Considering the Smartphone Learner: developing innovation to investigate the opportunities for students and their interest

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Case Study

Considering the Smartphone Learner: an investigation into student interest in the use of personal technology to enhance their learning

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Abstract

Ownership of mobile smartphones amongst the general consumer, professionals and students is growing exponentially. The potential for smartphones in education builds upon experience described in the extensive literature on mobile learning from the previous decade which suggests that the ubiquity, multi-functionality and connectivity of mobile devices offers a new and potentially powerful networked learning environment. This paper reports on a collaborative study conducted by an undergraduate student with the support of two members of academic staff. The research sought to establish the extent to which students are autonomously harnessing smartphone technology to support their learning and the nature of this use. Initial findings were explored through student interviews. The study found that students who own smartphones are largely unaware of their potential to support learning and, in general, do not install smartphone applications for that purpose. They are, however, interested in and open to the potential as they become familiar with the possibilities for a range of purposes. The paper proposes that more consideration needs to be given to smartphones as platforms to support formal, informal and autonomous learner engagement. The study also reflects on its collaborative methodology and the challenges associated with academic innovation.

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Introduction

Smartphones put powerful, user-owned computing devices into the pockets of students and academic staff. The student ownership of these multifunctional mobile devices is growing exponentially (Dixit *et al.*, 2011); whilst ways of making use of smartphones in higher education have been explored since they first became available in 2007, building upon interest and innovation in the use of mobile technologies for learning (Kukulska-Hulme and Traxler, 2005). It is important, therefore, for educators to understand the potential of these devices to teaching and learning, especially if their use by students is likely to erode constraints that currently deter effective learner engagement with the curriculum and academic innovation.

This paper begins by introducing smartphones and what distinguishes them from other Information and Communication Technologies (ICTs). It presents a rationale for and background to the study presented here which was designed to discover the extent of autonomous student interest in their use of smartphones to support learning. It discusses findings from the student-led study, reflects on the student-staff collaborative model that underpins it, and discusses the implications of smartphones as a potentially useful, albeit disruptive, learning technology.

Background

Distinguishing smartphones from other ICTs

Smartphones, such as the iPhone, emerged as hybrids of PDAs (Personal Digital Assistants) and mobile phones in the 1990s, bringing together connectivity and a diverse collection of hardware and software-based functionality. Smartphones have developed considerably since then, becoming increasingly commonplace following the release of Apple's iPhone in 2007.

The mobile operating systems found on smartphones allow users to run software, commonly known as 'apps', that deliver highly usable and tightly focused functionality enabling myriad applications. In some cases apps come pre-installed on smartphones, though many others are freely and cheaply available: over 425,000 different apps are available for the iPhone alone (Apple, 2011). This means devices become highly customised personalised platforms for communication, organisation, information production and content management.

Whilst smartphones are only pocket size, they incorporate computing power and memory capable of running complex software and storing huge amounts of data. Functionality including full 'qwerty' keyboards, cameras, audio recorders, gesture-based input, and high resolution displays, is complemented by a wide range of apps which include support for office productivity, location-based interactivity, media production, web browsing, social media, communication and entertainment.

Smartphones can conveniently and directly connect to the Internet through protocols including wifi and 3G and indirectly through Bluetooth. This connectivity allows data to be accessed from anywhere in a timely way, whilst it also allows the user to distribute content in

various media to others. A smartphone, therefore, offers a rich set of mobile computing functions with connectivity; this combination frees the user from desk-based ICT associated with traditional computing in education. Smartphones are ubiquitous and accessible devices that travel with the user, so empowering them to respond to situations, ideas and needs as they emerge. The capacity of a smartphone to access, manipulate, produce, store or share content almost as soon as it is created, wherever it is created, provides the rationale for why education needs to explore the technology. This versatility promises to change the nature of educational content and communication and therefore the nature of learning itself.

Mobile learning

Smartphones used to support learning need to be considered in the context of the literature on mobile learning.

Mobile learning research has considered a broad range of technologies, especially those that have emerged for the general consumer: mobile phones, PDAs, and cameras, for example. However, it has been difficult to define mobile learning. Early definitions concentrated on the mobility of the technology (Sharples *et al.*, 2009) and generally overlooked the significance of the personal, portable and ubiquitous nature of the devices, the new locations and communities that became available to the learner due to connectivity, the impact technology can have on engagement in environments as diverse as labs, the work place and lecture theatres, and how this can affect approaches to teaching and learning, learner engagement and control, formality and situatedness.

For some, therefore, the term mobile learning emphasises learning on the move; for others it is the personal, ever-present, and immediate nature of the devices (Kukulska-Hulme and Traxler, 2005). Both views emphasise mobile learning as a process characterised by the gaining of knowledge through exploration and conversation across a variety of environments. El-Hussein and Cronje (2010) offer a taxonomy to comprehensively understand mobile learning: mobility of technology, mobility of learners and mobility of learning. Others have described mobile learning as learning that happens anywhere, with anyone, and anyhow (JISC, 2005; Stoyanov *et al.*, 2010). All of these views, and others, point to the changing possibilities for learner engagement. Vavoula (2004) proposed that mobile learning has the potential to transform learning from being highly intentional, structured, and directed, to an experience that is able to value informal and open learner-centred activity more.

The prevalence of smartphone devices, and latterly tablets like the iPad, because of their widespread consumer acceptance demonstrated in their exponential growth in sales (Gartner, 2010), demand that higher education explores the potential for enhancing learner engagement and prepares itself to address student expectations for a more mobile learning experience.

Smartphones in higher education

There is evidence of growing interest in the use of smartphones in higher education leading to new pedagogical practices. Cochrane and Bateman (2010a), reflecting on three years of

action research into the pedagogical affordances of smartphones, correlate the user-centred and social value of Web 2.0 technologies to education with the smartphone's capacity to facilitate student-centred social constructivist pedagogies, which McLoughlin and Lee (2008) refer to as "Pedagogy 2.0".

Herrington (2009) discusses how smartphones were used to collect video, image and audio data for creating digital narratives or stories for use as curriculum resources.

Nortcliffe *et al.* (2011) discuss the tutor use of smartphone audio apps for giving intrinsic and extrinsic feedback and found that students appreciated feedback given this way. For the tutor, the connectivity in her smartphone audio app was liberating at times of high pressure associated with marking and feeding back on assignments; it reduced her dependence on her PC's tethered Internet connection.

Walsh (2010) and Ramsden and Jordan (2009) have both reported on the use of smartphones in supporting innovation with QR Codes: two dimensional coded patterns that, when scanned by a camera application, are capable of conveying and connecting to situated information. Ramsden and Jordan found that in 2009 the majority of students were able to access information on their personal devices, but were largely unaware of the technology and how it could be used, with only one in 50 ever having used a QR Code.

Student interest in autonomous ICT innovation

When students were presented with an MP3 recorder as part of an educational research project funded by Sheffield Hallam University's Centre for Promoting Learner Autonomy, they creatively established a variety of practical uses for their device to enhance their learning. The range of innovation discovered through this project highlighted student ingenuity in formal and informal situations, though students needed to be encouraged to think beyond their expectations of a traditional learning environment (Middleton and Nortcliffe, 2009a).

The National Student Forum Annual Report 2009 challenged "universities and lecturers to review their teaching methods… to assess whether they are sufficiently taking advantage of new technologies" (HEFCE 2010). This literature review, conducted for the HEFCE, reports on the way students think about technology. It presented a diversity of opinions in relation to e-learning, though it was clear about the need for the selective and appropriate use of technology and that the predominant challenge facing education is how to harness that potential. The online survey of 213 Further Education students underpinning the report suggests that opinion is evenly divided over whether mobile phones or PDAs (the precursors of smartphones) should be used to assist learning. However, research into stakeholder perceptions of the innovative use of technologies to support learning is problematic and unreliable: typically it must presuppose that respondents are conversant with emerging and complex ideas and practice relating to effective pedagogy and the application of technology.

The Committee of Inquiry into the Changing Learner Experience (2009) reported that whilst ICT is an important development for teaching and learning in higher education, for example in supporting the development of digital literacy and employability, many students still believe that conventional methods of teaching are better and that there is a deficit in the skills of staff to consistently and fluently adopt ICTs. At the same time HEFCE (2010, p.4) notes dissatisfaction and alienation amongst students "with older teachers continuing to favour old or outdated methods" including the use of established technologies such as PowerPoint.

Methodology

This paper explores the students' interest in using their own smartphones to support their learning. The study informing this paper was conducted as an undergraduate student project with the sponsorship of Middleton (an educational developer) and the support of Nortcliffe (the student's tutor).

The research aimed to find out the extent to which students are harnessing smartphone technology autonomously to support their learning and how this manifests itself. It was conducted in three stages, involving two online surveys followed by interviews with four students.

Initial online survey

An initial questionnaire was created and distributed to Sheffield Hallam University students using the Facebook social media networking site to establish the validity of the study: were students using smartphone applications? Approximately 100 students received the questionnaire and 54 responses were received.

In depth online survey

Having established the validity of the study, an in depth questionnaire was designed and delivered targeted at undergraduate and postgraduate students from the faculty of Arts, Computing, Engineering and Sciences (ACES) at the university. The survey was created and presented in Google Forms. This method was identified by the student researcher as being the most effective mechanism for engaging a wide range of students representing diverse courses. The questionnaire was distributed using an embedded link through email in Autumn 2010. Respondents followed the link to the questionnaire which was then displayed in their preferred web browser. The questionnaire was designed to be dynamic so that questions were selectively presented dependent upon how earlier questions had been answered. This type of dynamic questionnaire was felt to be more precise and likely to improve the respondent's experience of completing the questionnaire. It also helped to avoid collecting erroneous data which can be difficult to achieve when designing paper-based questionnaires. Students submitted their completed questionnaires electronically, with results being conveyed to a

Google Doc spreadsheet which was later exported to Microsoft Excel 2007 for further analysis.

The first part of the questionnaire gathered demographic data on the respondent's gender, age, current level of study, course of study and smartphone ownership. Depending on their response to the latter, the questionnaire continued by investigating information about the respondent's smartphone and their use of it, including their use of apps.

Based upon similar questions used by Park and Chen (2007), this section of the questionnaire asks about apps currently being used by the respondent, the technical challenges and constraints faced by respondents, the usability of the apps, and how app usage has affected their learning. Five point Likert scales were used to investigate the perceived usefulness of smartphones and smartphone apps in supporting their studies.

Finally, respondents were asked to identify features and tools they would like to see in a smartphone learning application.

Student interviews

Interviews were conducted with four students to validate the findings of the quantitative surveys and to develop those findings using a more qualitative, open-ended approach in order to provide insight through accounts of their experiences. The use of interviews made it possible to explore perceptions about benefits and to learn how users addressed the technical challenges and constraints they encountered.

Results

Initial online survey

It was evident from this small questionnaire that many students are using smartphones and apps autonomously for learning. The survey provided some initial insight into the nature of student interest in the technology. Fig. 1 shows responses to the question "What services or apps do you use for learning purposes?" At this stage of the research the findings suggested that the types of application were relatively commonplace and unspecialised. The phone's calculator, for example, is used by 33 (69%). The use of the phone's camera (20, 42%) and video capacity (13, 27%) indicate how personally owned technology may be starting to develop student's ICT usage in ways that institutional technology would not be able to support at scale.

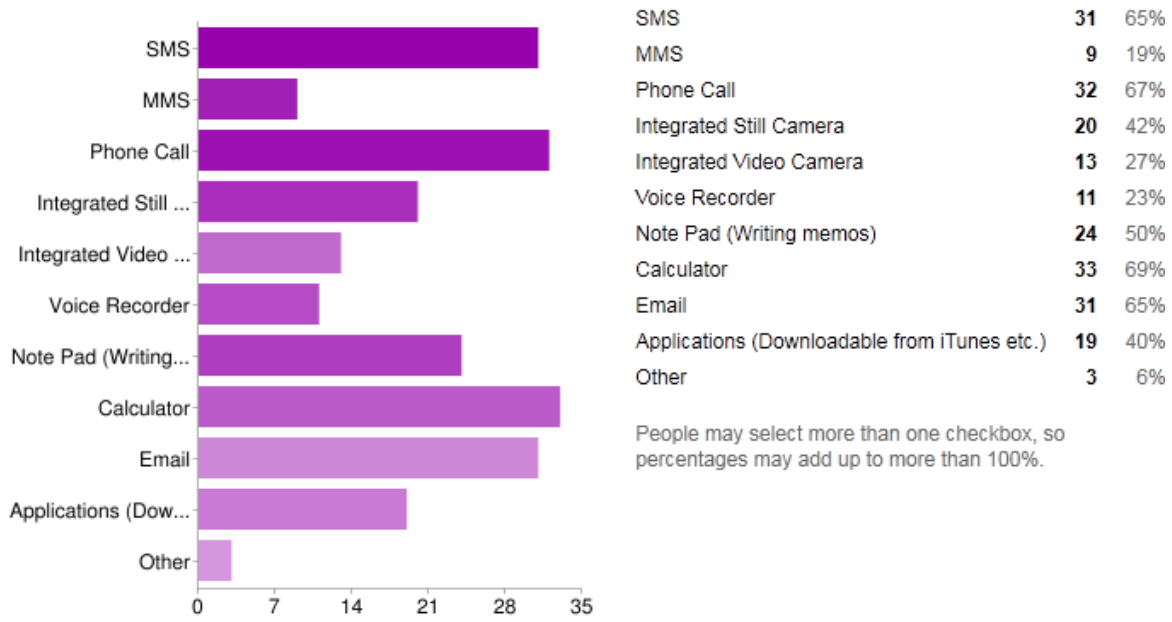

Figure 1: Smartphone Services and Applications used by Student for Learning

A further question sought to ascertain the degree of interest students might have in using their personal smartphones by asking them how much they would be prepared to pay for apps to support their learning. Twenty-nine (60%) indicated they would pay up to £5, whilst four said they would pay more than that.

In depth online survey

Of approximately 5,300 students invited to take part in the detailed survey, 272 students from the faculty of Arts, Computing, Engineering and Science (ACES) at Sheffield Hallam University responded to the online questionnaire. 91% of the returned surveys were submitted in the first three days. The general demographic picture shows:

- Smartphone ownership: 188 (69%);
- Gender: 227 (83%) were male and 45 (17%) were female;
- Age: 231 (85%) were aged 18-25; 20 were aged 26-30; 12 were aged 31-40; 7 were outside these age ranges;
- Study level: 217 undergraduate; 22 Master; 3 described themselves as graduates.

Smartphones are not functionally equivalent and apps are often platform specific. Cochrane and Bateman (2010b) found that the choice of smartphone is critical to students in the acceptance of its use as a function of both the social acceptance and the smartphone's ability to address the user's specific requirements. Participants in this study were asked therefore to state which smartphone they owned by completing an open text field (Table 1).

Table 1: Student smartphone ownership by brand

Smartphone Type	Popularity (%)
Android	34.22%
Blackberry	20.86%
iPhone	33.16%
Pirate iPhone (k0i2)	0.53%
Ord Phone	1.07%
Smartphone with bespoke applications	9.63%
Windows Mobile	0.53%
Total	100%

Phones using the Android operating system, iPhones and Blackberry account for over 88% of the devices owned.

Smartphones for learning

Of the 188 owning a smartphone, 88 declared using applications for learning purposes, and 76% of the remaining 100 responded positively to the question "Would you consider using an application if it benefitted your studies?" However, 4% disagreed, whilst the remaining 20% were neutral.

Apps being used by students

tudent respondents listed their preferred app functionality for learning. Fig. 2 presents the data as a tag cloud in which the largest text represents the most popular applications.

Figure 2: Wordle tag cloud showing preference of apps for learning by size

Further analysis of the apps and their purpose resulted in the identification of 10 categories. Table 2 presents the categories and indicates the frequency of references by respondents to their use of related application.

Table 2: Taxonomy of apps for learning showing frequency in the study with example general applications

Category	**Freq.**	**Examples**
1. Office productivity and assignment preparation	56	Word processing, spreadsheets, presentations, notes
2. Reading information	22	PDF readers, newspapers
3. Searching for, browsing information and reference	56	Web browser, dictionary, thesaurus
4. Audio, image and video media capture	9	Camera, sketching, graphing, voice recorders, video camera
5. Managing learning	59	Blackboard, library, group work, timetabling, personal organisation
6. Social media connectivity	7	facebook, twitter, students union app
7. Communications	22	Email, txt
8. Data manipulation	32	Calculators, convertors, formulas
9. Subject specific tools	37	Periodic tables, languages, databases, programming tools, stock market
10. Other	9	Job sites, memory training, puzzles, backup and data storage

Technical challenges, constraints and the usability of the apps

Respondents highlighted the need for hardware and software that is highly usable. They noted screen sizes can be too small especially for reading pages of text. The size of the phone's memory determines how many applications can be stored and this affects the decisions of some students when considering the purchase of phones, phone contracts and apps. Battery life is another factor that some students pay attention to, remarking how some apps drain the phone's power quickly. Other factors noted as being challenging were the time it takes to load applications and internet connection speeds.

The cost of running smartphones and buying apps is of course an important factor. Students in this study were not prepared or able to or pay more than £5 for an app and were likely to make do with factory installed apps and free apps even when the standard app is less than adequate for their requirements. However, nearly all students valued the way in which they could use their phones to support learning and signalled their readiness to pay out if they deemed an app to be particularly useful.

The effect of apps on learning and the perceived usefulness of smartphones for supporting learning

Students noted the main benefits from using their smartphones were ease and speed of access to the Internet and ready access to their own information e.g. emails, course material, personal organisation and time management.

The perceived usefulness statements suggest that the respondents believe their smartphones allow them to improve their productivity and this brings benefits to their learning performance. This has resulted in overall positive attitudes amongst the students surveyed.

Desired features and tools

When asked what features or tools they would like to have, the responses were varied and mostly specific to a student's personal needs. However, it was also evident that the majority of respondents wanted to able to access university related data, in particular their timetables, module content, email, library resources, lecture material and other learning materials.

Interviews

The interview data revealed that, even though useful applications for smartphones have been identified, students do not generally think of their smartphones as being core learning devices. They do not tend to systematically evaluate their phones or the app market from a student learner's perspective; rather they come across ways of using their phones to address particular needs as they emerge. It became clear that students associated their phones much more with playing games and other leisure activities than with learning.

For interviewees A and B, cost was an important factor in determining which phone to buy. Both stated that they would like to have chosen an iPhone 3GS if it had been cheaper, in preference to the phones they had purchased. The range of apps for the phones they owned was not comparable to what was available for the iPhone and they felt this disadvantaged them. As noted by Ramsden and Jordan (2009) there is therefore some concern about inclusivity.

The interviews supported the findings from the questionnaires about the perceived usefulness of smartphones. Whilst valuing access to Blackboard, several students indicated that they would find a Blackboard app more useful if it had been better designed. One of the main features they wanted from the Blackboard app was access to their timetable:

> Student D: "If I wanted a Blackboard app, the main thing I would want is access to my timetable and my email."
>
> Student C: "The only thing that would benefit me would being able to check my timetable on the move."

Neither interviewee C or D had used smartphone apps before and neither owned an iPhone 3GS. Both were demonstrated to them. Their responses to this substantiated the finding of the questionnaires about ease of use:

> Student C: "I understood what it did fairly quickly. It seemed to give me more than what I thought it would do."

All of the interviewees were positive about the potential of using smartphones for learning and said they would use them with a little guidance.

Discussion

On the methodologies

The methods used in this study resulted in the self-selection of respondents and the demographic profile, including gender balance, is not representative of students in general. The results, therefore, usefully indicate diverse behaviour and interest. Whilst this is appropriate for a qualitative study seeking to indicate interest, potential and innovation of a phenomena, it is not proposed that the quantitative data would be replicated in a similar study.

The methodologies used to inform the study need to be considered within the context of pedagogy and innovation in teaching and learning. The study is based upon an undergraduate research assignment in which there are three distinct, yet collaborative, roles: the student researcher designing and undertaking the study; the tutor establishing the framework for the study in terms of a formal assignment; the educational developer with responsibility for promoting innovation in teaching and learning acting as the project sponsor. This maps to a model proposed by Diamond *et al.* (2011) in which the student assumes the role of Developer, the educational developer assumes the role of Client, whilst the tutor's role is to establish and assess the assignment and to facilitate the Client-Developer relationship. The rationale for this model is to enhance authenticity, giving the student real world responsibility for designing and delivering a piece of work. Rule (2006) suggests that authentic learning actively engages the learner in the real world problems of professionals, open-ended inquiry, metacognition, and discourse amongst a community of learners, whilst empowering the learner to direct their own learning. Herrington and Oliver (2000) propose nine critical characteristics for authentic learning that include active learner engagement in a real life context, the modelling of processes and access to roles, collaboration, reflection, learner articulation, scaffolding and meaningful assessment. The model, and this assignment, demonstrate all of the features of an immersive authentic assignment with clear benefits for student employability.

Furthermore, beyond the specific focus of smartphones for learning, research collaboration involving students has the potential to engage the student in a metacognitive exercise as an equal partner alongside the facilitator and sponsor who, as practised academics, become mentors to the student.

Research into academic innovation, whether it involves technology or not, is problematic. If ideas and techniques are only emerging, knowledge informing the innovation will inevitably be in a formative and fuzzy state. The subject of the research, in this case the

potential of smartphones to enhance learning, is amorphous and dynamic. The research, therefore, can only expect to provide insight; the certainty required to instil confidence and impact on general practice at scale are likely to be far off. Nevertheless inquiry into innovative practice creates a valuable context for learning, advancing knowledge and professional development.

Further discussion of collaboration and internship is beyond the scope of this paper, however the value of collaboration was noted by all research partners.

Smartphones for learning

The primary research approaches strongly indicate that most students have not made strong connections for themselves between their personal smartphone technology, their needs as learners and the way they learn. However, the study also demonstrates great interest and openness to the potential: the students quickly began to understand and consider the opportunity once the suggestion had been made.

Disruption

Evidence in the literature and from the primary data strongly suggests that the exponential growth in personal computing power in the pocket of each learner will lead to the extension of the learning environments utilised in higher education beyond the physical and online spaces that are already familiar. This extension will not only change the ways students engage in terms of time, place, and pace, but change the nature of the traditional teaching and learning relationships. Because formal pedagogy is defined to some extent by its constraints (e.g. access to teachers and peers, the need for co-location in time and place, etc), it is important to consider technologies that disrupt these constraints.

Research into innovation

Whilst it is important to be clear that academic innovation is important and that it requires patience, this study highlights the difficulty of running and evaluating curriculum innovation projects, even where a potential may be clear to developers and some stakeholder groups.

Mixed messages from the literature and the lack of awareness evident in the respondents to this study suggest that students are often not equipped to provide an informed and meaningful response to research about innovative pedagogy, especially when it involves emerging technology. Research into stakeholder perceptions about the innovative use of technologies to support learning is problematic and unreliable: typically it must presuppose that respondents are conversant with emerging, complex ideas and practice relating to effective pedagogy and the application of technology. Quantitative methodologies are unlikely to be helpful, whilst findings produced using quantitative methods need to be validated with qualitative techniques. Claims to knowledge can only ever be tentative.

This study also highlights the ethical dilemma facing innovators with regard to the reliability of emerging learning environments and their associated exclusivity. However, the risk in this case is ameliorated by the emphasis on participant autonomy in using self-selected learning technologies. Academics interested in the potential of smartphones must, however, consider learner exclusion.

There is a need amongst those with responsibility for developing learning infrastructure and pedagogy to raise awareness, encourage interest and explore both general and specific opportunities further; for the moment, however, the autonomous use of smartphones by students for learning is only beginning to emerge and it is suggested that institutions are supportive of student interest in this area and continue to learn with them through small scale innovation studies.

For academics, Vavoula's (2004) proposition that mobile learning has the potential to transform learning from being highly intentional, structured, and directed, to an experience that is able to value informal and open learner-centred activity more continues to warrant consideration, for example in the design of tasks and learner engagement with the curriculum in general.

Conclusion

Increasingly students own smartphones and, as with other aspects of their lives, they will turn to them as a matter of course to enhance their experience of learning. This study has shown that once students begin using their smartphones for learning they begin to appreciate the benefits and the further possibilities that exist within their current frame of reference. Amongst smartphone users, this is already evident in the ways they seek to manage their lives as learners using apps to check Blackboard and timetables. However, it is not clear how smartphone learning can transition from the existing pedagogic paradigm to a Pedagogy 2.0 paradigm; how it can help to disrupt existing expectations to transform pedagogy in the way Vavoula (2004) suggests.

It is suggested that academics and educational developers continue to develop their understanding of personal technologies like smartphones and tablet PCs and, with that understanding, reflect on the differences between these emerging technologies and established learning environments and technologies. In doing so, educators need to also reflect on their assumptions about the design and delivery of the curriculum and the formal and informal engagement students can have with it.

This study has demonstrated how talking about the potential of personal technologies with students is likely to be insightful for both academics and their students.

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