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Technology as a creative partner: Unlocking learner potential and learning

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The value of technology in education is still discounted by many academics. In many instances where technology is considered for learning and teaching, it is done without any pedagogical reasoning or within traditional practices. This limits the role that technology could play in enhancing the learning experience and learning. While the intangible aspect of technology such as communication, collaboration, co-creation and sharing have the potential to significantly impact on student learning, the tangible affordances of technology made possible by 3D printers or Arduino cards can also play a critical role in student cognitive and creative development. Using Pedagogy 2.0 as a framework for the redesign of a first year computing course, this paper discusses the findings of how embedded use of mobile social media, Arduino and emerging 3D technologies, impacted on student and student learning within the proposed participatory design-based research (PDBR) approach. The paper reports on the implementation and findings from the first iteration of a two-iteration PDBR cycle.

Keywords: Pedagogy 2.0, heutagogy, mobile social media, participatory design based research

Introduction

Sir Ken Robinson (2001, 2003, 2011) and in his recent TED talk video titled “How to escape education’s death valley” arguably perpetuates how the current education system is stifling student creativity and innovation. Robinson (2003) argues the need to radically rethink the curriculum and the fact that education has remained unchanged for decades even when the world learners live in has (Laurillard, 2002). In particular, the change driven by ubiquitous devices and technology in general has redefined how we communicate and interact with each other and our surroundings (Siemens, 2005; Traxler, 2012). The increasing fluidity and ease with which technology is able to adjust or find a place within the life of an individual is perhaps one of its strengths. Not only does it situate itself well, it is able to enhance the worldview and knowledge through connectivity that makes it an undismissable ‘add-on’ to have.

The affordances of emerging technologies are always pushing the boundaries of what is possible. In this regard, one would imagine that the education sector would be utilising these affordances to maximise the learning and learner experience. This sadly is not the case as the acceptance, use and value of technology in learning and teaching still eludes many practitioners (Laurrillard, 2012). In cases where technology is considered for use with the students, it is still perceived and implemented as a plug-on within traditional teaching practices. This limits the opportunities to leverage off the affordances of the technology considered for learning and teaching (Herrington & Parker, 2013; McLoughlin & Lee, 2008a). According to Mishra & Koehler (2006) the use of technology in learning and teaching is a complex and multifaceted interplay between technology, pedagogy and the content to be taught. As such, for effective use of technology, pedagogy, technology and the teaching context has to be taken into consideration in relation to each other.

In this paper, we report on the preliminary findings from the first iteration of a PDBR approach. The focus of the study was to investigate the potential mobile social media and other emerging technologies such as 3D printing and Arduino programming have to unlock student creativity, increase student engagement in the learning process and to bridge the distinction between theory and practice for enhanced learning. Pedagogy 2.0 (McLoughlin & Lee, 2008b) was used as an overarching framework for the design and facilitation of the course.

Research context

The Computer Technology in Society (CTIS) course is the first paper the students enroll in the computing degree undertake as a part of their study and is delivered over two campuses. Prior to the start of the design of the course in Semester two, 2012, CTIS was taught in a traditional lecture mode where the students attended a one hour lecture and one hour tutorial in a week. The aim of the CTIS course is to introduce past and present technologies to the students and help them build an understanding of the role technology plays in shaping society, and evaluate its impact. This was achieved through a series of lectures. The lectures throughout the semester aimed to explain the role various technologies (past and present) played in shaping human society such as IBM and Holocaust, eWaste and Punched card technology. The students were assessed twice by administering exams at mid semester and at the end of the semester.

Methodology and data collection

In order to investigate the use of mobile social media and emerging technologies such as 3D printing and programmable Arduino cards, a hybrid approach of design-based research (DBR) and participatory action research (PAR) referred to as participatory design based research (PDBR) was deemed appropriate for use in this project. Unlike other research methods, DBR and PAR both provide an opportunity to situate the research within a context where design, practice and theory are explored in relation to each other (Amiel & Reeves, 2008; Argyris & Schön, 1989; Dede, 2004; Herrington, 2012; Kemmis & McTaggart, 2000; Reeves, Herrington, & Oliver, 2005; Wadsworth, 1998). The hybrid approach provides a stronger platform for collaboration between the practitioner and the researcher throughout the study. This collaboration mutually benefits both parties in gaining knowledge on how the design and the implementation behave within the context (Dede, 2004; Wadsworth, 1998; Wang & Hannafin, 2005). A stronger coupling of the two methods helps build rigour and at the same time helps overcome the time it takes to publish a DBR based project (Anderson & Shattuck, 2012; Herrington, McKenney, Reeves, & Oliver, 2007). While DBR and PAR share many ‘epistemological, ontological and methodological underpinnings’ (Anderson and Shattuck, 2012, p. 4) that cross-fertilises the phases in both approaches, they are however fundamentally different. In DBR, the focus is on designing, implementing and testing a solution over a series of iterations to produce “new theories, artifacts, and practices that account for and potentially impact learning and teaching in naturalistic settings” (Barab and Squire, 2004, p. 2). PAR is future oriented through shared ownership between the researcher, practitioner and the subjects of the research project in a participatory and collaborative context achieved through rapid prototyping. In proposing the new PDBR approach, the researcher aims to shorten the time taken to publish a DBR project (prolonged due to the series of iterations) by implementing the participatory nature of PAR. This allows a quicker feedback mechanism to understand the future design implications and iterations because the students become an active part of the research. At the same time, a change in practice can only be achieved if the practitioner is provided the support and scaffold needed to implement the design to use in facilitating the course. In this regard, PAR provides a community driven implementation, testing and evaluation environment in close collaboration with the practitioner and the subjects (Narayan, 2012).

The four iterative phases within PDBR approach (figure 1) were used to investigate and implement the use of learning technologies in the CTIS course.

Phase one of the study started late in 2012 where the researcher and the lecturer for the CTIS met to discuss the issues in class with the students with regard to learning and teaching. This formed the basis and a guideline for literature review. Some issues that arose in discussion and through literature review were the design of the course, student engagement and the overall learning and teaching approach that was mostly teacher-centred. CTIS was content heavy and exam driven with minimal student engagement verging on almost passive student participation. The use of technology in this case Mediasite (Lecture Capture) was done without any pedagogical underpinning and as a plug-on to traditional teaching practice. As Reeves (2008) highlights, the strength and at the same time the biggest weakness of technology is its ability to comfortably sit within old and new practices, meaning technology itself is not capable of leading to improved practice.
In phase two of the project, the solution to the problems explored was designed in line with the broad principles of Pedagogy 2.0. The design involved the redesign of the CTIS curriculum from content and exam heavy to a student-centred, collaborative, project-driven and community-driven facilitation and assessment with an end of

semester exam. The student grade was informed by 50 percent formative student project work and 50 percent end of the semester exam.

In phase three, the design was implemented with the first year computing students, a cohort of 125 students, and a small number (16) based on a separate campus in semester 1, 2013 (16 weeks). An overview of the design and implementation was provided to the students as part of PAR. Data was collected using an end of semester project survey, student created artifacts such as student contributions on the community page (blog posts and microblogging), videos and pictures, 3D models and printed artefacts and an end of the year group poster and report. Reflections, feedback and observations on student uptake and use of the solution were also collected on a daily and weekly basis within the community established between the practitioner, researcher and the students. As this is the first iteration of the design, the findings discussed are an outcome of PAR after the first cycle. The design implications for the second cycle are informed by the findings after the first iteration. *In the fourth phase*, where the focus is on design principles and enhanced solution, a set of preliminary design principles are discussed that will inform the design changes of the second iteration.

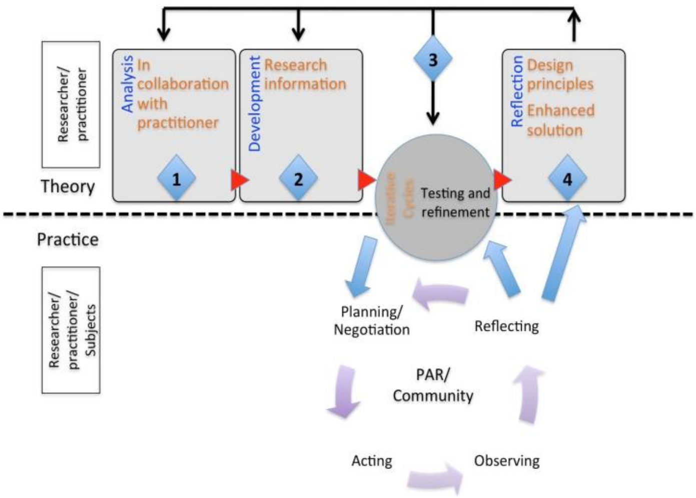

Figure 1 - Participatory design-based research (PDBR)

Theoretical frameworks underpinning this project

For far too long, education has stripped learners of the right to have a voice in the learning process. Over decades, in an attempt to deliver effective education, the learning process has been highly refined and students have been reserved a 'spectator' seat in the classroom. The consequences, even when prevalent in the classrooms today, are still being ignored with the same decades' old practice repeated with a hope of a different outcome.

Pedagogy 2.0

Since the identification of "a second generation, or more personalised, communicative form of the World Wide Web that emphasises active participation, connectivity, collaboration and sharing of knowledge and ideas among users" (McLoughlin & Lee, 2007, p. 665) also called Web 2.0 (O'Reilly, 2005). A number of pedagogies have emerged attempting to harness the affordances of Web 2.0 technologies for use in learning and teaching. For example, connectivism (Siemens, 2005), authentic learning (Lombardi, 2007) and mobile or mlearning (Sharples, 2002), all attempting to enhance student learning by leveraging off the affordances of Web 2.0 tools and technologies.

Pedagogy 2.0 espoused by McLoughlin and Lee (2008a; 2008b) is a framework that stresses pedagogical design of learning and teaching for embedded use of Web 2.0 tools to achieve the learning outcomes required. Where the Web 2.0 tools engage students into learning events that are *personalised* (learner driven, customisation and self-regulatory), *participatory* (learners engage in meaningful discussions, collaborative, communicate and are connected as a community) and *productive* (as an outcome, learners create the content to evidence their learning, collectively advance in knowledge and events or transactions that inspire creativity and innovation) (McLoughlin and Lee, 2008b), this advocates active learner participation through social constructivist and socio-cultural pedagogies (McLoughlin & Lee, 2008b; Vygotsky, 1978, 1986). Pedagogy 2.0 is an open pedagogy and endeavours to encompass the true nature of Web 2.0 for learning and teaching. Given the open nature of Pedagogy 2.0, it forms an overarching umbrella for pedagogies such as connectivism and heutagogy (Blaschke, 2012; Hase & Kenyon, 2000; McLoughlin & Lee, 2008a; Siemens, 2005).

While Pedagogy 2.0 does not explicitly acknowledge the role of mobile devices, it has however been shown that mobile devices or mlearning play an important role in operationalising Web 2.0 tools for learning (Cochrane, 2012; Cochrane & Bateman, 2010; Herrington & Herrington, 2007; Laurillard, 2007). The ubiquitous nature of mobile devices bridges the learning context (formal and informal) and plays a critical role in enabling learner-generated context and content (Cochrane & Bateman, 2010; Narayan, 2012).

Heutagogy, or self-determined learning, is a holistic learner-centred approach to learning and teaching. Where self-determined assumes "that people have the potential to learn continuously and in real time by interacting with their environment, they learn through their lifespan, can be lead to ideas rather than be force fed the wisdom of others, and thereby they enhance their creativity, and re-learn how to learn" (Hase & Kenyon, 2003, p. 3). In the process, the learners engage with and create their own context and content as a part of enhancing and informing their own learning (Blaschke, 2012).

Design and implementation

The design of the solution for CTIS was informed by the overarching Pedagogy 2.0 framework within which, heutagogy and mlearning frameworks formed the guiding principles for learning and teaching.

The concept map (figure 2) outlines the Web 2.0 tools used to support learning and teaching along with student owned devices such as smartphones, tablets and computers. Other computer specific technologies for example, Arduino programming boards and 3D modeling and printing were used to drive student group projects.

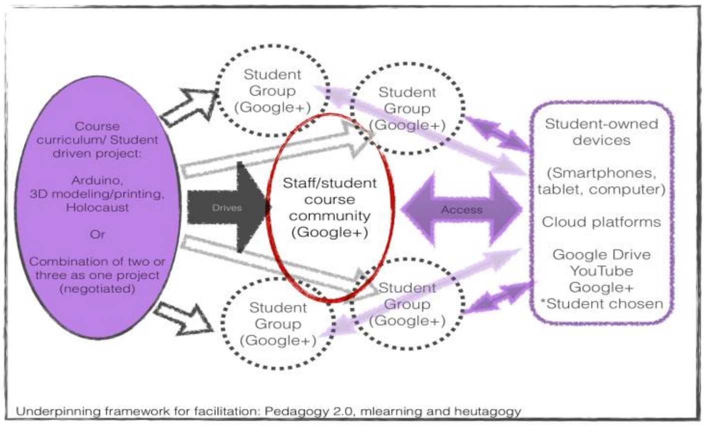

Figure 2 - The design of the learning environment using student owned devices

Google applications such as Google+, YouTube and Drive were heavily integrated in the design of the course. A class community was set up using Google+ that connected all the students in the class and provided a platform for communication, collaboration and sharing ideas. The Google ecology was chosen due to its fluidity with different platforms, such as mobile devices, tablets, laptops and computers. The user experience on any device is almost the same. Google+ apart from the social affordances for learning also provides a 'Hangout' function (10 user video conferencing system) over the browser. This further amplifies the opportunity for collaboration and communication and delivers a seamless experience over smartphones and tablets.

A private Google+ class community was set up and all students in the class were invited to join. The students were shown how to use the platform across different platforms. The Hangout feature and its potential for collaboration and communication was also demonstrated to the students. Students were encouraged to use the platform for sharing ideas and resources, and discussing the course content and lecture. The students were also encouraged to activate 'push notification' for the class community. The push notification feature sends a message to the user's mobile device whenever an activity eventuates within the community page; for example, when someone shares a resource or comments on a message. Students were also given an overview of how to create a document in Google Drive and share it with an individual or with a group. An overview of how to upload a video taken using a mobile device to YouTube was also given during the tutorial session.

The Google class community was used as the CTIS student social learning space. A space that students took care of, maintained, created, customised and built together. The teacher and the teaching assistants provided support and guidance within the space when needed by the students and at times posted resources relevant to the topic covered in lectures. The institutional learning management system (Blackboard) was used for course administration purposes, for example, posting class notifications, reminder to students, and course, group and project information along with a forum driven by the lecturer.

Students were asked to create a group project community page for members to use for collaboration and communication purposes and at the same time as a platform for documenting the journey and individual contribution. The students were given four project options (3D printing, Arduino programming, MOOCs (Massive Open Online Courses) and Holocaust documentary) to choose from. The students also had the opportunity to negotiate any other topic of interest with the lecturer. Out of the four project topics, the students could also combine two or three of them into a single project if the group members agreed and wanted to push the boundary of their collective group knowledge. For example, while creating a documentary on Holocaust, the students could also design and print 3D models of the technology used at the time.

Table 1 outlines how the principles of Pedagogy 2.0 were integrated in the design and facilitation of the course.

Table 1: Pedagogical embodiment of pedagogy 2.0 in the design and facilitation of the course

Pedagogy 2.0 elements	Embodiment of Pedagogy 2.0 in the design and learning process
Participation Encourage learner communication and collaboration	Establishment of a class community on Google+. • Sharing ideas and knowledge • Sharing resources • Collaboratively curating resources
Personalisation Empowering the students by open and flexible facilitation and assessment methods	Learner driven learning process. • Groups establish a Google+ community for project work. • Students work with their own device and resources in the project. • Students have choice over the topic and 'make-up' of the project and mutual interests within the group members drives the project. o Bring your own device o Create your own project and artefacts
Productivity Enabling learner-generated content	Student outcomes in the class community: • Discussions • Peer support and encouragement • Sharing of resources • Collaboratively building or curating resources to scaffold learning. Group outcomes: • Creating and curating resources to build the project. • Application of ideas to create project artefacts, such as: o Poster o Meaning and ideas o Digital and other tangible outcomes such as videos, 3D printed models and concepts.

Results

Pre-project survey - Understanding the learner and the devices they won

The pre-project survey was designed to gather data from the students on the type of devices they owned, their age, computing background and if this was their first year at a university. A total of 125 students completed the survey, a return rate of 95% (n=132). From the 125 students who completed the survey, 64% indicated that they were in the 16-20 year old age group, 24% indicated they were in the 20-24 year old age group, while 8% and

4% indicated they were within the 25-30 year old and >30 year old age group respectively. 88% of the students in the CTIS course were 24 years old or younger. Of the 125 students who attended the survey, 64% indicated that this was their first year of study in a university setting. And a further 60% indicated that they did not have any computing experience apart from basic Microsoft Office and operational computer knowledge. All students who completed the survey indicated they had access to a computer, either a laptop or a desktop. Of the 125 students, 40% of them indicated they owned a smartphone (iPhone, Android or a Windows phone) and 18% of the students had access to a tablet device (iPad, Android or a Windows tablet). All students except one had Internet connection at home of which 92% had wireless access.

The result showed that the students had high computer and mobile device uptake. The majority of the students in the course were young, fresh out of college with minimum computing knowledge.

Post-project survey and student projects - Arduino, Holocaust, 3D Printing and MOOCs

A total of 31 groups undertook 30 different projects as part of the CTIS course. One group was disestablished due to student withdrawal from the course. Out of the 30 remaining groups, 12 groups explored 3D modeling and printing. Five groups decided to do a documentary on the role technology played during the Holocaust. Six groups undertook projects using Arduino programming boards. Two groups enrolled in a MOOC to evaluate the learner experience. And five groups combined Arduino, Holocaust or 3D printing into a single project.

In using technologies such as Arduino and 3D printing and in experiencing a MOOC course or revisiting a historic event, the students did not only learn to critique the role technologies play and the impact it has or could have on the society; they were also forward thinking, creative and innovative. The section below discusses some of the 30 projects that show how the design and facilitation of the course not only helped students critique the role of technology but also helped unlock creative thinking, innovation and build confidence for future study. A full list of student projects and output can be accessed here (https://docs.google.com/document/d/1lOMEMmswTe-E3XCmKbRqCupOcpGMhfcasCdyjE_beuY/edit?usp=sharing)

A number of student projects looked at 3D printing as a solution to many everyday issues faced by people and manufacturing industries. For example, a group designed and printed a 3D prosthetic limb (a leg) as a possible solution and argued how the cheap printing costs could revolutionise lives of many people (http://youtu.be/KaNcs5xulIY). While another group pushed the boundary of 3D printing and from their experience of rapid design change and printing reflected how F1 racing cars and competitors could leverage the affordance of 3D printing to customise car design and components for every track (http://youtu.be/01yzMRU2YrQ). Similarly, groups using Arduino programming boards designed smart systems such as a Burglar Alarm that sends data detected to the users smartphone (http://youtu.be/nD0rf58ft0g). Another group designed a Smart Tank through the use of Arduino boards and complex programming scripts that would enable it to navigate any terrain unassisted (http://www.youtube.com/watch?v=uLmw4Ali57s). While the students in this group could not complete the project in time due to problems with sourcing the required parts, they did, however, learn valuable lesson in time management and better planning. As for the MOOC enthusiasts and groups interested in Holocaust, it was interesting to observe how these students used technology to support their process of gathering data, communication, collaboration and reflection. The MOOC group critically reflected on their experience in a MOOC course using Hangout (http://youtu.be/EF_E89UaFHk). Similarly, this documentary was created by the group investigating Holocaust and the role technology played in the process (http://youtu.be/qScq9mWE1dg) using a mobile device to capture footage and pictures from the museum.

In completing the projects, students did not just investigate the impact past, current and emerging technology has had or could have on the society; they also learnt valuable skills in the process such as programming in doing Arduino projects, 3D modeling and software such as Maya, AutoDesk and Google Sketchup and effective use of mobile devices and social media for learning. Important life-long skills such as collaboration, communication, co-creation, time management and digital literacies were learned through active participation within the class community and group work.

Post-project survey, Google+ and student-owned devices in the process

Class community

The institutional learning management system, Blackboard (BB) gave the students enrolled in the CTIS automatic access to resources and content. The course lecturer primarily ran the discussion forums on BB and it was emphasised on multiple occasions during lectures how important it was for the students to participate in the forum, ask questions and comment. On the other hand, the Google+ Class community page was set up by the teaching staff but left up to the students to drive, with the lecturer and the teaching assistants only engaging when addressed directly by the students for help. In spite of the apparent disparity of teacher presence in the Google+ Community, student engagement in this space was superior when compared to the BB course page. At a basic level, only 7% of the students invested time in updating their profile on BB with a picture or a brief introduction compared to the Google+ community, where 66% of the students elected to upload a picture of themself or an avatar and updated their biography. The discussion forum on BB attracted 208 responses while the Google+ community received response in excess of a 1000 student contribution. In the post-project survey, 41% of the students agreed that the Google+ Class community provided an effective platform for deeper learning in collaboration with the peers and the lecturer. Presumably, the high participation rate and student perception that Google+ was a better learning platform are because of the pedagogical integration of Google+ and increased student ownership in the learning process.

Fifty-four students completed the post-project survey, of which 9% of the students agreed that the BB course was the best solution; while 35% of the students agreed that a combination of both platform (Google+ community and BB) provided a better setup. The almost even distribution of student preference between Google+ community and a combination of BB and Google+ perhaps outlines that the students appreciated a space with stronger teacher presence (BB course) where the teacher took a more active role in leading the discussions. 81% of the students in the post-project survey strongly agreed that the facilitation of the course, the learning opportunities and tools used helped build their confidence, knowledge of technologies and other computing skills.

At the end of the semester, students in the class community discussed if they will have access to the community created and whether they could continue using it for learning purposes for the semester to come. This reflected the value and learning experience of collaborative and social learning that helped students learn. It was decided in negotiation with the students that the community will be available and other staff from the faculty who are interested would join to support student discussion and learning.

Group work

The use of Google+ and other Google applications such as Google Drive and YouTube played an important role in enabling a platform from which students could build upon their ideas, coordinate events, share, collaborate and communicate. The availability of the Google+ mobile application for many students meant time or location was no longer a barrier for engaging with group members. The convenience factor enabled by the affordances of mobile devices and social media such as ubiquitousness, social connectedness, the ability to operate across different platforms (desktop, laptop, or a mobile device) and in learner-driven contexts (formal and informal learning spaces) enabled a high student engagement within the group. In the post-project survey, 84% (n=54) of the students either strongly agreed or agreed with the statement "I found the use of Google+ community for managing, communicating and collaborating with my group members on the project, useful." And 77% of the 52 students who attended this question wanted to see similar use of the tools in other courses.

Discussion

The design of the learning space using contemporary Web 2.0 tools and learner-owned devices in the CTIS course gave students flexibility, choice and ability to brainstorm, design, negotiate and co-create resources to grow and learn as a group (Whitworth, Garnett, & Pearson, 2012). The design and facilitation of the course underpinned by the principles of Pedagogy 2.0 mainly, collaboration, communication, creation and co-creation helped students build confidence and knowledge. A result driven by student interest and having the space and opportunity to be creative in being unbound by the limitations and restrictions normally observed in a university course. In this first year paper, many students enrolling had no prior experience or knowledge of computing. In the redesigned CTIS course, students were able to experiment with ideas and in the process not only discovered their own potential within the discipline but also many attributes of computing that they could pursue during the three year program.

Unlike before, where the students only got to hear and read past events and evaluate the role and impact of technology in the process; the new design and facilitation gave students an opportunity to work on their own ideas, to design, create and then evaluate the impact from their own experience within an authentic context (Herrington, 2009; Herrington & Parker, 2013).

The student project output at the end of the semester was impressive, but it was only made possible through the scaffolding process (McLoughlin & Lee, 2008b). In particular, learner freedom to drive their own learning, having a voice and presence within the group and wider class community, flexibility over space where learning happens and access to support and advice when needed (Hase & Kenyon, 2000). The use of technology such as Google platform and student-owned devices (such as mobile devices, laptops and desktops) provided the students space that they could customise, nurture and co-create to drive their learning (Luckin, 2008; Luckin, et al., 2011; Whitworth, et al., 2012). And the ability provided by the affordances of mobile social on mobile devices allowed the students to transcend the time and geographical barriers enabling learning through learner interaction in different contexts (Pachler, Bachmair, & Cook, 2010; Whitworth, 2008).

In this study, majority of the students (71 of 125) indicated that they owned a smartphone. However, all students in the course had access to a computing device (desktop, laptop or a smart-device). While a smart-mobile device (Android, iPhone or iPad) was observed to have been advantageous in certain instances, however, the cross-platform social media tools (such as Google+, YouTube and Drive) used in this course allowed students flexibility with working on devices they owned and were comfortable with. With bring your own device model; the choice of platforms with operational functionality across-platform and devices is an important design element that has to be considered. In this study, Google Apps such as Google+, Drive and YouTube provided a consistent and stable platform across different student-owned devices.

An important output in DBR is the emergence of the design principles that could be used by others in a similar context with similar problems. While in DBR the design principles are continually refined with every iteration, the principles that guided the design and implementation of the course discussed in this paper included elements such as: (1) pedagogical design for embedded use of technology in the course. This means that the course keeping the problem in mind needs to be redesigned with regard to appropriate pedagogy and technology with a view of active learner participation. (2) The outcomes and expectations are made clear to the students from the beginning and reiterated regularly. (3) Students are provided technological scaffold; not every learner knows how to use the technology or how to use the technology for learning. (4) The teacher needs to model the affordances of the technology that students can leverage to enhance their learning and how. (5) Open pedagogies (student-centred), technologies (ability to operate across-platform) and assessments are used that allow freedom to express creativity without fear of being penalised. (6) Emphasising the need for collaboration with peers in class and within the group. (7) Reconceptualising assessment as ‘assessment for learning’ with student output and contributions informing the grade. And (8) active teacher presence in student learning spaces to provide support and advice when needed.

Conclusion

The CTIS project has shown a creative approach to the use of learner-owned technology for learning and teaching and for developing critical learner skills through learner empowerment. The learning and projects driven by the use of technologies such as mobile social media, Arduino and 3D, gave the students an opportunity to think differently and to be creative with their ideas. The increased ease for collaboration and communication increased group productivity and created opportunities for student-driven creation of learning resources to scaffold and drive their own ideas from conception to creation. An open approach to course facilitation underpinned by the notions of Pedagogy 2.0 allowed students to explore their potential in different computing streams such as programming, 3D modeling, mobile devices and apps and project management.

Future iterations of CTIS will be informed by the findings from this research to improve course facilitation, student engagement and empowerment. This will give the first year computing students a good understanding of the computing field in general and build skills that will help them through the three years of study.

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