Design, development and implementation of a mobile learning strategy for undergraduate medical education

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Abstract

This paper describes the process of introducing a mobile learning strategy into a medical school by issuing iPads to clinical students. Data was collected from focus groups, surveys and by engaging a number of student "iPad champions". Students had a positive attitude and experience with the iPads for learning and highlighted some areas for improvement particularly for electronic sign-off. Introduction of mobile technology into medical education is proving to be popular with medical students. Early adoption of mobile technology brings medical students closer to the digital healthcare environment which is rapidly adopting the use of electronic health records, electronic x-ray and laboratory order and online evidence-based practice tools to support patient care.

Key words: mobile learning; medical education; iPad; undergraduate medicine; e-books; m-learning; e-health; m-health.

Background

Increasingly information technology is a part of everyday life. According to the International Telecommunication Union, 2.7 billion people are using the Internet, which corresponds to 39% of the world's population (31% in developing countries compared to 77% in developed countries) (1). Mobile technology is also expanding in clinical practice (2, 3). Different medical schools have introduced mobile medical education targeting pre-clinical and clinical years and the use of different mobile devices, such as personal digital assistants (PDAs) (4); and tablet devices (5, 6). This paper describes how the process of integrating mobile learning into the undergraduate medical school was carried out and supported by the medical library team at Imperial College London. It highlights all the areas of development and implementation introduced as part of the pilot project (2013-2015) targeting 800 undergraduate medical students in the final clinical years of the undergraduate medical curriculum (Imperial College iPad project, 2013) (7).

Introduction

In January 2013 a working group was set up to explore the idea of mobile learning in greater detail. The main stakeholders in this working group were academics, clinicians, administrators and students from the School of Medicine, Information and Communication Technologies (ICT) team from the wider university and the Library.

The idea of pursuing the development of a mobile learning strategy was based on a study carried out in 2011 when a respiratory course for 1st year undergraduate medical students was redesigned as a blended learning course using iPads in class. An analysis of this project showed a positive attitude of students when learning supported by the use of iPads and interestingly a more positive attitude was

shown by students who owned a tablet device. A high mark in the test at the end of the blended learning course was correlated with higher mark in their end of year exams (8).

The working group of about 30 contributors worked together for 6 months to assess the available options. The main outcome of this assessment highlighted the importance of concentrating on clinical years when a large number of clinical students are spread across multiple hospital and general practice sites across North West London. A business case was presented to the Faculty of Medicine for iPads Mini to be issued in Years 5 and 6 at the beginning of the academic term (2013/14) concentrating on the following areas of development.

iBooks

One of the key areas of development was the standardisation of course guides provided during different clinical attachments in iBook format for different attachments incorporating, videos, assessments, PowerPoint slides, quizzes, etc. allowing the introduction of interactive learning materials accessible offline.

Within their first month of receiving their iPad, 5th year students used the Pathology Museum iBook in a unique manner for interactive teaching within the classroom. Students had vignettes of patient cases, pictures of some pathology specimens and a location key for finding the correct physical specimen in the pathology museum, which is located at one of the main teaching hospitals.

Other iBooks have also been created for the various clinical placements that students rotate through in 5th and 6th year. *Figure 1* shows some of the iBooks that were produced for some of the attachments.

Interactive teaching

The Pathology course was delivered using a combination of tutorials and lectures. The students were given the paid App iAnnotate and they were encouraged to download hand-outs and annotate them electronically using iAnnotate App on their iPads. Interactivity was also introduced to the didactic lectures using the Apps Virtual G-Pad and Mentimeter. This encouraged student engagement during the lectures.
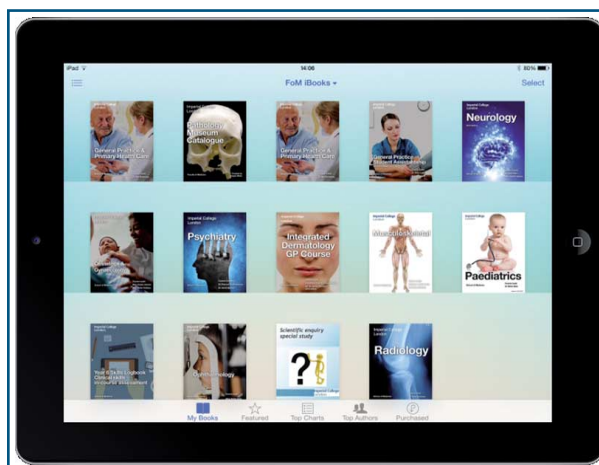

Figure 1. *Year 5 iBooks*

eBooks

Despite the name, eBooks differ from iBooks and refer to an electronic copy of a published book. Many eBooks have been made available to medical students via the library service. Students have to log in to the library via the browser on their iPad and search for a book in the library. If there is an eBook version available for this title, the student is able to read this book either online or download it to their iPad. The availability of certain books and the ability to download to their iPad or to only read them online is dependent on the licenses agreed by various publishers. Instructions on how these eBooks can be viewed are available on the College Virtual Learning Environment: Blackboard which can be accessed via the browser or the Blackboard App on the iPad.

Medical Apps

Imperial College Library Services has provided a license for the BMJ Best Practice App to allow students to access the learning materials available via the App. This is supported by the Library team and it allows students to access up-to-date medical guidelines and other learning resources quickly offline and in whatever location they are, which is especially important for clinical students on placement.

Imperial College Library Services has also recently provided a license for the UpToDate Anywhere App following requests for access from students.

Electronic submissions and signoffs

Electronic submissions and signoffs have been implemented in two different ways due to various reasons explained in the *Table 1* below.

SharePoint system	eForms App
SharePoint is used for electronic submissions to accommodate open-ended questions requiring formatting as well as submitting attachments (PDF, Word documents, etc.)	eForms iPad App (5) is used for electronic submissions in Years 5 and 6. It allows submissions of assessments (end of attachment, DOPS, etc.) via student iPads. The system allows clinicians to electronically sign the form online/offline and to receive an electronic copy of the submissions via email. Students also receive a confirmation via email and administrators can track submissions online.

Table 1. *Electronic submissions in Years 5 & 6 via SharePoint and eForms App*

iCalendars

The timetables given to the students during the different clinical attachments were designed using different layouts and different formats. iCalendars were introduced as a way to standardise the process of accessing timetables during clinical attachments and making the process of making updates to the timetables more efficient. Students are able to subscribe to an iCalendar and see all their personal appointments merged with the clinical attachment sessions in one Calendar on their iPad.

Methods

At the beginning of Year 5 and 6 in 2013 approximately 800 students received a Wi-Fi only iPad Mini with 16 GB of storage. The iPads were managed by the Mobile Device Management (MDM) system: AirWatch supported by ICT which enforces passcodes and track lost devices. All students were required to sign an iPad Agreement emphasising appropriate use of the device in relation to patient confidentiality and general code of conduct. The iPads were provided as a loan in the first year and were given for free in the second year. The MDM managed the initial setup of the iPad pre-loading the iBooks and the medical and learning related Apps: BMJ Best Practice App, iAnnotate, Mentimeter, eForms, etc. All students received one hour training on basic use of the iPad and the use

of the different Apps and iBooks. Drop-in sessions were available at different sites for a period of 2 months.

Data was triangulated using qualitative and quantitative data from surveys, focus groups and feedback from student iPad Champions at different stages throughout the 2 years project (see *Figure 2*).
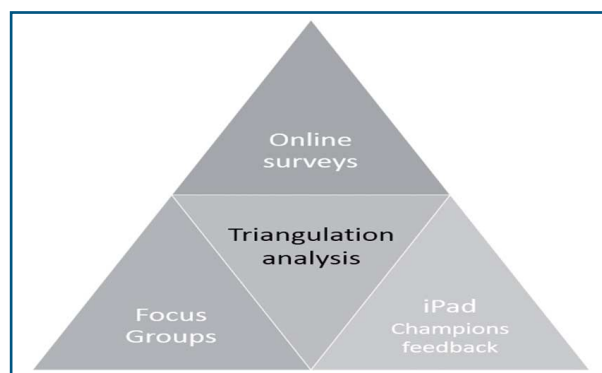

Figure 2. *Triangulation analysis – iPad Project*

The idea of this project is part of a wider initiative of "Students as partners", which is an initiative to involve students at a higher level within the School. iPad Champions were involved at different levels, channelling feedback from the student groups and producing videos on how to use the iPad effectively encouraging peer-to-peer support.

The studies carried out between 2013-2015 involved two Focus Groups conducted at the end of attachments in Years 5 and 6, quarterly meetings with iPad champions and seven surveys.

An initial survey was administered at the end of the Pathology course (Year 5) in June 2013 with 128 student responses (34% of the year group) and included demographics questions and additional questions that related to their experience with the iPad during the pre-clinical phase. A second survey was administered on the 5th month of the clinical phase to Year 5 students. 67 responses were received. This survey was focused on the assessment of the student experience in the use of electronic sign-off forms embedded in the iBooks using the Bookry system. A third survey was carried out in November 2013 with 12 responses from clinicians assessing their experience in providing feedback to students using the electronic sign-off forms available within the iBooks using the Bookry system.

A fourth survey was also administered to Year 6 students after two months of using their iPad to assess their experience with the iPad with 55 student responses. Based on feedback another system for electronic sign-off forms (eForms App) was introduced at the end of 2013. A fifth survey was administered in February 2014 to gather feedback on the use of the new eForms App with 24 responses from students and 29 responses from General Practice tutors. A sixth survey was administered in May 2014 with 25 student responses assessing the student experience accessing iCalendars on their iPad.

Results

Two Focus Groups were conducted at the end of the attachments in Years 5 & 6 in November 2013. The overall feedback received from Years 5 and 6 students on the iPad experience was quite positive. However, there was mixed feedback on the use of electronic sign-off forms delivered using the Bookry system from Year 5 students. In the focus group Year 5 students identified the limitations when using Bookry for electronic sign-off forms and the inconvenience of having some forms on paper and some electronic.

At the same time, the feedback received from clinicians involved in the electronic sign-off using Bookry was more on the positive side with suggestions to include signature functionality and to receive a copy of the submitted form via email which was later provided using the eForms App.

Pre-clinical survey results – Year 5

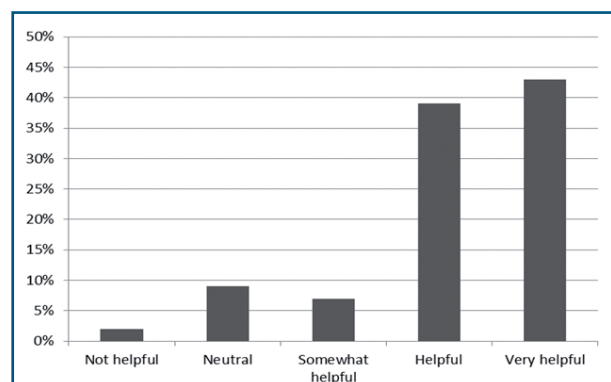*Figure 3* shows the evaluation carried out after the

Figure 3. *To what degree the use of iPads helped you learning during the Pathology course?*

Pathology course in Year 5 (n = 128) shows positive results. More than 80% of the students found the use of the iPad helpful.

Figure 4 also shows high levels of engagement annotating hand-outs electronically using the iAnnotate App. However, as seen on *Figure 5* only 30% of the students used eBooks available from the Library.
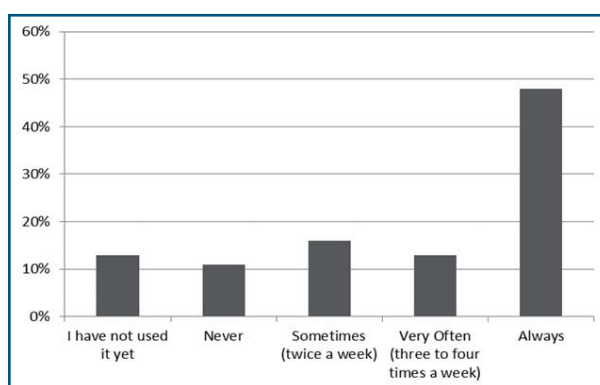
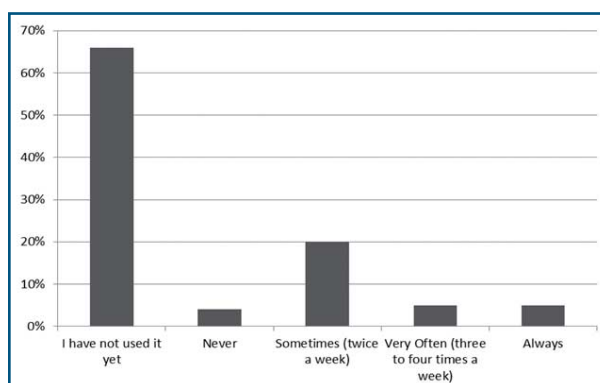**Figure 4.** *Student engagement in the use of iAnnotate App during pre-clinical phase – Year 5*

Figure 5. *Student engagement in the use of eBooks during pre-clinical phase – Year 5*

Figure 6 and 7 show how the students (n = 67) continued to find the use of iAnnotate App helpful during clinical attachments as well as the BMJ Best Practice App provided by the Library. *Figure 8* also shows over 50% of the students finding the use of eBooks from the Library helpful.
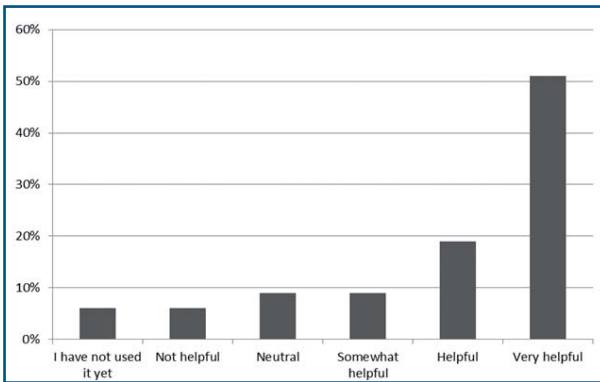
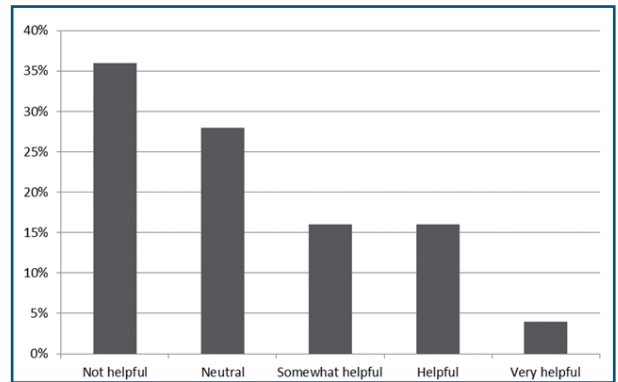**Figure 6.** *Student engagement in the use of iAnnotate App during clinical phase – Year 5*

Figure 9. *Student engagement in the use of electronic sign-off using Bookry system – Year 5*
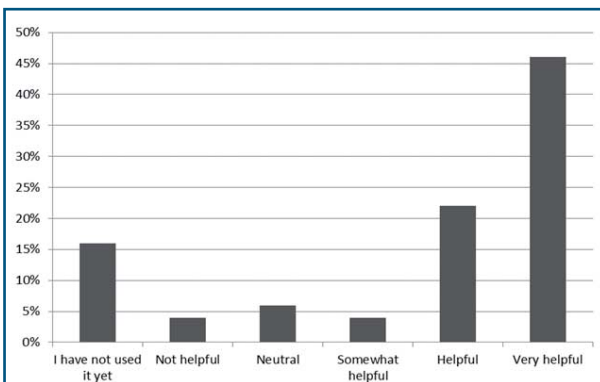

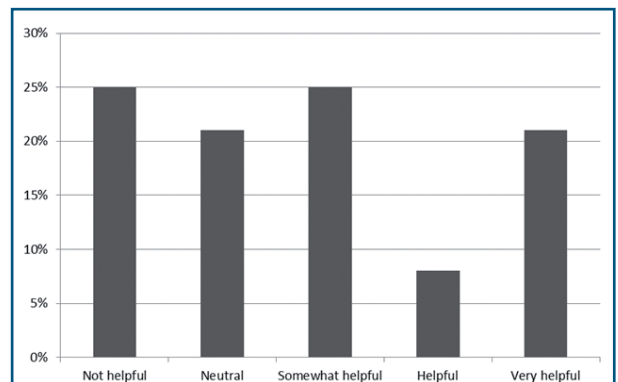**Figure 7.** *Student engagement in the use of BMJ Best Practice App during clinical phase – Year 5*

Figure 10. *Student engagement in the use of electronic sign-off using eForms App – Year 5*
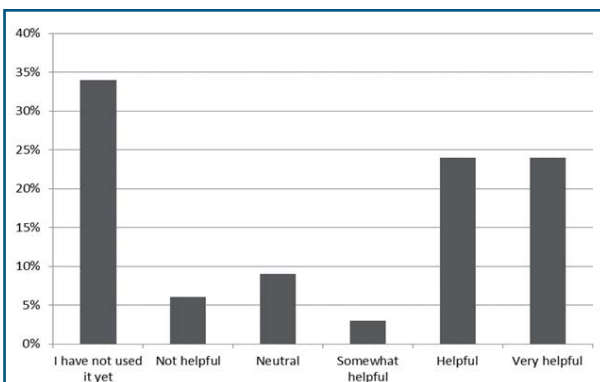
Clinical survey results – Year 6

Figure 11 shows Year 6 students also finding the use of iAnnotate App helpful as well as the BMJ Best Practice App showed in *Figure 12* and the eBooks in *Figure 13*.
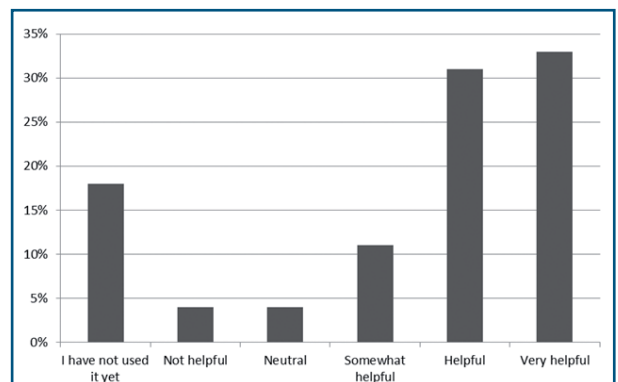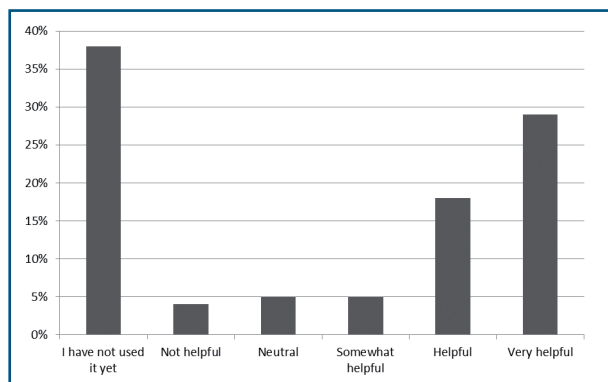

Figure 8. *Student engagement in the use of eBooks during clinical phase – Year 5*

Figure 11. *Student engagement in the use of iAnnotate App – Year 6*

Figure 9 shows the students not finding the electronic sign-off process provided via iBooks using Bookry very helpful. However, *Figure 10* shows students perception in the use of the eForms more positively.

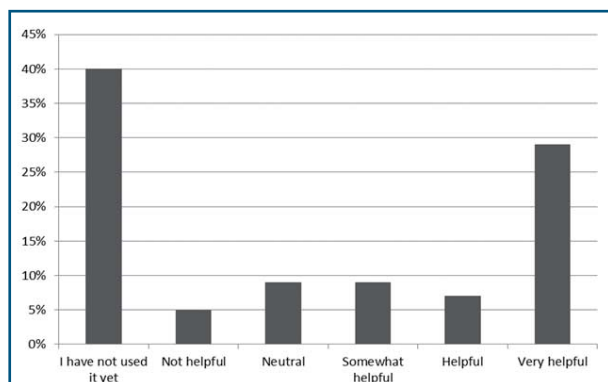**Figure 12.** *Student engagement in the use of BMJ Best Practice App – Year 6*

Figure 13. *Student engagement in the use of eBooks – Year 6*

Survey results–electronic sign-offs – Clinicians

Figure 14 and 15 show a positive attitude from clinicians towards the use of both Bookry system and eForms App in Year 5. In both instances they highlighted the importance of having signature
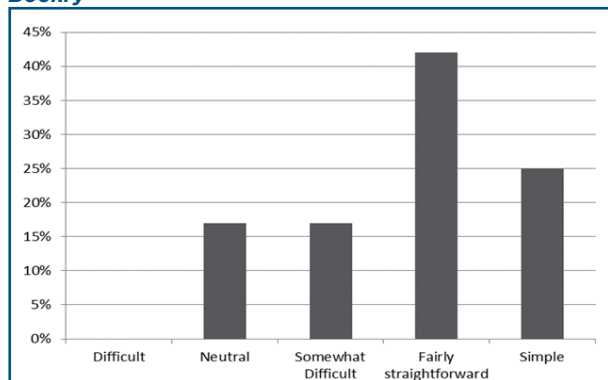
Bookry

Figure 14. *Clinician engagement in the use of Bookry system – Year 5*

eForms App

Figure 15. *Clinician engagement in the use of eForms App – Year 5*

functionality on the electronic forms which only eForms App provided.

Discussion

This study shows evidence that students used iPads to support clinical decision and learning during pre-clinical and clinical phases having more opportunities for evidence-based decision support any time at the point of care.

This study also provides evidence of the benefits in the provision of electronic sign-off forms, evidence-based practice tools and the distribution of course and learning related materials on the students' devices (iPads). The digitisation of clinical related assessments (e-forms) provides a more efficient and robust mechanism to audit assessment submissions during clinical attachments.

Careful engagement with key stakeholders and feedback from students and clinical staff is key in the development of the mobile learning strategy which should have transparency in the implementation of explicit educational tasks delivered using mobile devices (9).

Early adoption of mobile technology in medical education brings medical students closer to the digital healthcare environment which is rapidly evolving in the adoption and use of electronic health records, electronic x-ray and laboratory order and online evidence-based practice tools to support patient care.

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