iPads as digital platform for medical study: The SAMR model for mapping impact

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Abstract
Conventional educational wisdom would caution against technological innovation without having all pedagogical outcomes fully mapped out. Our experience introducing iPads into medical education at the undergraduate level demonstrates significant augmentation over the traditional learning medium and manifests a digital platform enabling previously-unforeseen learning benefits. This study uses Puentedura's SAMR model of technological intervention to describe and categorise these benefits, as well as to illustrate the pleasing successes possible through an experimental and innovative approach.

Key words: SAMR model; mobile learning; feedback; formative assessment.

Introduction

Conventional educational wisdom would suggest that technology is a tool that should serve pedagogical ideals and that when considering incorporating digital tools, one should have a robust educational plan in place from the start to avoid your pedagogy becoming subservient to the latest technological trends (1, 2). In the words of M. Fullan, "Without pedagogy in the driver's seat there is growing evidence that technology is better at driving us to distraction…." (3). We would not disagree with this completely. However, requiring a complete road map before incorporating digital innovation can constrain innovation and introduce a crippling level of inertia. We believe that creating a digital platform – providing student iPads for learning materials and activities – can open up powerful educational opportunities even when a specific endpoint is not fully conceived. Our experience demonstrates an innovative project taking root and bearing fruit despite many unknowns, and a pleasing discovery that students contribute abundant resources toward realising the vision of such a project.

In 2013, the Leicester School of Medicine (based at the University of Leicester) had the opportunity to provide each of our first year students with iPads. At this stage the main drivers for doing this were to reduce the printing of paper workbooks and to democratise student access to online learning materials. What follows is an account of how the project grew from these simple pedagogical beginnings into a fundamental component of the teaching and learning on this degree course.

To illustrate this we have used Dr Ruben Puentedura's SAMR model (4) as a framework for our project. This model is a useful way of assessing the impact that digital technology has on teaching and learning by describing broad hierarchies of impact. These hierarchies are found in the acronym SAMR and relate to Substitution, Augmentation, Modification and Redefinition, representing increasing levels of technology impact as illustrated in *Figure 1*. We will use SAMR to illustrate our iPad project and give a definition for each of the levels as we introduce them.

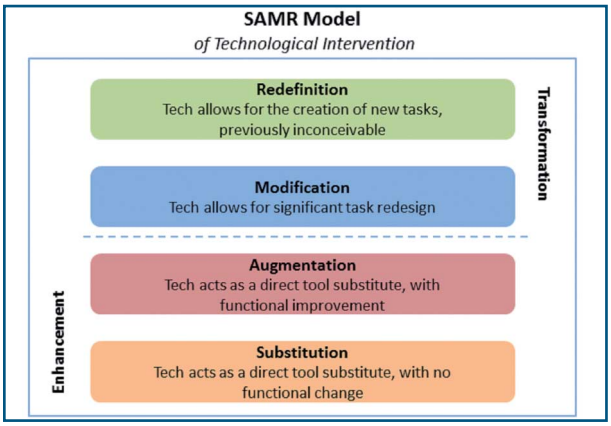

Figure 1. *SAMR Model.*

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S - Substitution - Tech acts as direct tool substitute, with no functional change

Our initial approach was to convert our paper workbooks into PDF files (with some minor changes in formatting) and make them available to download through Blackboard, our virtual learning environment (VLE). We recommended students use the PDF annotation app Notability as it was good value and highly rated by other users. We also encouraged students to regularly back up their work which was made straightforward by Notability having built-in links to a variety of free cloud-based storage solutions. Providing PDF versions of workbooks aligns to Substitution on the SAMR model. Substituting PDF versions for paper workbooks required very little additional work on our part. In fact, the administrative burden was significantly reduced as the printing process and physical distribution of the workbooks was removed. Academics were also afforded extra time to work on their unit materials as a print deadline was no longer an issue. These cost savings are all additional to the obvious ecological gains of this approach, in that thousands of paper copies were no longer being printed.

We were however anxious to see how the students found using the iPads as a replacement for the more traditional medium of pen and paper. We surveyed the students at regular intervals during this first year asking them a consistent sequence of questions to assess if their attitudes changed over time. Representative students quotations regarding the use of iPads to read and study learning materials include:

- "At first I was a little apprehensive as I was used to paper format. However once I started using the iPad I had adjusted to the style of learning… I now find it easy to use a combination of the iPad and written notes…. The iPad is extremely useful when trying to access specific material. It also saves carrying lots of documents!"
- "I have found that I am more likely to do spontaneous revision by having all my work so readily accessible on the iPad."

Figure 2 illustrates student response to a question about reading on the iPad. Survey 1 was conducted about three weeks after students were first given their iPads in autumn term 2013. Survey 2 was conducted about 12 weeks after students were given their iPads.

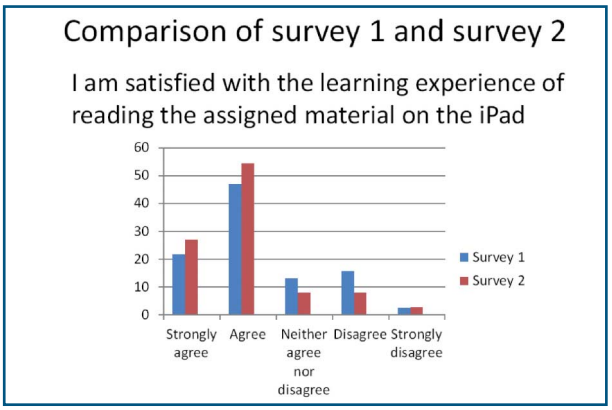

Figure 2. *Comparison of replies to the statement "I am satisfied with the learning experience of reading the assigned material on the iPad" occurring in surveys 1 and 2*

A - Augmentation - Tech acts as a direct tool substitute, with functional improvement

It soon became obvious that our act of substitution was in fact yielding broad Augmentation for staff and students alike. Very early in the use of mobile devices for learning, the promise of learning anywhere anytime was being realised (5, 6). It quickly became evident that our students were experiencing the beneficial affordances of mobile learning, allowing them as learners to freely move throughout their physical and virtual environments (7). Not only so, but mobile devices were opening possibilities of new inter-relationships and inter-dependencies among different types of content, and various interests, preferences and motivations of learners (8). These affordances are evident through student comments:

- "The iPad is fantastic to use during group work, …in fact, I'm not entirely sure how previous years managed these sessions without it!"
- "I think the iPads have been a good way to learn. It makes studying possible in more locations."
- "Its portability means I am not lugging heavy books everywhere, but have some ebooks neatly stored onto the iPad library – much easier to flick through these whilst going over notes."
- "The iPad is useful, able to have all workbook information and lectures at all times, and useful to have two things up at once, e.g. workbook on iPad whilst looking at lecture slides that have been annotated on the computer screen through Dropbox."

We also noted that the students were able to share their work and ideas with ease (for example using AirDrop, a file transfer service on iPads), whether that be across their group work table or a lecture theatre. Their connection to each other was noticeably augmented by these devices and as a result sharing was encouraged.

Electronic flashcard apps were also frequently being used. The augmentation advantage of these apps over paper based flashcards was not only the ability to widely distribute content but that students could tag and organise content for much more targeted retrieval. Questions that had been created at different times could be searched and viewed together to help the review of a particular topic. Students could also personalise their learning by rating the difficulty of individual questions. This in turn would automate the frequency that these questions appeared in future review sessions targeting weaker areas of understanding.

The example of electronic flashcards providing augmentation over traditional non-digital learning tools was a common theme. On the surface of it the iPads provided students with comparable tools – the ability to annotate documents, to read textbooks, to fill in surveys – but with all of these, there were layers of extra functionality. The most pleasing aspect of this was that it was student-led. We would find out or witness them using these digital tools in ways that supported their learning. If it wasn't beneficial or superior to traditional techniques, then it wasn't adopted.

M - Modification - Tech allows for significant task redesign

As the number of yearly cohorts with access to an iPad grew, so did the opportunities to exploit this digital platform. A key opportunity was the ability to significantly redesign our practice of formative assessment, thereby placing this task in the Modification category of the SAMR model. One of the greatest challenges facing our Medical school over the last few years has been a sustainable way to provide students with increased levels of timely and personalised feedback. Students value detailed and timely feedback; when feedback is delivered too long after the learning event, they perceive it to be of low quality and even of no value at all (9). While a level of digital automation would have been helpful in achieving this goal we realised that we had to have a complete rethink of how and when we could give students useful feedback and how our digital platform could facilitate this process. We eventually came across e-assessment software called ExamSoft which was fully functional on an iPad. This software could act as a complete exam management solution and also deliver secure offline exams in multiple formats.

Following pilot studies and using feedback from the students, we have developed a format that enables us to deliver some of our feedback improvement goals. Students receive regular formative quizzes (using ExamSoft on their iPads) that test key learning outcomes from the previous week's topics. Quizzes are in the format of single best answer (SBA). With ExamSoft, students receive immediate detailed feedback; if they select the incorrect choice, the correct answer is given, along with a short paragraph of information to help them understand what is incorrect, how this relates to the learning outcomes, and how to optimise their study. At their convenience students may log into an online portal and review their exam performance along with the detailed feedback, coloured according to a "traffic light" system highlighting correct, incorrect and partially correct answers. They can take the exams more than once and check improvement of their understanding through a continually updating portal which stores feedback from all their quizzes. The feedback in essence allows students to target weaker areas of understanding by providing immediate specific guidance as well as general signposting to appropriate unit resources. The portal allows students to visualise the trajectory of their learning in a way that has not been possible previously, and our hope is that students will be better equipped to self regulate their learning behaviour because of this feedback.

To our surprise, the student feedback on this e-assessment strand of the project was initially very hostile; to a survey question whether they found the user interface of the ExamSoft app to be easy to use, 60% of the students either disagreed or strongly disagreed (10). However, after several weeks the students became very appreciative of the assessment feedback. At the conclusion of the module in January 2016, students gave the highest feedback marks ever received for that module, and many

specifically cited the formative assessments with instant feedback as the reason for their positive appraisal.

This system is therefore a significant modification over previous formative assessments, in that students can practice-test their understanding and receive instant, detailed feedback. Other welcome features include unanswered questions being highlighted by the software so that the student cannot accidentally miss questions, and the ability to include good-quality colour images and videos in exams. The redesign of the formative assessment task enabled by iPads has been both significant and welcome.

R - Redefinition - Tech allows for the creation of new tasks, previously inconceivable

The nature of our progress in teaching and learning with iPads is such that it is constantly evolving. Through horizon-scanning, we have discovered and trialled some systems which allow us to teach in ways we could not have previously imagined, placing such tasks in the Redefinition category of SAMR.

Socrative and Top Hat are systems enabling live polling and surveying of students in class. It is notoriously difficult to encourage interaction and response from students in large classes, so any tools that enable this are very welcome. Live-interaction systems can instantly check students' understanding so the instructor has the option to adjust the teaching in real time. Students can also visualise how their answers compare with the rest of the cohort.

Lecturers in the Medical School had used some polling systems in the past which required bespoke equipment ("clickers"), but had been prohibited from going much further due to not owning enough clickers. Now that students all have an iPad, however, new possibilities are opened with results we could not have previously conceived. The following recounts by one instructor using Top Hat in a large lecture on clinical diagnostic thinking.

- **Free-text answers:** An instructor lecturing to a group of approximately 200 gave a complicated clinical diagnostic question. Using the Top Hat app, students typed in words and phrases indicating the main symptom they believed would present because of the described condition.
- **Students and teacher see how students "think around" a topic**: The replies were instantly synthesised into a word cloud displayed from the front, so that both teacher and student could understand how they were thinking about the topic and what should be their next steps in learning that topic.
- **Dynamically-changing discussion**: Students could change and add to their answer as the lecture continued, immediately updating the word cloud, deepening the discussion.
- **Instructors discover students' "knowledge map"**: Students responses are kept in a portal. After class, the instructor examined individual replies, reflecting on how students were constructing knowledge and beginning to synthesise and evaluate information on the topic, judging whether students were reading around the topic well enough and progressing in diagnostic thinking, and learning where he should intervene and further facilitate their development.

None of us could have envisioned the ability to instantly synthesise students' free-text replies to questions in lectures and how this would deepen in-class discussion, or the ability to reflect on these later to judge how to change teaching focus to address gaps and develop further. Our digital platform had redefined the lecture experience in this case.

Conclusion

Our experiences of creating a digital platform have been incredibly positive. From relatively simple beginnings we have seen real 'game changing' developments take place and, most pleasing of all, the students themselves have often driven these forward. This ground-up, student-led approach means that the project's momentum has been achieved without huge numbers of support staff, making it a very sustainable process.

The creation of a digital platform has allowed us to address challenges with a powerful set of new tools, enabling us to include learning opportunities that have previously not been possible. From improved connectedness to e-assessment, our teaching and learning experiences have been enriched to a point

where it would be inconceivable to return to our old methodology.

Through mapping a proportion of our activities to the SAMR model, we have attempted to illustrate the real impact on student learning that has occurred as a result of this project, as well as to demonstrate that the initiative has been extremely cost-efficient both in terms of financial outlay and in staff capital. Not only so, the creative processes involved in bringing this innovation to fruition have proven to be enjoyable for students and staff alike.

Received on 12 February 2016.
Accepted on 20 February 2016.

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