

Affordances of Learning Technologies in Higher Education Multicultural Environments

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Abstract: A cluster of research has been conducted in higher education to investigate the affordances (action possibilities) and the influence information and communication technologies (ICT) may have on students' learning experiences and outcomes. Such studies have given rise to the implementation of a wide range of educational frameworks with a great deal of empirical evidence on the benefits of using technologies to improve learning. However, these benefits do not appear to have fulfilled higher education expectations for more meaningful and transformative learning experiences. In this paper, I argue that part of the problem is either the content or teacher-centric perspective of these frameworks and the need to explore the benefits from a more student-centric perspective. Learning is contextual, with learners having different abilities to learn and varying preferences for educational technologies with greater potential to facilitate their learning activities. Drawing on an ethnographic study of culturally diverse computing students and teachers within learning environments that blend online and face-to-face pedagogies, I argue that our understanding of what ICT has to offer for the design and implementation of transformative learning activities is a far more complex issue than is often anticipated, particularly in the design and implementation of learning for computer science programs.

Keywords: academic disciplines, computer science, computing science education, e-learning, ICT affordances, learner's preferences, learning styles, learning technologies, media affordances, online learning

1. Introduction

There is an extensive body of research on the affordances of information and communication technology (ICT) to transform learning and teaching in higher education (see Collis 1997; Fowler & Mayes 1999; Goodyear 2005; Laurillard 2002; Oliver 2001). For example, in her influential Conversational Framework, Laurillard (2002) claims that for ICT to play an effective role in learning and teaching, there need to be mechanisms to support the interactive dialogue between teachers and students with the subject matter. Fowler and Mayes (1999) take a similar dialogical approach but primarily focusing on ICT to support the three essential learning stages of understanding: conceptualisation, construction and contextualisation; enabling the learner to move from a novice level to an expert level of learning. A different perspective is presented by Collis (1997) in her pedagogical profile of a course, where the intention of incorporating ICT into the course is to maximise flexibility, with more student engagement and locus of control. Collis sees two ways to achieve this: either through the pedagogical enrichment of the course profile or through a more transformative approach known as the pedagogical re-engineering approach where the components of the course are expected to be radically changed. In the Australian Flexible Learning Framework for the Vocational Education and Training sector, according to Oliver (2001), the underpinning theme is for the use of ICT to support the design of the three learning elements which represent critical components of any learning setting for knowledge construction: learning activities, learning resources and learning support. Similarly, in Goodyear's (2005) conceptual design framework for networked learning environments, the use of ICT is instrumental in supporting the institutional combination of two elements: the teacher's pedagogical approach (teachers' philosophy to teaching) and the educational setting including the learning environment, the learning tasks and the learning activities.

However, despite significant investment in infrastructure and training and a wide-scale uptake of such ICT-mediated educational frameworks, the promised transformative effect on student learning is yet to be actualised outside of small pockets of innovation (Arenas & Lynch 2012; Price & Kirkwood 2014). Of particular interest are students' approaches to learning in multicultural learning environments where ICT is considered as integral to teaching and learning activities. The above discussed models appear to overlook factors like that learning is cross-cultural, that learners have different abilities to learn and modes of approaching the intellectual inquiry; and that all these factors may affect the way students perceive ICT-mediated learning activities (Arenas 2012). Specifically, this research addresses the following questions:

- In the context of computing science programs, what are students' preferences for ICT media in their learning activities?
- What is the relationship between the different types of ICT media, their action possibilities and the way these ICT media best support the learning of computer science?

2. Related work

Two interlocked aspects of learning and teaching appear to be critical in the choice of ICT to support learning: 1) the nature of the subject matter (within an academic discipline) that we as teachers believe students need to construct their knowledge and, 2) students' learning styles of intellectual inquiry (Becher 1994). In this respect, Biglan's classic model on academic disciplines and Kolb's learning styles theory might shed some light.

With reference into the similarities and differences of academic disciplines, no other framework has been as extensively cited and used as Biglan's classic model (Arbaugh 2013; Lam, McNaught, Lee & Chan 2014; Li, Long & Simpson 1999; Pike & Killian 2001; Schommer-Aikins, Duell & Barker 2003; Stoecker 1993).

In his model, Biglan (1973) uses the cultural and epistemological uniqueness found in each branch of knowledge to classify the nature of academic disciplines. In doing so, Biglan (1973) differentiates the academic disciplines according to their specific characteristics including the object of research, body of knowledge, theory, principles and research methods. Two dimensions emerge from these characteristics. The first dimension distinguishes between paradigmatic and non-paradigmatic fields, i.e. hard or soft respectively. For example, physical sciences are 'characterised by the existence of paradigms that specify the appropriate problems for study and the appropriate methods to be used' (p. 195), while social sciences and non-sciences areas like history 'do not have such clearly delineated paradigms' (p. 195). The second dimension perceives the subject matter in terms of 'its requirements for practical applications', i.e. pure or applied (Biglan 1973). On those grounds, Biglan (1973) sees academic disciplines divided into four groups: hard-pure, hard-applied, soft-pure and soft-applied.

The educational context of this study is computing science and in terms of Biglan's categorisation, it falls into the hard-applied category (Baldwin 2011; Clark 2003). According to Becher (1994), in the hard-applied disciplinary group, the nature of knowledge is purposive and pragmatic where individuals are concerned with the technical mastery of physical environments to build products. Consequently, the effective choice of ICT in the design and implementation of computing learning and teaching activities should consider these characteristics of the computing science discipline.

Kolb's experiential learning theory (ELT) has been instrumental in understanding learners' preferences and the way they approach learning. According to Kolb and Kolb (2005), learning is a process where learners construct knowledge through their experiences with the environment. Kolb sees knowledge as the result of combining the way individuals grasp and transform their experiences (Kolb & Kolb 2005). According to this theory, there are two dialectically related modes of grasping experience: Concrete Experience (CE) and Abstract Conceptualisation (AC). Similarly, there are two dialectically related modes of transforming experience: Reflective Observation (RO) and Active Experimentation (AE). For example, when a learner is exposed for the first time to a concrete experience (CE), there is an initial stimulus for the reflective observation (RO) of the new experience, which in turn gives rise to a thinking process characterised by abstraction and conceptualisation (AC) to assimilate the new experience. Once the new experience is assimilated the learner is prepared to act upon and transform it into something different through active experimentation (AE). This learning cycle repeats in the construction of new knowledge and varies depending on the personality and experiences of the learner (Kolb & Kolb 2005). In other words, there is a preferred way of choosing amongst the four abovementioned modes of learning shaped by individual's previous experiences, learning behaviours, prior learning and the learning environment. To understand Kolb's ELT in the context of computer science, there is a need to explore first what computer science constitutes in terms of an academic discipline.

A provocative and thoughtful description of the nature of computer science as an academic discipline is the one given by the prominent computer scientist and computational theorist Juris Hartmanis (considered by many as one of the fathers of computer science education). During his *Turing Award* lecture on *computational complexity and the nature of computer science*, he stated that computer science is all about the creation of many levels of abstraction to deal with computational problems. It involves the creation of 'intellectual tools to conceive, design, control, program and reason about the most complicated of human creation' (Hartmanis

1994; p.39). A similar view is shared by Donald Knuth (the father of the analysis of algorithms) who in a personal communication to Hartmanis commented that:

Computer science is a field that attracts a different kind of thinker. I believe that one who is a natural computer scientist thinks algorithmically. Such people are especially good at dealing with situations where different rules apply in different cases; they are individuals who can rapidly change levels of abstraction, simultaneously seeing things in the large and in the small' (Knuth in a personal communication to Hartmanis March 10 1992, in Hartmanis 1994; p.39).

In the light of Harmanis and Knuth, and in terms of Kolb's modes of learning, computing students are individuals with a converging style of learning with abstraction, conceptualisation, and active experimentation as the main dominant learning abilities. Consequently, the choice of ICT for learning purposes should be consistent with the learning style of these individuals.

Following Biglan and Kolb's work, this paper builds upon our knowledge about how computing students go about learning in learning environments with ICT as an integral component in the design of transformative learning and teaching. The analysis presented below elaborates specifically on computing science students' diverse responses to particular ICT-mediated learning activities, and through this analysis I argue that our understanding of what ICT has to offer for the design and implementation of transformative learning activities is a far more complex issue than is often anticipated, and this is so particularly in the design and implementation of learning for computer science programs.

3. About the study

3.1 Participants

This paper draws on an ethnographic study (Arenas 2012), conducted at two universities in Australia, that explored the behaviours, attitudes, perceptions and conceptions of teaching and learning found within multicultural learning environments that blend online and face-to-face pedagogies.

Data were collected from participants located at two qualitatively different sites. Within each site, two postgraduate computing courses (or units of study) were targeted for data collection: NetSec (Network Security) and SAD (Systems Analysis and Design) at Site 1; and BAM (Business Analysis and Modelling) and FOIS (Fundamentals of Information Systems) at Site 2. The first site (henceforth referred to as Site 1) was located in one of the metropolitan campuses of a multi-campus medium-sized regional Australian university, and the second site (henceforth referred to as Site 2) was located in a large metropolitan Australian university. Site 1 student body comprised international students only, whereas Site 2 was located in a university that catered mainly for domestic students with a relatively smaller population of international students. The learning management system (LMS) used at Site 1 was a purpose in-house built system whereas at Site 2 students used Blackboard™, a popular commercially available learning management system.

The purposive, culturally diverse sample from both sites comprised of a total of 18 student participants from nine countries of origin and their respective teachers. The following is a description of the sample based on participant-reported background information.

The student sample at Site 1 was comprised of twelve students. They had diverse educational backgrounds, with varying residency time in the country. Prior to the commencement of the semester term, Site 1 students had been residing in Australia for periods of between 3 months and 18 months, with half of them for less than 12 months and five students for only three months. Of the twelve student participants, six were men and six women, including nationalities from Pakistan, China, Bangladesh, Kuwait and India. Before participating in this study, six students already held a postgraduate degree and three had more than two years' experience in the field of information technology. All students who provided information about their skills reported that they were experts at writing academic arguments in the English language. They also reported to have expert level knowledge using computer hardware and software and discussion forums; however, only three students reported to have experience using blogs (electronic journals).

At Site 2, there were six student participants: three men and three women including nationalities from Australia, Oman, Vietnam, Indonesia and China. Prior to the commencement of the semester term, except for

one domestic student, Site 2 students had been living in Australia for a period of between one month and two years, with two students residing in Australia for fewer than three months. Also in contrast to Site 1, where six students already held a postgraduate degree, at Site 2 all students held only an undergraduate bachelor degree before the conduct of this study. Three students had between four to thirteen years' experience working in an information technology field. Only one student claimed to have only novice expertise in computer hardware and software and discussion forums compared to the rest who reported to be highly experienced using those tools. Similarly, two students reported having novice experience writing academic arguments in English, with the rest reporting to have expert level essay writing skills. Except for one student, none had substantial team work and management experience.

The teacher participants at Site 1 were two young but experienced teachers: Georgina taught NetSec and Richard taught SAD (pseudonyms are used throughout to refer to teacher and student participants). Before the conduct of this study, Georgina had more than three years' experience teaching information technology subjects on a sessional basis, that is to say, through separate contracts for the duration of each semester term. Georgina combined her professional academic practice with full-time paid work in a senior systems administration role at a prominent Australian financial organisation. She held a Masters degree in information technology from an Australian university. Richard was a full-time academic staff member with three years' experience teaching information systems subjects. Before his full-time academic tenure, Richard was a Site 1 alumnus and after his graduation he worked as a teacher on a sessional basis at Site 1. He held a Masters degree in information systems and a Graduate Certificate in university teaching.

In terms of Site 2 teachers, BAM staff was larger than FOIS, and included three experienced professionals with different industrial and academic backgrounds. Sophia, the principal academic teacher and teacher participant responsible for this subject, had completed a PhD in Computer Science and also a Graduate Certificate in university teaching. She had extensive experience as a research scientist in information architecture; and usability analysis and design for various industrial and research projects locally and internationally. The other two teachers did not form part of the sample.

While BAM had three academic staff, FOIS was managed and taught by a single staff member, Shane. Shane was a senior lecturer within the Faculty of Science at Site 2 with extensive experience teaching online courses. He held a PhD in Information Systems and a Graduate Certificate in university teaching.

3.2 Data collection

The study used multiple data sources to gain insights into the behaviours, attitudes, perceptions and conceptions of teaching and learning found within these multicultural blended learning environments. The data included digital textual records of online discussions, semi-structured interviews, field notes from classroom observations, a reflective research journal, course-associated documentation, and students' assignments.

The first source of data consisted of digital texts produced by both student and teacher participants during their interactions with the online component of the learning environments at each site. During the term, teachers provided the students with various online learning activities for individual and group work.

At Site 1, student participants were required to maintain an electronic journal (blog) to reflect on their own learning experiences and perceptions of the course. The blog was based on nine topical questions spread over the last nine weeks of the semester and was assessed. The teaching staff provided structured marking guidelines to promote quality work and to ensure each student contributed the nine expected reflections. They also monitored students' progress and provided weekly feedback. At Site 1, students also used a laboratory simulator (LabSimTM), a simulation tool where students could experiment with real world problems in a virtual environment. The LabSimTM acted as a virtual tutor guiding the students through complex and technical configurations of secured networks. The system could challenge the student to conduct tasks that replicated the real world providing immediate feedback after the completion of the task.

At Site 2, students were required to use a discussion forum to extend their engagement with learning activities initiated in face-to-face classrooms. There were six discussion forums. Three of them were designed for individual participation where students were asked to challenge or critique at least one of the questions raised by the lectures or fellow classmates during the classes. There was a general discussion forum to discuss

general issues arising from the course and two group-project-related discussion boards. Of the six forums only the general discussion forum was moderated by the teaching staff. The other forums were only moderated to check students' progress and to prevent language flaming.

Classroom observations were conducted at both sites to record reflective notes and provide descriptions of students' face-to-face classroom activities and behaviours, stimulate personal views of participants in interview, and record events such as student consultations and class participation. The classroom observations were instrumental in the selection of the purposive sample for the student interviews.

Individual semi-structured interviews were conducted with both teachers and students. The duration of each interview was between 30 and 45 minutes. The purpose of these interviews was to gather participants' reflective views of their teaching and learning experiences in the learning environment. Semi-structured interviews were preferred to structured interviews because this method is more consistent with the ethnographic aspect of this study. Through the use of open-ended questions, semi-structured interviews allow for the exploration of new ideas and themes, something hard to achieve with the rigorous setting of questions, commonly found in structured interviews (Creswell 2007).

The identification of potential interviewees was based on the criterion-based selection as recommended by Schensul and LeCompte (1999). Specifically, four teachers responsible for the delivery of the subjects were interviewed: two at Site 1 and two at Site 2. Student participants were interviewed in the middle of the second semester, by which point there was an opportunity to observe the students and assess the level of engagement and participation in both face-to-face and online forums. Sample diversity was maximised by choosing students from the following groups: those who were quiet in the classroom but very active online; those who were active online but not in face-to-face sessions; those who were very active in both environments; and, those who were passive face-to-face and online.

The interviews contained a range of open-ended questions that asked participants to reflect on the multicultural, pedagogical and technological aspect of the units of study.

Additional data sources were used such as a research journal, subject outlines, profiles, content and accreditation documents, and students' assignments, to investigate the relationship between students' reported perceptions of the subject and the documented learning aims, course content and student behaviours in the course.

3.3 Data analysis - coding

Nvivo™, a qualitative research computer program developed by QSR™, facilitated the data analysis. During the process, a large number of units of data analysis were created, managed and organised aimed to develop codes from the multiple data sources. Codes that made explicit reference to both expected elements of the study and to unexpected elements that represented unusual information to the researchers and/or participants were chosen and labelled (Creswell 2007). This coding process produced a total of forty-six nodes with direct or indirect relevance to the focus of the research.

Nodes were examined in search of themes that were meaningful in relation to the aim of the study in that they related to students' behaviours, attitudes, perceptions and conceptions of teaching and learning within a blended, multicultural context. For each theme think-aloud and concept mapping processes were used to develop conceptions of the patterns in the nodes and refine the coding process. As a result, some of the nodes were merged and others, considered to be redundant, excluded from further analysis and representation. The resulting thirty-six nodes were hierarchically clustered into five broad themes: 1. Adapting to a new learning environment – cultural and social dimensions; 2. Preparing to learn; 3. Keeping pace with the learning activities; 4. ICT integration; and, 5. Perceptions of pedagogical practices.

It is beyond the scope of this paper to discuss each of these themes, which are reported elsewhere (Arenas 2012). Instead, addressing the research questions, in this paper the focus is on the *ICT integration* theme, which incorporates codes associated with the affordances of ICT in learning and the types of ICT-mediated learning activities that appear to be a better fit with the expectations and behaviours of computer science students than others.

4. Discussion of the findings

In relation to educational technology, the term *integration* means different things in different contexts and it is often used without precise explanations of what it might mean to different people and for different authors. In this paper, a number of ideas and practices related to integration are explored in the context of computing students using ICT in their learning activities and could be interpreted as any of the following: the way different online tools and their access are presented to students, the relationship between online and face-to-face components of a unit of study, the link between learning aims and the use of ICT, the link between assessment tasks and the way ICT is used; and the underlying assumptions of teaching and learning tasks for different aspects or components of a unit of study and how this relates to the way ICT is used.

Having said that, this study showed that the vast majority of student participants perceived the integration of ICT into learning activities as useful, convenient, flexible, encouraging reflection and good for knowledge sharing and asynchronous interactions.

These findings are consistent with those reported by similar studies (e.g. Stacey & Rice 2002), where the use of learning technologies is seen to be a positive experience for students, enabling them to engage in learning activities even when the parties are spread geographically, providing resources, idea sharing and a sense of a learning community. Let us take the case of Vert (India, Site 1) for example, who had the need to urgently fly to his country owing to family problems during the teaching period. He recognised that through the blended learning approach, he was, while overseas 'able to keep in contact with lecturers, tutors, catch up with lectures, and lecture notes, materials and so on' (Vert, India, Site 1, interview excerpt), which in a conventional face-to-face teaching and learning program he would have found it difficult to do, given his personal situation. But, if for Vert the use of ICT in his studies was a matter of flexibility and convenience, for Jacquie (China, Site1), an experienced user of the tools, it was necessary for learning. She referred to the discussion forums and blogs as 'indispensable for learning', to the extent that she would not have been able to conduct her studies without them. There was evidence of this engagement and facility with these learning tools by Jacquie through the high number of conscientious and thoughtful posts she generated during the semester term. In her interview, she particularly emphasised the ubiquity of the tools, her confidence to express feelings, and the wide audience she was able to reach with them:

They provide you with interactivity that traditional face-to-face methods could not provide; they are also 24/7. I think that maybe people tend to be shy in modern society. Maybe sometimes when I meet you face-to-face I could not say some words directly or I feel tensed or something [like that], I do not want you to know it is me who said that, but with these tools you can solve all those problems. It can also involve large scale people, students, coordinators, lecturers and tutors that could discuss a problem together, not just limited within a classroom (Jacquie, China, Site 1, interview excerpt).

Jacquie's words are consistent with a cluster of research (Suler, 2004) highlighting the disinhibiting effect of online text-based interactions and particularly the potential that this has for international students (Lanham & Zhou, 2003) when socio-cultural factors and English language issues might otherwise inhibit them from participating in face-to-face forums.

In terms of the affordances or action possibilities of ICT in transformative learning and teaching, the focus of this paper; two findings are relevant to the discussion: 1) the integration and alignment of ICT-mediated learning activities with students' learning needs and preferences; and 2) students' diverse responses to different types of digital media discussed next.

4.1 Alignment of ICT-mediated learning activities

While the integration of ICT into learning activities was seen by many students to be beneficial for their learning, many also reported difficulties with the particular array of ICT-mediated learning activities that they experienced.

Some students reported perceptions that the ICT-mediated learning environment did not give them the option to choose from learning tasks and that somehow they were misaligned with their preferences and needs. Take for example the case of Eloisa (Australia, Site2), a mature student with an extensive information technology

working experience, who expressed disappointment that the first learning task was not aligned with her immediate preferences and needs:

I prefer not to have subjects where I have to submit a real-life situation. I do not mind if it is a theoretical problem or an essay, a case study but the fact that we have to use a real-life case, I find it difficult but mostly I find it pointless when I am working. My goals are to learn something other than workplace. I do not need experience talking to people; I do not need experience in dealing with teams because it is part of my work. It is frustrating; I rather spend the time doing the review (Eloisa, Australia, Site 2, student interview excerpt).

This time referring to the use of discussion forums, Eloisa believed that the use of ICT as part of the online learning activities turned out to be counterproductive. She was frustrated by the lack of alignment between teachers' expectations as articulated in the course's objectives and the students' actual participation and collaboration in the forums. In her own words: 'contextually, nothing happened'. In relation to student participation, she said that the discussion forums were fragmented, disjointed and hard to follow:

The discussion forum itself is fine but not effectively used in this subject. Perhaps the way we try to use the system is not quite right ... I am not sure if it is the system by itself. I think it is the way the posts are put in the discussion forums which are very fragmented and the way they are used ... It is all being kind of disjointed and hard to follow up (Eloisa, Australia, Site 2, student interview excerpt).

An analysis of the online discussion data confirmed Eloisa's perceptions showing fragmented and disjointed contributions from her peers. Many students did not appear to have skills in communicating effectively via online discussion forums. For example, simple procedures such as copying a part of the post and pasting it onto their own post before responding to it, was not taken into account by some students, making the discussion difficult to follow. Another example is that names were rarely used in posts and replies, that is to say, the social networking etiquette of initiating a post with a short greeting followed by the recipients' name and closing the post with the senders' name was overlooked in a vast majority of contributions. From the given examples, students appeared to be operationally literate when using the discussion forums but they seemed to lack the cultural and critical skills (Goodfellow, 2004) required to use them in a meaningful way.

Eloisa's disappointment was evident when she talked about the effective use of the tools to promote knowledge sharing and collaborative learning:

Even though everyone is there trying to say something and you think that it would be collaborative but I think that there is still an element of competition perhaps. I have seen in other subjects where the lecturer said that if you found an interesting article just posted it for everyone to share and no one posted anything. I cannot believe that no one found an interesting article. They are not sharing articles because they believe that should be used for their advantage. All of those things are working against the idea of sharing information, helping each other (Eloisa, Site 2, student interview excerpt).

The student data suggests a competitive culture amongst the participants, contrasting with the teachers' assumptions and expectations of communicating in a collaborative way. The data also suggests that the assumptions and expectations held by the teacher (Sophia, Site 2), which she hoped were built into the teaching and learning environment, were not understood or shared by the students. Unfortunately, not much work was done by Sophia to make her assumptions and expectations explicitly known and understood by the students from the start of the term, which she later recognised as 'a big mistake'.

Another situation is the one expressed by Peter (India, Site 1), who perceived the use of blogs as problematic to the extent that knowing that he had to contribute by posting his reflections became a burden and not aligned to his expectations:

The way blogs were used in this subject was a kind of obstacle for me. For starters they were compulsory. You had to do them regardless since they had marks allocated. It should be a reflection of the subject done spontaneously and not on a weekly basis as they have been set up for this subject (Peter, India, Site 1, student interview excerpt).

From the quote, there was a reported feeling of frustration and concern in Peter's words regarding the way the blogs had been implemented in the study of the subject matter. He did not think the way they were used

was consistent with the spirit of reflection and was instead in favour of using them 'spontaneously', that is to say, in response to a self-generated urgency of recording personal reflections on topics discussed in class, and not for the sake of a mark allocated.

In summary, from the findings, the requirement to do all the learning tasks was not well received. Students would have preferred a learning environment with a higher level of flexibility in terms of choice of content management and the mode of learning consistent with their professional interests and learning needs (Biggs 2003; Cornelius, Gordon & Ackland 2009; Guest 2005; Marton & Booth 1997). The approach to learning should support program designs which include a wide array of ICT-mediated learning activities but where students are given scope to both select and pursue learning activities that align with their interests and preferences, as well as being supported to engage with non-preferred modes.

4.2 Students' diverse responses to different types of digital media

With reference to students' diverse responses to different types of digital media, Norman's (1990) work in human computer interaction (HCI) along with Laurillard's (2002) analytical framework, which identifies the affordances of both communicative media and adaptive media are both useful here in discussing this finding.

Norman (1990) argues that the affordances (or action possibilities) of an environment as perceived by an actor depend not only on the physical capabilities of the actor but also on their intentions, plans, values, beliefs and previous experience (Norman, 1990). In other words, to examine the effectiveness of ICT in learning, there is a need to understand the capabilities of the learning environment as perceived by teachers and students.

According to Laurillard (2002), particular technologies are understood to have particular affordances and constraints (Laurillard, 2002), that is, a particular technology can be analysed and understood to afford some types of usages and behaviours while constraining others.

Following this line of reasoning, this study found student and teacher participants responding differently in their perceptions of the value of different types of digital media. Take for instance the following comment from Georgina (Teacher, Site 1) when referring to effective interactions using the discussion forum in the course she was responsible for:

Through discussion forums international students may only be interested in getting solutions to the problems. Give me the answer from the collaboration point of view (Georgina, Site 1, teacher interview excerpt).

She was concerned that, within this context, students may only be motivated to use these tools to acquire or consume knowledge, and get answers without any concern for the process; defeating what she was aiming, for which was a two-way collaborative and engaging learning system.

From the student perspective, Natalie (Oman, Site 2), who found the flow of the discussions irrelevant and not engaging, the affordance of the learning technology was somehow similar. She particularly lamented the apathy, the lack of participation of fellow students and the low quality of their arguments:

I find the discussion forums superfluous and that is why I do not do participate a lot. You post interesting topics and no one replies with sound arguments (Natalie, Site 2, student interview excerpt).

It is worth noting that Sophia, the teacher who implemented the discussion forum in Site 2, took a proactive approach by implementing some changes part way through the semester to improve participation and the quality of the contributions; however, this change produced only minor improvements. Her attempt to use the forum as a discussion place for sharing and possible meaning-making was a failure. During the interviews, Sophia was asked what she thought was the cause of this problem. Even though she was not sure about the roots of the problems, she mentioned a wide array of student factors that could have contributed to its ineffectiveness; from time constraints, lack of interest and doing the minimum to get a pass, to lack of confidence in working out the appropriate argument for posting. All these explanations point to the students. In a more personal reflection, Sophia was prepared to accept part of the responsibility for flaws in her implementation of the discussion forum. Firstly, she did not manage to motivate the students to use the tools for learning purposes and, secondly, she failed to get it right from the start of the semester. Her future agenda is to learn from this mistake. She identified strategies that she could adopt in the future, including to better

cater for a range of language abilities, familiarising students with discussion forums as learning environments, and scaffolding the learning process by modelling what is expected, amongst others.

Contrary to the implementation of the discussion forums, the implementation of the LabSim™ and its integration into the wider unit was very successful. As mentioned above in section 3.2, at Site 1 the LabSim™ (laboratory simulator) was a computer learning tool integrated to the NetSec subject. Its intention was to help students experiment with real world problems typical of complex and technical configurations of secured networks. This strategy was very well received by all Site 1 students including Manuel, who praised LabSim's capacity to guide him to construct real world scenarios without being actually exposed to them: 'I found the LabSim very useful ... for example, in my home computer I could build a virtual environment to learn routing and networking' (Manuel, Bangladesh, Site 1, student interview excerpt). In Bernie's case, the LabSim™ went beyond the construction of virtual networking environments, enabling him to achieve deep learning:

In the beginning when I planned to do this course and realised that it had something to do with security, I thought to get some basic expertise in security since that is my future goal in my career path. Once I started the course, I found lots of practical things, specially the LabSim ... very industry like. That inspired me to put more effort to get a deeper understanding and to implement the knowledge I could get from it (Bernie, Kuwait, Site 1, student interview excerpt).

Taking the teacher's perspective, Georgina underscored the practicality of the LabSim™, particularly in those circumstances where it is not possible for the students to use a live environment where they could practice what they learn in theory:

The integration of the LabSim in the subject was really helpful because a pure technical subject like this should have some hands on practical activities. Because we cannot give them a live environment, giving them a simulated environment like the LabSim is as close as it can be (Georgina, Site 1, teacher interview excerpt).

In summary, the use of communicative media (e.g. blogs and discussion forums) was perceived as problematic. Some teachers and students were dissatisfied with the use of these technologies, specifically in relation to supporting reflection, discussion and collaboration. The main sources of this dissatisfaction are evident in the findings of this study. First, although social constructivist theories of learning suggest that students learn best through collaboration, dialogical conversations and critical thinking, for some students their willingness to learn collaboratively and to participate in the communicative environments was inhibited by a number of socio-cultural factors such as cultural differences and attitudes towards cultural diversity. Secondly, although these types of skills and interactions are promoted at the level of policy (e.g. through stated graduate attributes), the fit between these types of reflective and dialogical activities and the culture of computing science (Dijkstra et al. 1989; Lynch et al. 2001) is not necessarily good, such that computing students do not necessarily understand the potential value of engaging in the reflective, dialogical learning activities afforded by communicative media.

By contrast, while the use of communicative media appeared to be problematic in the context of this study, the use of interactive and adaptive media in the form of the LabSim™ (laboratory simulator) was a different story. Laurillard (2002) states that interactive media support the investigating and exploring nature of the learning experience. Adaptive media support the experimenting and practising culture that is important in computing education. The learning activities that made use of adaptive media (i.e. through the use of the LabSim™) were well received by the student participants who could see their value. Further, the sorts of activities afforded by the adaptive media did not present challenges to the students' socio-culturally laden conceptions of, and skills in, learning in the same way that the communicative media did. In essence, the findings suggest that some types of ICT-based learning activities appeared to be a better fit with the expectations and behaviours of international computing students. While some other types appear to offer much potential for developing desired learning outcomes and providing flexibility and accessibility, they may need to be actively 'sold' to these students.

5. Conclusion and implications

This study contributes further evidence of the complex issues associated with the effective integration of online tools in learning. The finding that some types of ICT-based learning activities appear to be a better fit

with the expectations and behaviours of computer science students than others makes a significant contribution to computing education because of the implications it has for learning design. The cultural preference found amongst computing students for adaptive rather than communicative media suggests a very significant cultural barrier to effective engagement in online dialogical exchanges, barriers that for some students are not easily overcome. The study sheds more light on the advantages and disadvantages of different types of ICT media, and the need to properly integrate them in computing education scenarios. There is a need for further exploration of the affordances of communicative and interactive media and for the appropriate integration of such media in computing learning activities that best prepare computing students.

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