iPad use in fieldwork: Formal and informal use to enhance pedagogical practice in a bring your own technology world

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Abstract
We report on use of iPads (and other IOS devices) for student fieldwork use and as electronic field notebooks. We have used questionnaires and interviews of tutors and students to elicit their views on technology and iPad use for fieldwork. There is some reluctance for academic staff to relinquish paper notebooks for iPad use, whether in the classroom or on fieldwork. Students too are largely unaware of the potential of iPads for enhancing fieldwork. Apps can be configured for a wide variety of specific uses that make iPads useful for educational as well as social uses. Such abilities should be used to enhance existing practice as well as make new functionality. For example, for disabled students who find it difficult to use conventional note taking iPads can be used to develop student self-directed learning and for group contributions. The technology becomes part of the students' personal learning environments as well as at the heart of their knowledge spaces – academic and social. This blurring of boundaries is due to iPads' usability to cultivate field use, instruction, assessment and feedback processes. iPads can become field microscopes and entries to citizen science, and we see the iPad as the main 'computing' device for students in the near future. As part of Bring Your Own Technology/Device the iPad has much to offer, although both staff and students need to be guided in the most effective use for self-directed education via development of personal learning Environments.

Keywords
fieldwork, mobile learning, experiential learning, technology enhanced learning, device usability, student participation, personal learning environments, bring your own device, BYOD

1. Introduction
Fieldwork is undertaken in many academic areas; anthropology, biology, geography and geology. Fieldwork may be for a day or for protracted periods of weeks or even months away from 'base'. A field notebook is traditionally used for this purpose, typically being some form of paper-leaved and bound 'notebook'. Classic examples are those of Charles Darwin (darwin-online.org.uk/EditorialIntroductions/Chancellor_fieldNotebooks.html). Laboratory and theoretical scientists also use such notebooks (for example, Enrico Fermi, www.lib.uchicago.edu/e/spcl/centcat/fac/fac_img54.html). Indeed, many other areas of investigation use notebooks to record events as an integral part of investigations; journalists and police, social workers and their case notes are other examples. Some of these notes may be used forensically, and thus require special treatment of ownership, date, times and locations for example.

Students, in progressing from novice to expert status or accredited practitioner, will almost certainly need training and experience in the compilation and use of notebooks. In geology for example, field observation is a necessary skill in mapping and the production of a map. A citation for the Oxford Geology Group's Field Notebook competition (oxgg.org.uk/competitions/field-notebook-competition/) suggests:

> '*A geologist's field notebook is analogous to the wizard's wand – it is indispensable. Geologists maintain them to keep track of projects, to note interesting geologic features, and as an aide-mémoire. A notebook has the potential for many alternative uses; as a scale for photographs, a weather shield for your head, a swat for midges and most importantly as a vade mecum for the next time you find yourself yomping* the same terrain. The Oxford Geology Group Field Notebook Competition (J. M. Edmond's Cup) recognises the importance of a well-kept notebook and aims to promote this aspect of good field practice*.'

(*see http://en.wikipedia.org/wiki/Yomp)

Indeed, a notebook, acting not only as a memory jog but as a virtual revisit, is another view of a notebook. The fragility and fickleness of human memory is well known as well as vision in the 'gorilla experiment', where events are not seen because of distraction (Chabris & Simons, 2010). Similarly, students need to be trained in making observations, to know what is important for particular purposes, in geology and other 'field sciences'. We report here on how iPads can enhance the fieldwork experience for students in a variety of ways, but also show how these devices can further improve investigations and research for all practitioners and beyond fieldwork within pedagogic frameworks.

Our project on enhancing fieldwork learning (www.enhancingfieldwork.org.uk) has investigated ways in which iPads are enhancing student experience as well as providing a knowledge base for professional use of iPads. As far as possible we avoid naming specific 'apps', not only as we do not wish to endorse particular products but because our investigations have applicability for tablet devices other than iPads and Apple's iOS.

As individuals and institutions have taken up iPads, there has been considerable promotion of specific apps that can be used, in our case, for fieldwork. We have shown students and tutors how iPads can be used as meaningful computers in the field and are not just expensive toys. Tutors may take as much convincing as students that iPads can offer more than field notebooks via the affordances of apps. We report on views of iPads and apps in terms of usability, student experiences and questionnaire responses to use and barriers to use. We use the integrating concept of the personal learning environment to look in general terms at how educational experiences for students can be enhanced by tablet technologies.

2. Methods and data collection

This paper investigates usability of iPads as devices for collection of field data.

It works within a basic framework (Figure 1) of usability, and employs responses from a questionnaire to fieldwork practitioners about their use (or not) of technology in student fieldwork. It also views envisaged barriers to using technology and how students use iPads in practice in the field.

3. The iPad as a field notebook: facilities and usability

The model (Figure 1) after Koole (2009) is a useful way of viewing interactions between device, user and social aspects for mobile devices.

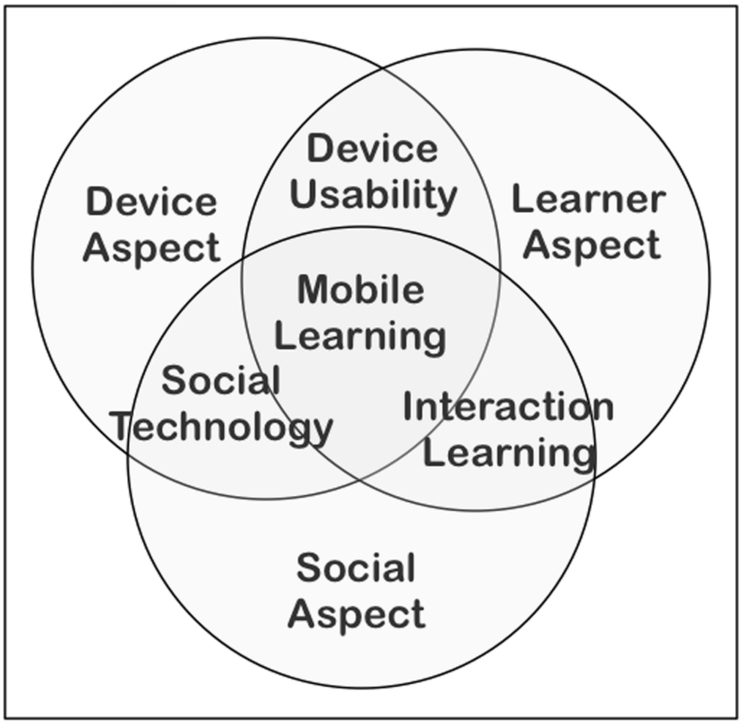

Figure 1: The FRAME model, after Koole (2009), illustrates the potential overlaps of Device, Learning and Social aspects of mobile device use. These apply in general to field use as well as for student learning.

The hardware attributes of tablet and smartphone device use, when coupled to their purpose and usability makes it possible to choose the most effective application ('app') for particular functions within the areas depicted by Figure 1. The framework is developed on a good psychological basis, involving learner prior knowledge, memory, context and transfer, discovery learning and emotions and motivations (Koole, 2009, Table 2). The three overlapping fields of Device, Learner Aspect and Social Aspect should operate within a knowledge space of information context and requirement. What these requirements will be may depend upon the subject area and detailed topic and use. Nevertheless, the wide variety of apps already available (and seemingly in ever-increasing numbers) can be viewed within the domains of Figure 1, whether from professional, instructor, or student remits. The pricing structure of apps means that sophisticated, yet workable, apps can be obtained free

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or at a small cost. Most notably, we have found that some apps may have uses beyond their original, intended audience. Indeed, students may be willing to experiment and find suitable apps to help solve specific problems. At present, in the main, it is tutors who make suggestions and recommendations for the use of specific apps in tablet devices.

The first question on usability is practical, 'what do you do when it rains?' The answer is, 'put it in a polythene bag'. This is actually easier to use than a paper notebook as students can type or draw on the polythene from outside. Specialised waterproof covers can be obtained and this makes a suitably encased (but bulkier) tool for note taking in water-proximity situations. iPads will work in extreme fieldwork conditions, for example in very cold conditions where it may be difficult to use a pencil but typing is possible. Bright sunshine may reduce readability of the screen. For some students with disabilities an iPad may be much easier to use than a conventional notebook, especially if audio recording is used. This usability is the main advantage over a laptop in the field as well as a conventional notebook.

As well as still and video image capture through on-board cameras it is possible to attach devices via wireless/Bluetooth. A field microscope can be shared between large numbers of students, and still/video images can again be shared between notebooks and reports. This is difficult for conventional paper notebooks. Field evidence (perhaps with time, data and GPS location) from a tablet's camera can be pasted into a report note directly.

Screen size on the 'standard' iPad with 'retina' display is about the same as an A5 printed page, but the iPad mini has the advantages of being able to pocket the device and lighter in weight. Although most iPad apps can be used on the iPhone (or iPod touch), the screen size of the iPad has benefits for both viewing and writing. Battery life is increasingly improved and will certainly manage a normal working day of continuous use. Photovoltaic power supplies can be used for remote situations, and rarely will a generator be necessary for recharging.

The basic notebook function can be facilitated by the basic iPad, although Wi-Fi and 3-4G (and Long term Evolution, LTE) connectivity can be useful for backing up information (via 'The Cloud') and providing GPS locations and downloading new resources as well as sharing information. Sharing data is frequently a necessity when fieldwork is done in groups. iPads make this possible in the field rather than subsequently exchanging paper-recorded data.

iPads for fieldwork activities tend to be used in groups of 4-5 students. This is mainly a matter of cost and that the majority of students, as yet, do not own their own tablets (although most now use their own mobile 'smartphones'). Until shown how apps can benefit their (fieldwork) learning, iPads tend to be viewed as leisure devices for the consumption of media. This applies to tutors as much as students.

4. Examples of iPad use for fieldwork learning environments

Fieldwork learning can be enhanced by technology, and we know this from students' perspectives (Welsh, Mauchline, Park, Whalley & France, 2013). We now suggest a few ways to illustrate how this can be done. For brevity, we list below a number of activities that can be accomplished under the general heading of 'fieldwork' that provide students with educational experiences and where the use of tablet computers can assist.

4.1 Pre-fieldwork preparation

Visualisation of the field site;
Explanation of field methods/use of equipment;
Explanation of use of field notebooks.

4.2 During fieldwork capture of site context/sense of place/visualisation

Digital storytelling;
Vidcasting;
Reflective diaries (Evernote);
Familiarisation of place;
Geotagging photographs using smartphones (Welsh et al., 2012);
Visualisation of landscape;
Podcasting to support student learning;
Using video during fieldwork;
Using augmented reality for examining new locations or in poster presentations.

4.3 Post-fieldwork revision/reflection/presentations

Access to literature/teaching materials/online resources while in the field;
Data management issues in the field;
Speed, amount and accuracy of data collection;
Storage, security and future access to data;
Data collation and analysis;
Data sharing.

The list shows aspects that are both formal and informal. Note needs to be taken of the way assessment is undertaken for student activities. For example, examination and essays do not align well with experiential education such as fieldwork. Conversely, presenting findings in reports and integrating with digital literacies follow from fieldwork experiences and are also aspects of 'employability' (Yorke & Knight, 2007). Fieldwork tasks and immediate reporting of results, even in the field, allow rapid feedback to students on tasks set.

5. Expectations of and barriers to field technology

Although smartphones are becoming more affordable and ubiquitous (Melhuish & Falloon, 2010) a recent study of undergraduate students Woodcock et al. (2012) found that many who own smartphones were largely unaware of their potential for their own education.

In order to assess the current level of technology being used on field courses, a questionnaire was developed on Survey Monkey (www.surveymonkey.com). Both qualitative and quantitative data and a range of question types were used, including closed multiple choice and Likert scale questions for comparison with earlier research by Fletcher et al. (2007) and open-ended questions, which give the opportunity for participants to share their experiences. Principally, UK higher education practitioners/tutors in biosciences, geography, earth and environmental sciences were targeted. The survey was open to anyone who participated in fieldwork; therefore some responses were obtained from archaeologists, anthropologists and secondary school teachers. The survey had questions which focused on technology used in fieldwork, and why the technology was introduced (if at all) to the fieldwork. Table 1 shows selected responses from this survey relating to reasons for using 'technology' in the field. Note that this includes technology as a whole rather than iPads per se. In practice, and despite the practicabilities of modern technologies, there seems to be a rather low uptake of computers for field use or even desire to use technology in the field. Computers may be used after a fieldwork element, to process data and write reports are typical examples. Our survey also showed that technology was not used much in the field, but mainly during the post-fieldwork phase where desktop and laptop computers were mainly used. Pre-fieldwork and field centre technology was again mainly computer usage. This is because of power consumption of laptops as well as impracticality in the field. Some in the field technologies used were portable, such as digital cameras (73), GPS (52), laptops (31), phones (27) and smartphones (20).

Pedagogic reasons for introducing technology	Frequency	Proportion of practitioners (n=76)
Data processing:	(∑=48)	63.2%
- faster/easier data collection (therefore greater amount)	22	28.9%
- data storage in the field	2	2.6%
- data security & future access	3	3.9%
- data analysis in the field	13	17.1%
- data sharing in the field	5	6.6%
- greater accuracy in data recording	3	3.9%

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Skill development:	(∑=37)	48.7%
- development of general ICT skills	9	11.8%
- development of subject-specific skills using specialist field technologies/equipment e.g. GPS	8	10.5%
- learning up-to-date methods	7	9.2%
- development of employability skills	8	10.5%
- dynamic, multi-mode, hands-on learning	3	3.9%
- enable students to evaluate pros/cons of different methods	2	2.6%
Post-fieldwork revision/reflection/reporting	9	11.8%
Enhancing the learning experience	8	10.5%
Facilitate communication	(∑=8)	10.5%
- between students in the field	1	1.3%
- between different countries/places	3	3.9%
- contact between field and 'base'	1	1.3%
- for safety	3	3.9%

Table 1: The main reasons for introducing technology to fieldwork. Practitioners often responded to the open question with more than one reason (total responses =146), 81% were from the UK.

Table 2 provides more detail from the participant/tutor survey as to the barriers perceived as difficulties with tablet technology. Since this general survey, the iPad allows most of these attributes in Table 1 to be practised in the field. iPads have major usability advantages over laptops in the physical attributes mentioned above, especially by virtue of their size, power consumption and general capabilities.

Barriers	**Frequency (total = 168)**	**Proportion of practitioners (n=79)**
Cost		
- general	24	30.4%
- availability of kit/cost to buy & maintain kit	19	24.1%
- risk of losing/damaging equipment	6	7.6%
- high roaming charge for smartphones	1	1.3%
- insurance of kit	3	3.8%
Reliability of kit/durability in rugged conditions	17	21.5%
Staff competence/confidence/imagination	16	20.3%
Student concerns		
- reluctance/competence of students	10	12.7%
- reluctance to use own equipment	1	1.3%
- don't all have same phones/devices	1	1.3%
- need simplified software/interface	1	1.3%
Staff preparation time/keeping up to date with technology	10	12.7%
Power supply/battery life	10	12.7%
Practicality/portability of some devices	9	11.4%
Web access at field centre/in the field (inc. costs)	8	10.1%

Technology doesn't seem useful/just don't need it	4	5.1%
Unreliable/Need technical support when problems arise	4	5.1%
Shipment abroad (inc. costs)	4	5.1%
Need to teach the fundamentals behind the process	3	3.8%
Gadgets can be a distraction to the students	3	3.8%
Screen readability of gadgets	3	3.8%
Lack of institutional support/poor IT infrastructure	3	3.8%
Access to technology for large groups at field centre	2	2.5%
Unwelcomed by interviewees	1	1.3%
Mobile phone coverage	1	1.3%
None	4	5.1%

Table 2. Possible barriers to the use of technology in fieldwork. Practitioners often responded to the open question with more than one barrier (total responses =168).

Table 2 highlights two main types of barrier to using technology in fieldwork. First, physical impediments such as cost and durability were deemed significant. Secondly, human perceptions of technology were considered important. This applied to both undergraduates and students, with low levels of digital literacy deemed to be a barrier. The cost is a decreasing inhibitor, especially if students are likely to bring their own devices.

6. Student experiences on field trips

The project has used iPads (series 2) to improve and extend the use of technology to aid participation and effectiveness in fieldwork. Undergraduates are generally working in small groups (4-5) in the field. We supplied one iPad per group for fieldwork sessions of 4-6 days in the UK, Italy and New York with both physical and human geography modules and in Iceland with international students on a biology field course. The FRAME model (Figure 1) shows where mobile devices such as the iPad can fit within the range of requirements of Table 1.

Although there were concerns that the equipment might get broken (which did not happen) the students' feedback was very positive. One student summed up the experience, 'The iPad was exceptionally useful for the fieldwork; instant note-taking; recording and manipulating data instantly.' Another noted that 'the tablet, brings together several useful applications in one place, for example, GPS, photo/video/ Internet, so we don't need 3-4 pieces of equipment.'

In practice, we have had to show how iPads can be used educationally in the field, for recording data as well as using them to record short videos of their activities, as in digital storytelling (France & Wakefield, 2011). Students may have to be shown how to use a clinometer app and thence into more complex geological recording and subsequent incorporation of field data into a digital notebook. However, once the principles are illustrated students themselves as a means of problem solving in general can explore the usability features of iPads. Data recording and analysis is also easy to achieve, although sharing is easy it would be useful for each student to have their own device and be familiar with them before going into the field.

7. Generalising learning experiences

We have taken the view that fieldwork (as indeed other 'out of classroom' activities such as work in archives or laboratory), benefits students by presenting them with experiential opportunities for their education. Tablets, such as the iPad, allow them to take full advantage of truly personalised computing. Table 1 shows some of these educational attributes that could be used widely for a range of academic disciplines. Figure 2 suggests that these attributes can be placed within an educational or pedagogic framework. Moreover, it is a structure that centres on learning activities. Fieldwork clearly provides one such activity although laboratory work is often an extension of fieldwork as well as an independent activity.

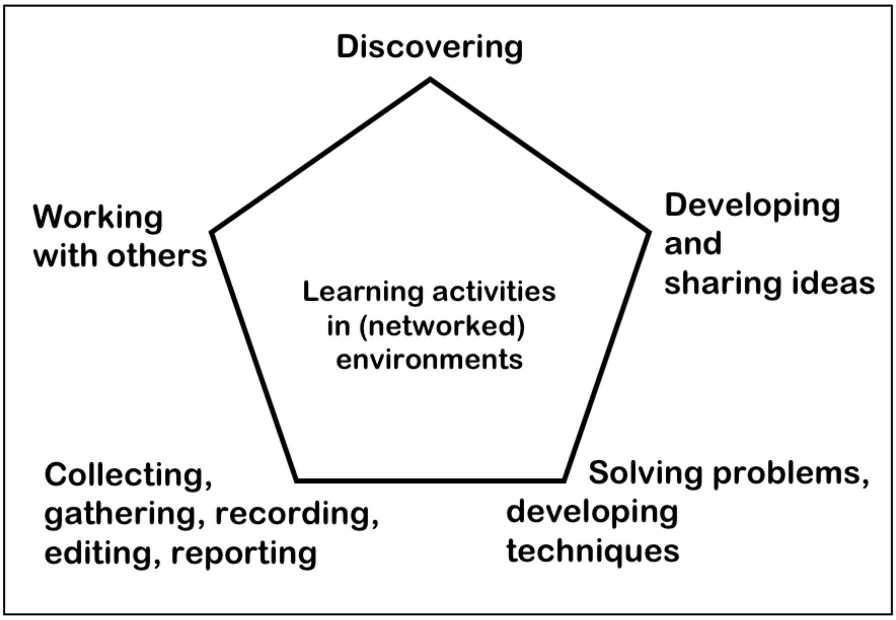

Figure 2: Five types of learning activity after Beetham (2013)

We would relate the activities and circumstances in fieldwork (or any out-of-classroom activity) that can be accomplished by the use of tablets such as iPads to Figure 2. We do not necessarily require networked activity for these activities. Communication can be asynchronous, according to local conditions and connectivity. The 'reporting' (that is, communicating and writing notebooks) aspect has also been added to Beetham's (2013) schema as we view that, especially in fieldwork, this is an important activity for students.

It is important that students benefit from iPad and cloud technologies, because they are simple devices and concepts in practice, but can be used to help solve difficult

questions. However, for any problem-solving approach, students need to be guided initially, not just in the field, but also by tutors in designing meaningful questions and structures for investigation. Figure 2 is a generalised example of structures to enable this. Further support for design practices have, amongst others, been suggested by Agostinho et al. (2013). We suggest that appropriate learning designs should be used in all forms of education to enhance student capabilities and advance from novice to expert. iPads can assist this progress greatly, but staff involvement is most important rather than students following a few early adopters (Welsh & France, 2012).
In general, mobile technologies 'are increasingly a user's first choice for Internet access (Johnson, Adams, & Cummins, 2012).

8. Personal learning environments and personal learning networks

We define a Personal Learning Environment (PLE) simply as a location where a learner happens to be. We include anyone who is learning about something, whether expert or novice. Thus, 'learners' will be moving within educational spaces as in Figure 3. Any activity, not just fieldwork, can be incorporated within this framework. Addition of an iPad, as a vade mecum, enhances the educational environment for students.

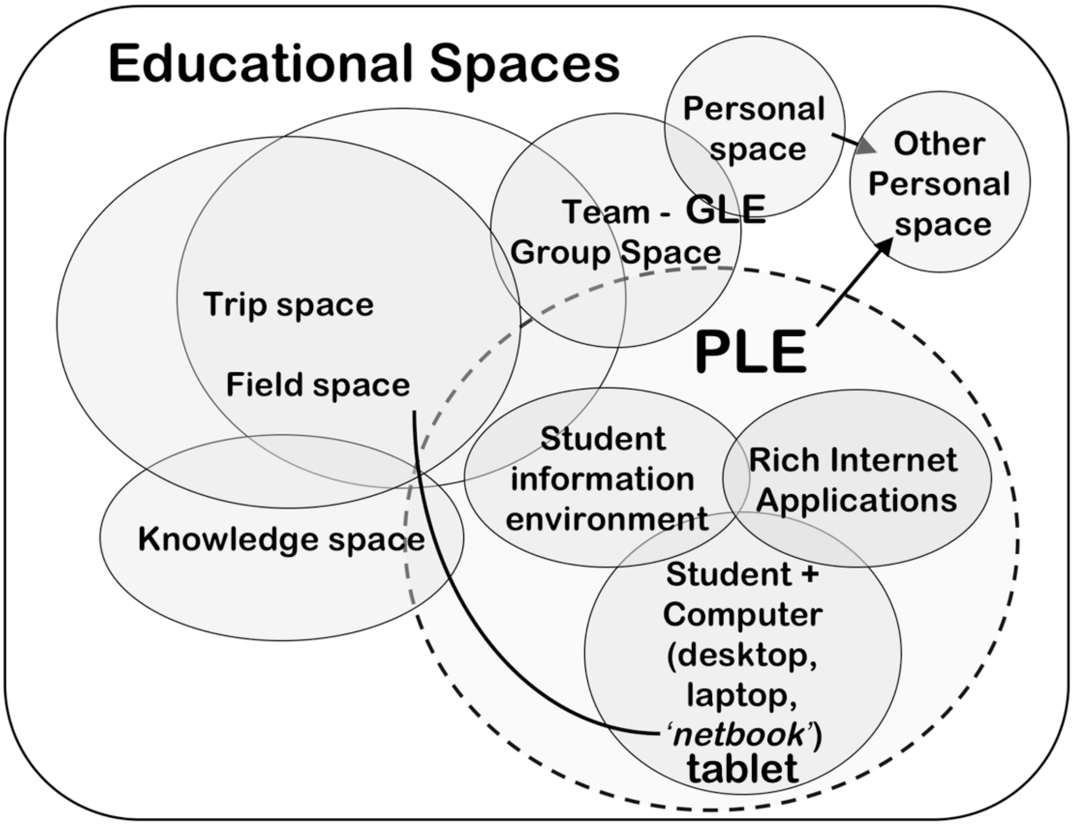

Figure 3: A generalised view of the domains in which personal learning environments (PLE) may exist

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Different PLEs can be configured for various situations and incorporate appropriate workflows. For fieldwork, 'desktop, laptop, netbook' computing power can now be substantially replaced by 'tablet computing' and 'Rich Internet Applications' can include apps as much as web-located facilities.

The implications of using iPads and smartphones within the domains of Figures 1, 2 and 3 can now be viewed as the ability for anyone to use these versatile devices. That they are versatile, for smartphones e.g. Welsh and France (2012) and iPads (Bedall-Hill, Jabbar & AlSheri, 2011) is now well established. We suspect students will soon buy tablets of their own for leisure and social activities, possibly as well as smartphones. How well these will be supported by institutions, especially in terms of Wi-Fi provision, remains to be seen. Importantly, students are likely to be purchasing them for educational purposes as well as social as they maximise the advantages of cheapness, usability and adaptation to a wide variety of requirements (Figure 1). As such, students will increasingly be prepared to Bring Their Own Devices, not only for fieldwork, but as replacements for bigger, less convenient laptops with a shorter battery life and so on. The BYOD movement is already gaining pace in education (D. Johnson, 2012). Educators, at all levels, need to be aware of designing educational materials with this in mind.

9. Conclusions

Our experience is that students, whether they have used iPads before or not, readily appreciate the use of tablet computers in the field to help record data, images and audio and to use these assets in a meaningful way to present reports via some form of field notebook. That such devices and attributes can be used under difficult field based situations promotes tablet use under a wide variety of personal learning environments. These student experiences promote reaching the digital shoreline (McHaney, 2011). On the way, they will learn new skills about dealing with the digital world on their own account by integrating their own learning experiences. Not least is the importance of understanding the nature of knowledge and the importance of digital literacies (Hess & Ostrom, 2011). We believe that the ease of use of iPads and software (apps) will make them increasingly common in everyday use and thus as part of education and subsequent employment via the Bring Your Own Device/Technology (BYOD/BYOT) movements, especially as prices fall (Welsh, France, Park & Whalley, 2011). Integrating this involvement is necessary on a day-to-day basis by educators. In particular, learning activities and tasks need to be brought into play in designing better educational experiences for students, as students themselves will be using tablet technologies to their advantage.

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