
Article:
Lumsden, C.J., Byrne-Davis, L.M.T., Mooney, J.S. et al. (1 more author) (2015) Using mobile devices for teaching and learning in clinical medicine. Archives of Disease in Childhood, 100 (5). pp. 244-251. ISSN 0003-9888

https://doi.org/10.1136/archdischild-2014-306620

Mobile Technologies for learning: Gimmick, Menace or Opportunity?

Introduction

The learning landscape has changed dramatically in the past decade and is undergoing a further seismic shift with the ubiquity of mobile internet connected devices. Smartphones and tablets can now provide access to an almost unlimited amount of information that is accessible anytime and anyplace. Mobile devices have become commonplace for learning (and perhaps even the norm) in the classroom, higher education and the workplace. Early evaluation data from such projects have revealed a heterogeneity in the adoption and acceptance of these devices amongst users. Whilst many see the undoubted benefits, issues including digital literacy and the need to integrate new ways of learning can be a barrier to uptake. With the increasing availability of highly intuitive devices and a generation of learners that access, and indeed process information in a completely different way than the generations that preceded them, the issue .is not whether we adopt these new technologies but whether we make the most of the opportunities they provide.

Access to learning within the paediatric environment

The paediatric clinical setting is a complex environment. Clinicians are expected to apply the highest standards of practice according to local and national guidelines. Perhaps for the first time patients, parents and relatives have almost unfettered access to the same reference resources and have consequently higher expectations of patient care. In addition it could be argued that the public are no longer willing to unquestioningly accept the opinion of a clinician. The instant access to high quality reference resources will be crucial to doctors both for their own learning and their clinical practice. Doctors are also being required to provide tangible evidence of competence and logging of clinical experience. This complex clinical environment requires both the demonstration of explicit knowledge (traditional resources) but also increasingly the need for tacit knowledge (opinion – through blogs, discussions or reflections on practice). There is therefore a need to provide solutions that are portable, convenient and available in the near patient environment.

Why is mobile learning different?

The ubiquitous availability of mobile devices brings with it many challenges to traditional learning theories and practice. Prior to the internet, resources were confined to paper based resources such as textbooks and journals. These required access to library resources and inevitably involved a delay between the need to access the resource and being physically able to do so. The internet changed this dynamic but in essence maintained the status quo of accessing information at a fixed location (desktop or laptop). The natural evolution of technology has seen a significant leap in access to resources and how they are presented. Not only are they available in traditional formats but this is now accessible on portable tablet devices and even formatted for access on smartphones. Burdette et Al described the huge potential for smartphone usage among physicians. They concluded that smartphones will allow a more efficient use of time and enable more clinically up to date care of patients (1) Mosa et Al performed a systematic review of Healthcare Apps in 2012 and concluded that “Medical applications make smartphones useful tools in the practice of evidence-based medicine at the point of care, in addition to their use in mobile clinical communication. Also, smartphones can play a very important role in patient education, disease self-management, and remote monitoring of patients”(2) Szekely et Al conducted a review of applications related to radiology in 2013. They concluded that “Smartphones and tablets offer new opportunities for diagnostic imaging practitioners; these easy-to-use devices equipped with excellent display may be used for diagnostic reading, reference, learning, consultation, and for communication with patients.” (3)

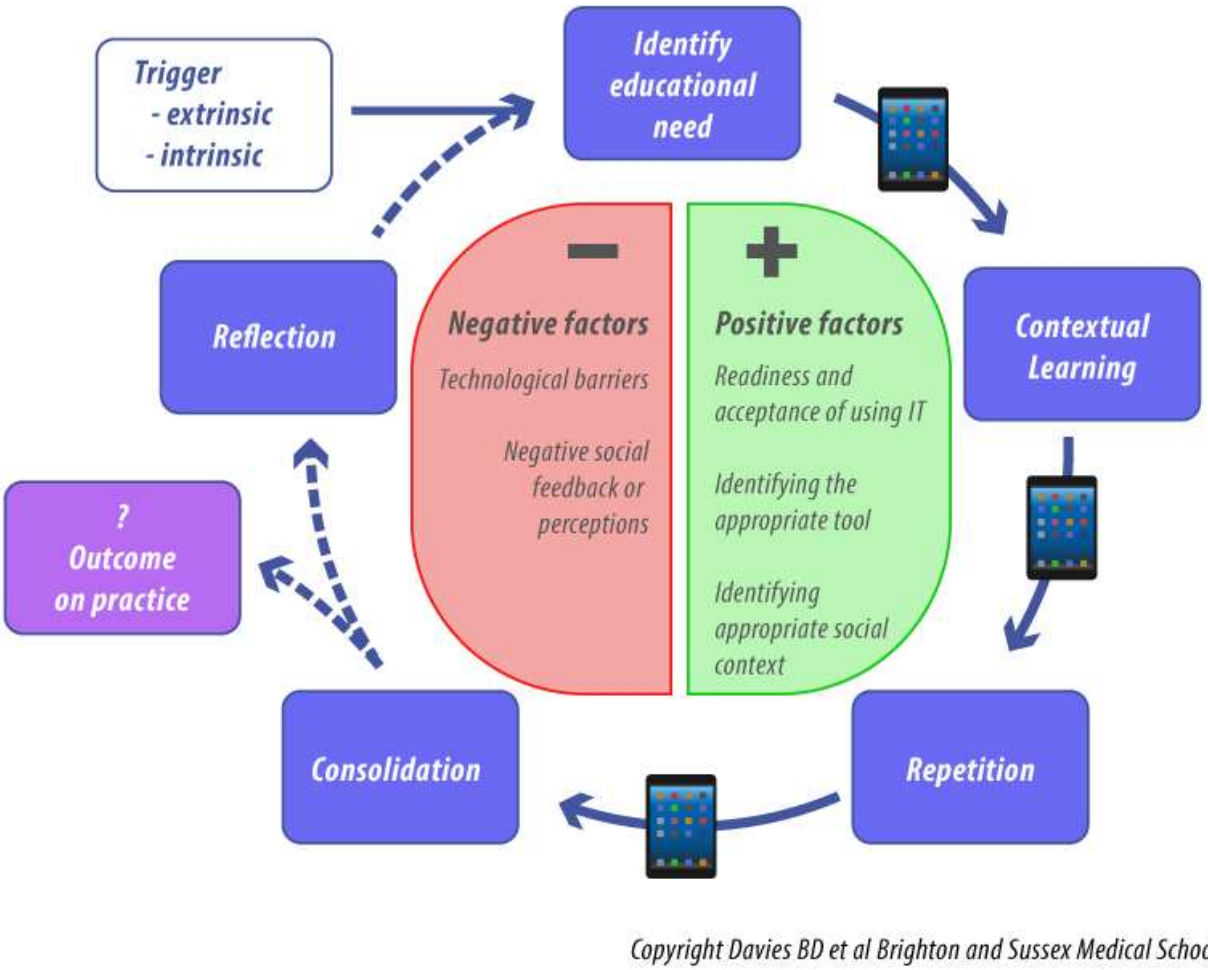

Fig 1. Conceptual framework for mobile learning Davies et Al 2012

New models of learning are therefore required to reflect these significant changes. Davies et Al perhaps for the first time developed a conceptual framework for mobile learning with enablers including: timely access to key facts (learning in context), consolidation of knowledge through repetition, used as a supplement rather than a replacement and making use of wasted time (4).

Just-in-time (JIT) learning as a concept originated in industry and began as a printed card that contained step-by-step instructions for performing a specific task. This was not intended for learning rather as a substitute for learning and a means of improving performance. JIT learning theory involves a highly individualistic model of learning that has several key concepts facilitated by new mobile technologies. This model involves learner control, is time and place-independent and results in the functional use of information. The learner control relies on constructivist learning theories in contrast to the more traditional information delivery systems. This integrated learning directed by the learner helps them to understand why, how and when to use information and tools. Opponents of constructivist (see text box on Constructivism) theory argue that these methods fail to provide strong content knowledge. It is clear however that trainees in practice have very limited access to traditional learning methods such as lectures and tutorials and therefore need to be able to learn experientially and in a self- directed manner. Finally the model holds that the information accessed are discrete functional tools or pieces of information that can be used as needed. This concept is particularly relevant within medical education whereby doctors in practice do require access to discrete pieces of information or resources to go about their everyday work. It does not

however teach the ability to construct this knowledge when considering complex cases or functions such as diagnostic ability or treatment evaluations. (5) This learning theory exists in stark contrast to what has been called Just-in-case learning whereby learners attain a large amount of knowledge in a broad field that can be retrieved at a later date.

Constructivism is a an educational theory that proposes learning is an active, contextualized process of constructing knowledge through the interaction of their experiences and ideas.

Key features:

- New experiences are assimilated by a learner into an existing framework or world view without changing that framework
- Accommodation occurs where the learner reframes their mental representation of the world to fit these new experiences e.g. learning from failure
- It is associated with teaching practices that promote active learning or ”learning by doing”

These processes mean that learners construct knowledge out of their experiences.

Just-in-case **Just-in-time with Transactive Memory**

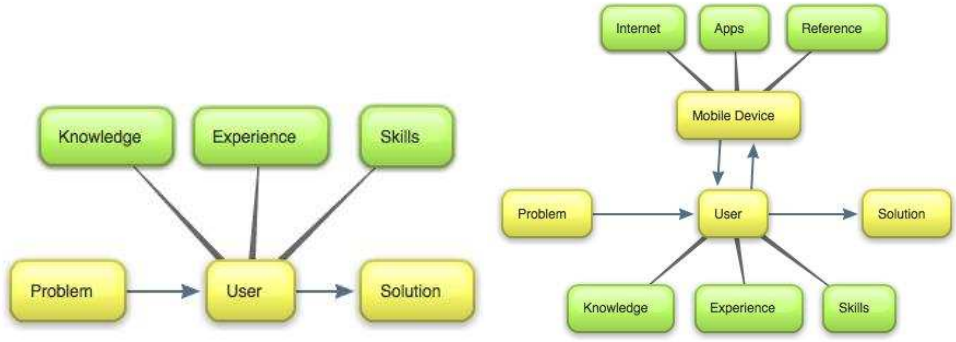

Fig 2. Just-in-time and transactive memory v just in case learning

A key component of Just-in-time learning is access to relevant resources at the point of care or learning. Wegner (a cognitive psychologist) introduced the concept of transactive memory whereby information is stored outside ourselves and accessed as required. Sparrow et Al conducted four experimental studies in 2011 suggesting that when faced with difficult questions learners are now primed to think about computers. The effect is that people who expect to have future access to information have lower rates of recall of the information itself but have an enhanced recall of where to access it (6). They concluded that the internet has become a form of external or transactive memory where information is stored. In essence we remember where to find knowledge rather than trying to remember the facts themselves. This concept is particularly pertinent to medicine whereby in previous generations doctors have been expected to carry large amounts of information due to the lack of access to these resources.

What are the potential issues involved with using mobile technologies in healthcare settings?

Concerns have been expressed about the professional standards of clinicians when working on mobile devices, with the assumption that they are only used for personal communications or social media use (7,8). The concern was such that guidance was issued by the General Medical Council in the United Kingdom (9). In addition there have been longstanding concerns regarding data protection and patient confidentiality. To a great extent the concerns around camera and video functionality appear to have been put to one side with the ubiquity of the devices and the impossible task of banning them from clinical areas. The approach therefore has been to issue unequivocal guidance to professionals around acceptable use and data protection. There is also a concern that patient perception of doctors may be affected detrimentally by the use of reference resources at the bedside or within consultations.

Are mobile devices just another fad?

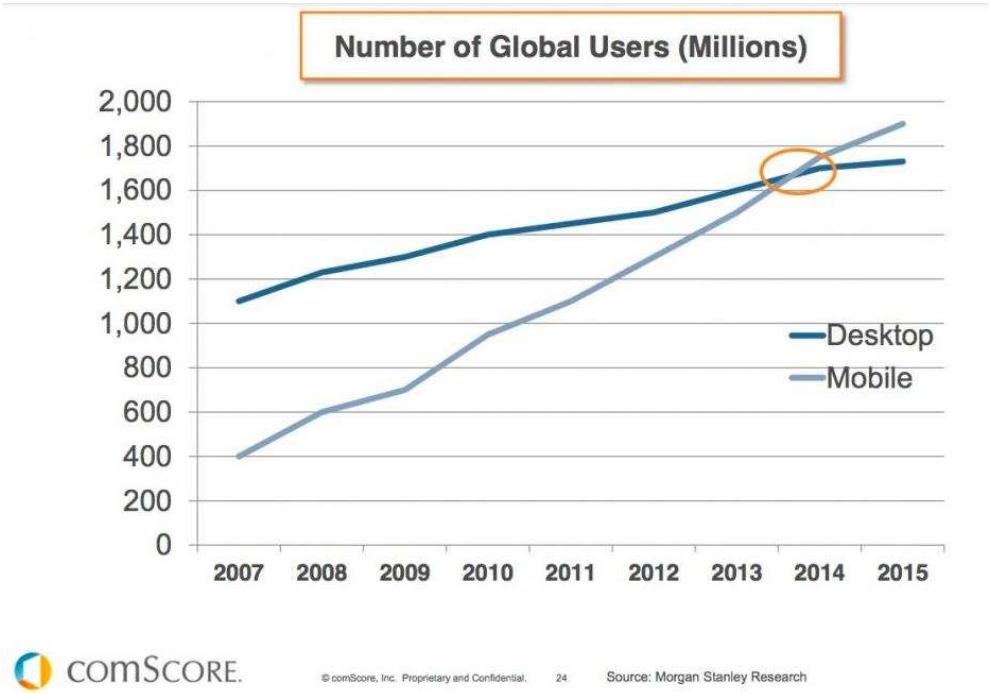

Fig 3. Mobile device usage predictions

Access to technology has traditionally been expensive but predictions (see Fig 3) estimate that for the first time mobile devices sales will outstrip traditional traditional computer sales . Added to that is the issue of access to the internet with Hospital networks reluctant to grant access for non-core NHS activities. Recent advances in technology and manufacturing have placed the power of the internet in the hands of anyone that wishes to access it. Modern smartphones and tablets have simple and intuitive user interfaces that encourage uptake and experimentation. This data would suggest that mobile devices are here to stay for the forseeable future

What software is available?

The self contained App has lead to a profusion of highly interactive, functional medical resources at minimal cost to the user.. In addition these resources can be disseminated to a large number of users for little or no cost. The ability to produce content at low cost and without technical know how is also driving the production of medical resources which clinicians are willing (and able) to produce and distribute worldwide. The availability of these resources and an always on internet connected devices presents a myriad of opportunities in the healthcare setting. These hold benefits for patients, parents, professionals and institutions. See Table 1

Education and Training	Patient Focussed	Professional	Healthcare and Institutions	Mobile Device Functions	Mobile Device Uses
eBooks	patient.co.uk	BNF/BNFc	Twitter (#FOAM)	Internet Access	Portfolios

Portfolio	Healthkit	NICE Pathways	Local guidelines and training	Audio Capture and Playback	Reference resources
Nearpod	Fitness and health tracking apps	WebMD		Video Capture and Playback	Cloud storage
Skills Logging	Patient information	BMJ Best Practice		Offline access to data	Social Media
Continuing Professional Development App	Automated appointment reminders	Up-to-date		Data Storage and collection	Productivity
		Don't Forget the Bubbles		GPS Positioning	Messaging
		Read by QxMD		External sensors	Push notifications and reminders
		Medical Calculators		Telephony (video and audio)	Calendar and Timetabling
		SIGN Guidelines			Maps and navigation
					Teaching via response systems
					Health Applications

Table 1. Resources and uses of mobile devices

For Professionals:

There are already a wealth of resources to distribute guidelines in interactive format such as the NICE pathways App or reference resources like the BNF and BNFc. This information is now easily disseminated worldwide. We are now able to access the entire breadth of medical knowledge from any location at any time. Mobile devices can now be used to log experience and update portfolios in real time. Complex medical calculations can be performed simply and effectively using Apps at the bedside. However, some clinicians have been concerned that there is a danger that the skills to perform such calculations will be lost but is this acceptable with the reduced probability of for example prescribing errors?. Systems are being developed to facilitate the input of patient data as opposed to paper-based notes. This will become increasingly important and indeed relevant as electronic patient records become the norm rather than the exception.

For Healthcare and Professional Institutions:

Professional bodies can make use of these technologies to aid with competency attainment and progression. This ability to capture data in real time for the first time provides the opportunity to assess performance and competence at the highest levels of Miller's Pyramid, thereby reflecting real world practice. This is a fundamental shift away from demonstrating competence in structured clinical assessments and examinations. Collecting multiple small pieces of data may vastly improve the confidence with which to assess a trainee or indeed consultant's competence in the workplace. This could also see the inclusion of patient views to triangulate data. The power of real time data collection and analysis lies with the ability to intervene quickly rather than waiting for an adverse outcome to bring poor practice or deficiencies to light. The School of Pharmacy at Manchester University recently ran a study collecting real time prescribing errors using iPads and feeding these back in a timely manner to medical staff with feedback on how to prevent such errors occurring in the future. Manchester Medical School has used tablets for admissions interviews on a large scale and has also used them for high stakes clinical examinations. Evaluation data has

shown that users readily accepted the use of tablet technology and found them intuitive requiring minimal training. A number of medical schools have adopted tablets for clinical examinations with benefits including cost reductions, increased accuracy of data collection, reduction of administrative burden and improvements in feedback to those sitting the examinations.

For Educators:

Mobile devices have also opened up a wealth of opportunities for learners and educators. Previously challenging concepts such as creating interactive elearning resources have been simplified dramatically with simple resources that allow creators of content to have very little or no IT expertise. Educators can now produce interactive, immersive content using formats such as the humble PDF to more sophisticated formats such as ePub and iBooks. These resources can be distributed worldwide instantly and be read in eBook readers. These resources are annotatable and can contain formative assessment to aid in knowledge acquisition and retention. Powerful learner interaction tools are becoming available that allow presenters to create interactive real time elements within seminars (eg Nearpod). There are several reference manager tools and even APps that update users of new abstracts within selected journals using push technology (Read by QXMd).

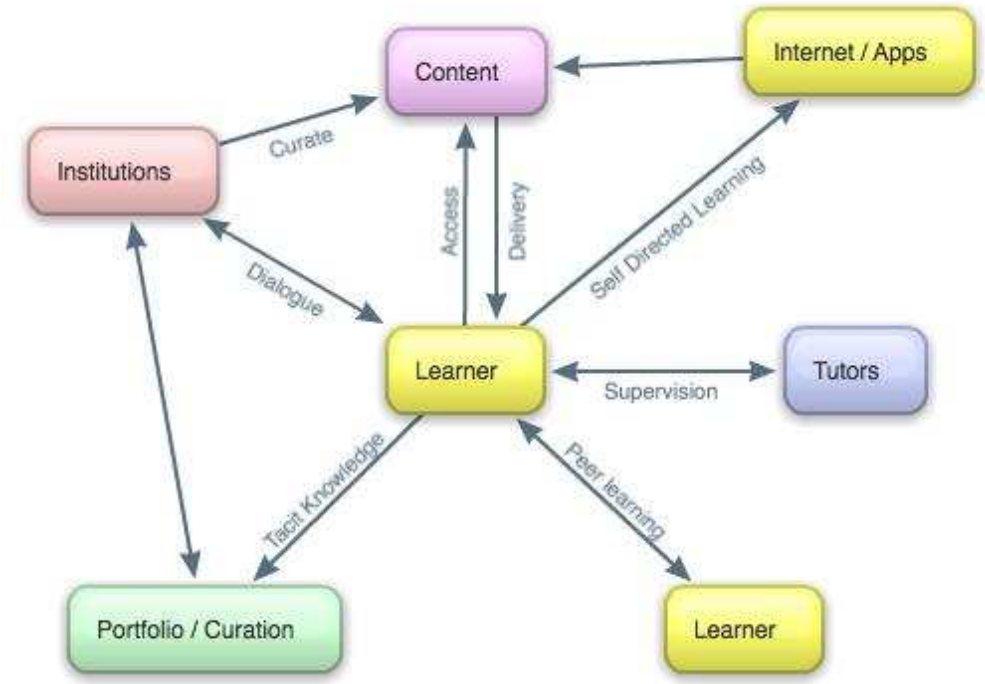

Fig 4 Educational uses of mobile technology

What are the threats to the use of mobile technology?

Mobile devices in clinical care have gained acceptance by their ubiquity. A more recent development has seen the development of wearable technology such as smartwatches (Apple Watch) and glasses (eg Google Glass). This presents both opportunities but also significant threats to confidentiality and patient consent. From a professional perspective it would be unethical to record all patient encounters without specific informed consent. There have been some excellent examples of use in education such as within operating theatres to allow trainees to see what the surgeon is seeing. Indeed this does provide a rich seam for research into how experts practice as compared to novices and may well form part of simulation training in the future. The alternate application could however see patients recording interactions with health professionals either overtly or covertly. This has been the subject of a recent GMC Fitness to practice panel and the covert recording of consultations is deemed to be within the law(10)

Putting it into practice

There is a widely held belief that mobile devices are simply a means of accessing the internet and emails. Whilst this may in essence be true these devices make that sum of human knowledge accessible and perhaps as importantly usable in a near patient context. A recent report demonstrated that for the first time the internet was being accessed more frequently from within apps rather than from mobile browsers(11). At their most simplistic level these devices do offer that functionality and using these functions offers no great advantage over any fixed internet connected computer other than convenience and portability. This does however ignore the wealth of other capabilities offered by such devices. Mobile devices can and will increasingly be used within the clinical context. Fig 5 demonstrates some of the uses mobile devices could and to some extent already do offer in the clinical workplace. An understanding of these possibilities is key to designing educational interventions that will be relevant to health professionals of the future.

Fig 5 Potential uses of mobile devices for learning and practice

This seemingly endless functionality requires exploration, investment in time and the guidance of educators. It could be argued that the educators are the ones in most need of guidance as this revolution post dates their training and working practices. Without this guidance for tutors and learners the benefits will be limited to those willing and able to engage potentially widening the digital literacy divide (12). As discussed previously these resources and functionality have been viewed as threats to the role of the teacher. What is clear is that human beings fundamentally crave interaction and personal contact. The challenge therefore is to blend these novel technologies with face-to-face contact and to make most use of the experience and expertise of others in the clinical environment. Rather than replace we must engage with these technologies and find new ways to incorporate them in to our working practices.

How have people used Mobile Technology for education?

The use of mobile devices in postgraduate education has been problematic as trainees and trainers have a widespread diversity of technology which they have as personal mobile devices. The creation of content and educational interventions is therefore greatly complicated by the need to develop tools which can be used on multiple platforms. This has been achieved to some degree by the Royal College of Paediatrics and Child Health by developing a WebApp for documenting CPD in real time. This allows clinicians to keep a real time log of CPD therefore saving time and effort in recording their activities. A similar interface is also now available to trainees in the UK to

facilitate uploading of activity to their online Portfolios. The more sophisticated use of mobile technology has been achieved in higher education but at significant cost to institutions who have provided a single platform for their students. Leeds Medical School were the first to distribute mobile devices and in 2010 began using iPhones. This project has seen the distribution of downloadable reference materials and the creation of a portfolio app that allows students to document learning experiences and reflect upon these in the near patient environment. Manchester Medical School became the first UK medical school to deploy iPads in 2011. The larger form factor facilitated new uses of these devices to encompass many facets of medical education including:

- Assessment of skills in the workplace and near patient environment
- Examination marking to facilitate rapid collation of results, analysis and provision of timely feedback on performance
- Collection of supervisory reports and student feedback
- Immediate collection and collation of interview station marks
- Provision of reference resources with distribution using "push" technology (eg BNF, BMJ Best Practice, Oxford Handbooks, NICE Pathways, Prescribing Apps)
- Downloadable multimedia resources (eg video lectures, procedural skills videos)
- Downloadable course specific materials (eg Rules, regulations, programme information)
- Electronic portfolio with mobile uploads of data in the near patient environment
- Up to date and accurate dynamic timetabling

Getting involved

The field is relatively new and there are many opportunities to get involved at an early stage. A good place to start is the iMedical Apps site which has over several years reviewed and rated mobile applications across all platforms http://www.imedicalapps.com/about/. Many Medical Schools have started using mobile technology and indeed deploying these technologies to their studentshttp://www.ucisa.ac.uk/~/media/Files/publications/case_studies/ASG_Effective_Use_Mobile%20Learning. There is also a growing use of social media in medicine which is particularly strong within Emergency Medicine. This new movement is called FOAMed (Free Open Access Medical Education) and is committed to sharing knowledge and resources worldwide using Twitter. There are increasing numbers of medical reference resources being produced by enthusiastic clinicians and teachers who simply wish to share their knowledge and experience. In addition there are literally tens of thousands of medical applications (both free and paid for) dedicated to medicine. A simple search on App stores such as the Android marketplace and the Appstore will reveal a huge array of resources. In addition there exist a great deal of excellent resources created for other purposes or settings that can be used in healthcare education or delivery. Nearpod is one example of a student response system that allows the simple creation of interactive learning presentations. These could be used to change the way you share your knowledge and potentially revolutionise your teaching.

What if you want to create something?

Making Apps or resources are not a difficult as you may think. There already exist good desktop publishing software to create multimedia resources. Authors wishing to distribute in electronic format can use the ePub format which can be viewed on most mobile devices and can be distributed worldwide with ease. Those wishing to adopt an Apple platform can use iBooks Author which is free on newer versions of their operating system OSX. This is restricted to iPads and Apple computers but has the advantage that they can be distributed for free worldwide via the

iBook store. Those wishing create bespoke applications need to firstly identify the issue they wish to address:

- What is it I want to achieve?
- Why does it need to be done on a mobile device?
- Where will the resources be accessed?
- What screen size will be needed?
- What functions do I want to use from the device?
- Do I wish to collect or distribute data?
- How will I use that data to stimulate learning?

Once these issues have been identified a detailed specification can be drawn up with a software developer and the creation of an App is often far less costly than one would imagine. Indeed in many instances these resources may already exist. Think also about security, patient identifiable data and NHS systems which can be difficult to overcome in a world where data security is quite rightly taken very seriously.

What about research?

Due to the fact that these devices are so new there is very little research in this area and it offers an opportunity for those wishing to explore further how these devices are used by students, patients, doctors and the public. MOMERN (Mobile Medical Education Research Network) is a new international research network dedicated to research in the field of medical education. Those wishing to get involved can look further at the research opportunities which may exist locally or nationally http://www.momern.org .

Conclusion

Mobile devices have become ubiquitous in the clinical learning environment. These devices and the resources they give access to are available to anyone who wishes to access them including patients of nearly all ages. Medical Schools are embracing mobile technologies in educating clinicians of the future. Clinicians and educators should recognise that mobile devices are here to stay and think about how they can be used in their own practice. Reflective practice will allow those who do so to think about how this technology can then be used to facilitate learning in the clinical environment and at an institutional level.

References

1. Burdette, S.D., Herchline, T.E. & Oehler, R., 2008. Surfing the web: practicing medicine in a technological age: using smartphones in clinical practice. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America, 47(1), p.117-122.
2. Mosa, A.S.M., Yoo, I. & Sheets, L., 2012. A Systematic Review of Healthcare Applications for Smartphones. BMC Medical Informatics and Decision Making, 12(1), p.67.
3. Székely, A., Talanow, R. & Bágyi, P., 2013. Smartphones, tablets and mobile applications for radiology. European Journal of Radiology, 82(5), p.829-836.
4. Davies, B. S., Rafique, J., Vincent, T. R., Fairclough, J., Packer, M. H., Vincent, R., & Haq, I. (2012). Mobile Medical Education (MoMEd)-how mobile information resources contribute

to learning for undergraduate clinical students-a mixed methods study. BMC medical education, 12(1), 1
5. Challenges of the Next Millennium: Education & Development of Human Resources. The Fourth Annual Conference of the Emirates Center for Strategic Studies and Research, Abu Dhabi, May 24-26, 1998 http://faculty.pepperdine.edu/mriel/office/papers/jit-learning/
6. Sparrow, B., Liu, J. & Wegner, D.M., 2011. Google effects on memory: cognitive consequences of having information at our fingertips. Science (New York, N.Y.), 333(6043), p.776-778.
7. Ramesh, J., Carter, A. O., Campbell, M. H., Gibbons, N., Powlett, C., Moseley Sr, H., ... & Carter, T. (2008). Use of mobile phones by medical staff at Queen Elizabeth Hospital, Barbados: evidence for both benefit and harm. Journal of Hospital Infection, 70(2), 160-165
8. Lo, V., Wu, R. C., Morra, D., Lee, L., & Reeves, S. (2012). The use of smartphones in general and internal medicine units: A boon or a bane to the promotion of interprofessional collaboration?. Journal of interprofessional care, 26(4), 276-282.
9. http://www.gmc-uk.org/Doctors__use_of_socil_media.pdf_51448306.pdf
10. http://www.mddus.com/mddus/news-and-media/notice-board/october-2012/covert-patient-recording.aspx
11. http://www.flurry.com/bid/109749/Apps-Solidify-Leadership-Six-Years-into-the-Mobile-Revolution#.U1kHQV7nucc
12. Sandars, J. (2012). Technology and the delivery of the curriculum of the future: Opportunities and challenges. Medical teacher, 34(7), 534-538