</td>
<td>Male: 1.1 Female: 2.8</td>
<td></td>
<td>Indian: 6.1</td>
<td>White: 17.0</td>
<td>0.017</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Urban: 13.4</td>
<td>0.017</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Peri-urban: 8.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rural: 15.6</td>
<td></td>
</tr>
<tr>
<td>5. How often do you use the tablet to access anatomy-related content?</td>
<td>No Comment: 0.6 Male: 0.6 Female: 1.1</td>
<td></td>
<td></td>
<td></td>
<td>0.701</td>
</tr>
<tr>
<td>Everyday</td>
<td>Male: 6.1 Female: 15.6</td>
<td></td>
<td>Indian: 18.4</td>
<td>White: 1.1</td>
<td></td>
</tr>
<tr>
<td>Twice a week</td>
<td>Male: 7.8 Female: 16.8</td>
<td></td>
<td>Indian: 4.5</td>
<td>White: 1.1</td>
<td>0.017</td>
</tr>
<tr>
<td>More than 3 times week</td>
<td>Male: 11.7 Female: 8.9</td>
<td></td>
<td>Indian: 17.3</td>
<td>White: 1.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Urban: 10.1</td>
<td>0.017</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Peri-urban: 6.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rural: 14.5</td>
<td></td>
</tr>
<tr>
<td>6. Which of the following do you most frequently access via your tablet?</td>
<td>No Comment: 1.1 Male: 1.1 Female: 1.1</td>
<td></td>
<td></td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Male: 29.6 Female: 62.0</td>
<td></td>
<td>Indian: 71.5</td>
<td>White: 3.4</td>
<td>0.004</td>
</tr>
<tr>
<td>Actual lecture</td>
<td>Male: 1.7 Female: 1.7</td>
<td></td>
<td>Indian: 2.2</td>
<td>White: 1.1</td>
<td></td>
</tr>
<tr>
<td>Demo &amp; Practical</td>
<td>Male: 1.1 Female: 1.7</td>
<td></td>
<td>Indian: 1.1</td>
<td>White: 0.6</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Urban: 1.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Peri-urban: 1.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rural: 1.7</td>
<td></td>
</tr>
<tr>
<td>7. Which method of studying anatomy do you find most beneficial to you?</td>
<td>No effect: 2.2 Male: 4.5 Female: 0.6</td>
<td></td>
<td></td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td>Visual aid</td>
<td>Male: 6.7 Female: 15.1</td>
<td></td>
<td>Indian: 3.4</td>
<td>White: 2.8</td>
<td></td>
</tr>
<tr>
<td>Physical dissection</td>
<td>Male: 24.0 Female: 6.9</td>
<td></td>
<td>Indian: 10.6</td>
<td>White: 2.2</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Urban: 22.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Peri-urban: 18.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rural: 29.6</td>
<td></td>
</tr>
<tr>
<td>8. Do you have internet access at home?</td>
<td>Yes: 5.6 Female: 35.5</td>
<td></td>
<td>Indian: 6.1</td>
<td>White: 3.4</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>Male: 27.9 Female: 19.6</td>
<td></td>
<td>Indian: 12.3</td>
<td>White: 3.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Urban: 19.6</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Peri-urban: 17.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rural: 36.9</td>
<td>0.004</td>
</tr>
<tr>
<td>9. Where do you generally use your tablet?</td>
<td>On Campus: 24.6 Male: 36.3 Female: 60.0</td>
<td></td>
<td></td>
<td></td>
<td>0.093</td>
</tr>
<tr>
<td></td>
<td>Home: 7.8 Male: 27.4 Female: 21.2</td>
<td></td>
<td></td>
<td></td>
<td>0.040</td>
</tr>
<tr>
<td></td>
<td>Hospital: 0 Male: 1.1 Female: 0.6</td>
<td></td>
<td></td>
<td></td>
<td>0.040</td>
</tr>
<tr>
<td></td>
<td>Campus &amp; Home: 1.1 Male: 2.2 Female: 2.8</td>
<td></td>
<td></td>
<td></td>
<td>0.040</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Has the tablet made accessing anatomy-related content more convenient for you?</td>
<td>No Comment: 1.1 Male: 5.6 Female: 5.6</td>
<td></td>
<td></td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>Yes: 24.6 Male: 43.0 Female: 51.4</td>
<td></td>
<td></td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>No: 7.8 Male: 17.9 Female: 19.6</td>
<td></td>
<td></td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td>P Value</td>
<td>0.093</td>
<td></td>
<td></td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>0.040</td>
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<td></td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>0.040</td>
<td></td>
<td></td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td>P Value</td>
<td>0.039</td>
<td></td>
<td></td>
<td></td>
<td>0.000</td>
</tr>
</tbody>
</table>
### 12. What do you consider most beneficial to you?

<table>
<thead>
<tr>
<th>Option</th>
<th>No Comment</th>
<th>3.4</th>
<th>5.6</th>
<th>6.7</th>
<th>1.7</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>2.8</th>
<th>1.1</th>
<th>5.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Live streaming of lectures and practical’s only</td>
<td>1.1</td>
<td>0.6</td>
<td>1.7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.6</td>
<td>0</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>B: Physical attendance to lectures and practical’s only</td>
<td>0.6</td>
<td>1.1</td>
<td>1.1</td>
<td>0.6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.6</td>
<td>0.6</td>
<td>1.1</td>
</tr>
<tr>
<td>C: Live streaming of lectures AND physical attendance to lectures and practical’s</td>
<td>11.7</td>
<td>19.6</td>
<td>27.9</td>
<td>2.8</td>
<td>0</td>
<td>0.6</td>
<td>0</td>
<td>10.1</td>
<td>10.1</td>
<td>11.2</td>
<td></td>
</tr>
<tr>
<td>D: Access of anatomy-related study material only, i.e. lecture notes</td>
<td>1.1</td>
<td>1.1</td>
<td>1.7</td>
<td>0.6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.1</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>E: Live streaming of lectures AND access of anatomy-related study material, i.e. lecture notes</td>
<td>2.8</td>
<td>5.0</td>
<td>3.4</td>
<td>2.8</td>
<td>0.6</td>
<td>1.1</td>
<td>0</td>
<td>5.6</td>
<td>1.1</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>F: Physical attendance of lectures and practical’s AND access of anatomy-related study material i.e. lecture notes</td>
<td>12.8</td>
<td>33.5</td>
<td>34.1</td>
<td>6.1</td>
<td>2.2</td>
<td>3.4</td>
<td>0</td>
<td>15.1</td>
<td>11.7</td>
<td>19.6</td>
<td></td>
</tr>
</tbody>
</table>

| P Value | 0.708 | 0.320 | 0.000 |

### 13. In addition to the provision of the tablet, do you still record notes during the lecture?

<table>
<thead>
<tr>
<th>Option</th>
<th>No Comment</th>
<th>1.7</th>
<th>0.6</th>
<th>1.7</th>
<th>0.6</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>1.1</th>
<th>0</th>
<th>1.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>16.2</td>
<td>43.6</td>
<td>14.2</td>
<td>12.8</td>
<td>2.8</td>
<td>3.9</td>
<td>0</td>
<td>25.1</td>
<td>14.5</td>
<td>20.1</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>15.6</td>
<td>22.3</td>
<td>34.6</td>
<td>1.1</td>
<td>0.6</td>
<td>1.1</td>
<td>0.6</td>
<td>8.4</td>
<td>11.2</td>
<td>17.9</td>
<td></td>
</tr>
</tbody>
</table>

| P Value   | 0.032 | 0.014 | 0.116 |

### 15. Does the provision of the tablet affect your attendance to lectures and practical’s?

<table>
<thead>
<tr>
<th>Option</th>
<th>No Comment</th>
<th>4.5</th>
<th>2.8</th>
<th>4.5</th>
<th>2.2</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>3.4</th>
<th>1.7</th>
<th>2.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>2.8</td>
<td>5.6</td>
<td>7.3</td>
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<td>0</td>
<td>0</td>
<td>2.2</td>
<td>3.4</td>
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<tr>
<td>No</td>
<td>26.3</td>
<td>57.5</td>
<td>64.2</td>
<td>11.7</td>
<td>2.8</td>
<td>4.5</td>
<td>0.6</td>
<td>28.5</td>
<td>20.7</td>
<td>34.1</td>
<td></td>
</tr>
</tbody>
</table>

| P Value   | 0.144 | 0.752 | 0.867 |

*Questions numbered according to Questionnaire (Appendix A)*
Table 3: User engagement of learners with tablets (n=179)

<table>
<thead>
<tr>
<th>Activity Group</th>
<th>Male (%)</th>
<th>Female (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Email</td>
<td>5.0</td>
<td>11.2</td>
<td>16.2</td>
</tr>
<tr>
<td>• Web-browsing</td>
<td>26.2</td>
<td>50.8</td>
<td>77</td>
</tr>
<tr>
<td>• Time-keeping</td>
<td>0.6</td>
<td>-</td>
<td>0.6</td>
</tr>
<tr>
<td>Personal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Social Media</td>
<td>0.6</td>
<td>1.1</td>
<td>1.7</td>
</tr>
<tr>
<td>• Social Videos</td>
<td>3.4</td>
<td>5.0</td>
<td>8.4</td>
</tr>
<tr>
<td>• Gaming</td>
<td>1.7</td>
<td>5.6</td>
<td>7.3</td>
</tr>
<tr>
<td>Learning Tools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Accessing notes</td>
<td>29.6</td>
<td>62.0</td>
<td>91.6</td>
</tr>
<tr>
<td>• Alteration of Documents</td>
<td>10.1</td>
<td>16.2</td>
<td>26.3</td>
</tr>
<tr>
<td>Learning content</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Drug guides</td>
<td>1.1</td>
<td>0.6</td>
<td>1.7</td>
</tr>
<tr>
<td>• Anatomy E-books &amp; software applications</td>
<td>1.7</td>
<td>4.5</td>
<td>6.2</td>
</tr>
</tbody>
</table>
Contributors

All three authors are justifiably credited with authorship, according to the authorship criteria. In detail: LL collection, analysis and interpretation of data, drafting the article and final approval of the version to be published. RS: analysis and thematic development, revising the article and final approval of the version to be published. KSS: revising the article and final approval of the version to be published.

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Competing Interests

We have read and understood BMJ policy on declaration of interests and declare that we have no competing interests.

Ethical approval

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Data Sharing statement

No additional data are available.
References


APPENDIX
TABLET TECHNOLOGY IN MEDICAL EDUCATION

The purpose of this survey is to provide faculty with information about whether you utilize mobile devices as they relate to your studies in the Anatomy Program. This survey is for general program development and is voluntary. However, your participation is greatly appreciated and will be useful in course planning, development and improvement. Please mark with a tick where appropriate.

Age: ____________

<table>
<thead>
<tr>
<th>Sex</th>
<th>M</th>
<th>F</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Population Group:</th>
<th>Black African</th>
<th>White</th>
<th>Indian</th>
<th>Coloured</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Socio-Economic Background</th>
<th>Urban</th>
<th>Peri-urban</th>
<th>Rural</th>
</tr>
</thead>
</table>

1. When did you receive your tablet? _____________________________________________

2. Did you have access to a tablet prior to receiving the current one?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

3. Were you familiar with the visual learning programme prior to the provision of the tablet?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

4. What do you frequently use the tablet for? (Please cross the most applicable option)

<table>
<thead>
<tr>
<th>Academic</th>
<th>Personal</th>
<th>Academic and personal</th>
<th>Other</th>
</tr>
</thead>
</table>

5. How often do you use the tablet to access anatomy-related content? (Please cross the most applicable option)

<table>
<thead>
<tr>
<th>Everyday</th>
<th>Twice a week</th>
<th>More than three times a week</th>
</tr>
</thead>
</table>
6. Which of the following do you most frequently access via your tablet? (Please cross the most applicable option)

- Lecture notes
- The actual lecture
- Demonstration of prosected specimens

7. Which method of studying anatomy do you find most beneficial to you? (Please cross the most applicable option)

- Visual aid (learning via the tablet)
- Physical dissection and viewing of prosected specimens

7.1 Please explain your preferred choice:
_______________________________________________________________________
_______________________________________________________________________

8. How does the use of the tablet for the access of anatomy-related content assist with your clinical skills?
___________________________________________________________________________
___________________________________________________________________________

9. Where do you generally use your tablet? (Please cross the most applicable option)

- At campus
- At home
- At hospital during ward rounds

9.1 Please explain the reason for the selected location?
___________________________________________________________________________
___________________________________________________________________________

10. Do you have internet access at home?

- Yes
- No

10.1 How does this affect the usage of your tablet to access anatomy-related content?
___________________________________________________________________________

11. Has the tablet made accessing anatomy-related content more convenient for you?

- Yes
- No
11.1 Please elaborate about your choice

________________________________________________________________________________________________________

________________________________________________________________________________________________________

12. What do you consider most beneficial to you? (Please cross the most applicable option)

<table>
<thead>
<tr>
<th>Choice</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Live streaming of lectures and practical’s only</td>
<td></td>
</tr>
<tr>
<td>Physical attendance to lectures and practical’s only</td>
<td></td>
</tr>
<tr>
<td>Live streaming of lectures AND physical attendance to lectures and practical’s</td>
<td></td>
</tr>
<tr>
<td>Access of anatomy-related study material only, i.e. lecture notes</td>
<td></td>
</tr>
<tr>
<td>Live streaming of lectures AND access of anatomy-related study material, i.e. lecture notes</td>
<td></td>
</tr>
<tr>
<td>Physical attendance to lectures and practical’s AND access of anatomy-related study material, i.e. lecture notes</td>
<td></td>
</tr>
</tbody>
</table>

13. In addition to the provision of the tablet, do you still record notes during the lecture?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

14. What applications do you most frequently use on your tablet? (Please list in order of preference)

1. 
2. 
3. 

15. Does the provision of the tablet affect your attendance to lectures and practical’s?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>
Tablet technology in medical education in South Africa: a mixed methods study

L Lazarus, R Sookrajh and K S Satyapal

*BMJ Open* 2017 7:
doi: 10.1136/bmjopen-2016-013871

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