

How seamless are technology-rich learning environments? The voice of IT educators

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ABSTRACT

Educational environments in higher education Information Technology (IT) courses typically involve the use of multiple technologies. Such technology-rich learning and teaching environments (TRLTEs) can enhance a student's learning experiences and support learning in different settings (in-class and out-of-class, individual and group learning) and promote flexibility in learning in terms of time, space and access to learning resources. However, these can be complex teaching environments for educators to manage. A challenge for educators is to ensure that learning across multiple technologies and contexts happens *seamlessly*. Seamless learning is a notion whereby students transition smoothly from one learning setting to another, typically aided by technology. This paper reports the findings of an exploratory qualitative study of IT educators' experiences of a TRLTE. Semi-structured interviews were used to elicit IT educators' views of enablers and barriers to learning seamlessly. Data were analyzed using a thematic analysis technique. The findings revealed several issues in facilitating learning in a TRLTE and IT educators used various technologies to bridge the *seams* in their students' learning. We discuss the findings and the implications for providing a seamless learning experience.

CCS CONCEPTS

Computer and Education → Computer and Information Science Education

KEYWORDS

Educational technology; mobile technology; seamless learning; technology-rich teaching and learning environments

1. INTRODUCTION

In the last couple of decades the increased use of technology in higher education has seen creation of technology-rich learning

and teaching environments (TRLTEs). A strong motivation for educators to use technology is to enhance their students' learning experiences and for institutions a main driver is often to create efficiencies in teaching programs.

A TRLTE typically integrates a range of technologies enabling learning and teaching in many new ways [7, 15]. A review by Groff [7] of technology use in innovative teaching and learning environments found that technologies such as portable computers, virtual learning environments, e-portfolios, and social media technologies form a basic standard deployment. However, the integration of technologies such as mobile technologies, virtual and augmented reality, and simulations has brought about evolutionary changes in education, enabling learning in many new ways and contexts.

A TRLTE with multiple technologies used in different teaching modes and contexts forms a complex teaching and learning situation. Technologies such as web and mobile technologies provide opportunities to reduce this complexity by bridging across different modes (e.g. online and face-to-face) and different contexts (e.g. in-class and out-of-class) [7, 17]. A challenge is to understand how learning within a TRLTE can transition from one learning situation to another *seamlessly*.

2. SEAMLESS LEARNING

A *seamless learning* environment provides uninterrupted learning across informal and formal learning settings typically with the support of various technologies [17]. Learners in a seamless learning environment are able to have smooth interactions, collaborations, discussions, and explorations, across devices and contexts [3, 17, 23].

Seamless learning is a key consideration for IT education programs, facilitating the development of 21st century learners who can study individually or collaboratively, face-to-face or

on-line, and in-class or out-of-class, developing skills such as problem-solving, creativity, and self-directed learning [1, 9, 13, 21–23]. In a recent study by Shuler [17], mobile learning experts highlighted the need for a systemic and smooth integration of in-class and out-of-class learning. The establishment of seamless learning environments through the integration of ubiquitous technologies has been flagged as one of the “overarching goals for the future of education” [14, p. 13].

However, seamless learning can be difficult to achieve in a TRLTE. This is because without careful design, *seams* can occur during transitions between devices, technologies, personal and group learning, and different learning contexts [15]. A *seam* in this study is defined as a situation that causes difficulty to the educators and/or learners during the teaching or learning process. It is important to identify where such seams can occur and find ways that they can be reduced or eliminated [4, 7, 8, 11].

A number of studies that have investigated seamless learning have focused on connecting in-class and out-of-class learning. The most common approach to forming a seamless learning environment is to use mobile technology as a mediator or “learning hub”. Several studies (e.g., [2, 6, 10, 12, 14]) report the use of mobile devices such as a smartphone or tablet to connect learning in formal (in class) and informal (out-of-class or in-field) settings. Similar approaches were used in several investigations of seamless learning at an elementary school in Singapore [14, 18, 21, 22]. However, in a search of the literature no studies were found that explored educators’ experiences of seamless learning in TRLTEs in higher education institutions (HEIs). This paper aims to fill this gap in the literature.

The aim of the research reported in this paper is to explore IT educators’ experiences of teaching in a TRLTE to investigate where seams can occur in students’ learning experiences and how they may be overcome. The research questions used to guide this study are:

1. Where do seams occur in a TRLTE?
2. What do educators do to facilitate seamless learning?

The findings from this study provide insights into the barriers and solutions to facilitating seamless learning.

3. RESEARCH APPROACH

Our study used a qualitative approach to investigate IT educators’ experiences in a TRLTE. Semi-structured interviews were used to explore the IT educators’ perspectives of learning situations that their students found problematic and the educators’ strategies for addressing these. This form of interview gave the educators the opportunity to describe their experiences [19] and allowed the researcher opportunities to probe further with additional questions in order to gain more insights. [5, 16]. The interview questions were designed by the researcher in consultation with the other authors of this paper.

3.1 Setting and participants

The setting of this study was a university IT faculty with a TRLTE. IT educators with at least one year of teaching experience in the university were recruited for the study. A total of 21 educators were invited to participate in an interview, with 11 (4 females and 7 males) agreeing to be interviewed.

3.2 Interview procedure

The interviews were conducted by the first author of this paper in December 2016. The interviews were held in each educator’s office or a nearby meeting room. Each participant gave permission for an audio recording of their interview. The researcher used online transcribing assistive software to manually transcribe the interviews. The transcripts were exported to Nvivo 11 software for coding and analysis.

3.3 Interview analysis process

Thematic analysis was used to analyze the data with multiple analysis steps. The process was inductive in nature [9]. In the first stage of analysis the researcher read through each transcript while listening to the interviewee’s recorded voice. This was done in order to hear the tone of the interviewee and gain better understanding of the meanings expressed. During this overview a few themes emerged from the data and these were recorded in Nvivo, each labeled with a name and short description.

In the second stage, three transcripts were read through several times to compare the similarity of the themes and more themes were identified. Themes were then grouped as sub-themes under main themes. Several main themes were found but the two main themes that relate to this study were “factors that cause seams in learning” and “enablers and drivers of seamless learning”.

In the third stage, the researcher read through each transcript to extract statements related to the subthemes. After a few rounds of repetitive reading and coding, more sub-themes emerged. Sub-themes were constantly adjusted to the related main themes and edited to have more meaningful names.

In the fourth stage, the researcher revised and examined the relationship of the main themes with the research questions and objectives. A few sub-themes were merged and collapsed or reassigned to other main themes.

In the fifth stage, the researcher listened to each audio-recorded interview while reading the transcripts in order to examine the accuracy of coding in the final themes. At the same time, statements were examined from different perspectives to delve deeper into their meaning and implications. For example, a complaint from a lecturer who doubted the usefulness of technology in class, on further analysis, it became apparent that there was misalignment with the institution’s purpose for introducing the technology and how the lecturer had been using it. Using this process of deeper analysis more hidden implications were derived from the participants’ interviews [19].

4. SEAMS IN LEARNING

This section reports findings from the analysis of the interviews with IT educators. In our analysis, we found seven situations where seams can occur in learning in a TRLTE. These

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related to technology, pedagogy, and student learning behavior and needs. We describe each situation with illustrative quotes from the educators and present strategies that the educators use to provide a seamless learning experience for their students.

4.1 Virtual learning environments

The experiences of the IT educators in using their VLE (Moodle) were mostly negative. They claimed the VLE was hard for both students and educators to use. Common complaints were that the design of the VLE was confusing as it was crammed with too many features and too much information. A couple of educators explained:

“I think Moodle has so many features that to make the best use of it you really need to understand the system very well. ... I think it is confusing for the students as well... so many things: discussion forum, quizzes, map, icons everywhere and little things flashing in it. It's quite of alarming I think.” ~E6

“from my personal experience, ... there are many fancy functions in Moodle but most of them I won't use ... it's not very useful in the real teaching experience.” ~E9

The design of the VLE had hindered the educators' provision of resources and their interactions with their students, and the design had impeded the students' access to the learning support across all learning settings.

The educators proposed that from a pedagogical point of view, technology should be “transparent or invisible” and fade into the background. As one suggested:

“getting a nice clean interface with just what they (students) need with just the resources for that learning activity ... will be good - without overly extra stuff.” ~E6

Key finding and suggestion:

To achieve a seamless teaching and learning experience, it is essential that the educational technology is intuitive and user-friendly. We suggest that providing a mechanism for contextual feedback in the learning management platform and key technologies would allow students and educators to provide feedback where and when they face any usability problems.

4.2 Technology availability, accessibility and compatibility

The availability, accessibility and compatibility of technologies caused problems for both the IT educators and their students.

Some educators mentioned that students may not possess the particular technology necessary to participate in a learning activity. One gave an example:

“I'm looking at a piece of technology that allows me to have everyone use their smart phones and draw... It requires everyone to have a smartphone, and everyone to have the right kind of smartphone, and everyone to have the app on the smartphone.” ~E2

A couple of educators mentioned compatibility problems in using technologies for their teaching:

“when I'm using the Keynote (Mac-based) it actually takes a lot of time to convert from conventional PowerPoint (Window-based) into the Keynote form.” ~E10

“some presentation material is not very compatible with the computer in the lecture theaters.” ~E9

In order to solve this transition problem, the lecturer (~E9) stated that he used his own notebook.

The educators had various other suggestions for overcoming compatibility problems. For example, using technology with minimum requirements:

“the reason why I use Google Cloud is because it only requires an Internet connection.” ~E2

One educator proposed a more general solution to accessibility and compatibility issues:

“It would obviously be good if we could do things on just a single platform, which makes it more accessible ... and also when students are using different types of devices, they could get connected to the same platform or system to get access to all necessary technology – that would be ideal.” ~E10

Key finding and suggestion:

Different devices, file formats, platforms, and software incompatibilities cause seams when transitioning across technologies and learning settings. We propose that the transition across technologies and contexts could be more seamless through designing the learning content to be responsive to different devices and providing more platform support.

4.3 Complex topics

The IT educators mentioned challenges they faced in teaching complex topics. Particular topic areas where seams occurred were algorithms and programming. As one educator commented:

“programming has a lot of abstract concepts that are actually somehow quite hard to explain.” ~E10

The educators had various techniques that they used to help students learn difficult concepts. One educator (E4) gave a vivid example of using YouTube to explain an algorithm.

“I have made use of YouTube ... I found some really interesting YouTube videos where a group of Eastern European folk dancers, were doing dances that represented basic algorithms. So they would show you how, for example, quicksort worked and how a selection sort worked. So I used those sorts of visualizations to help students understand what was going on because I found that the students tended to “think of the algorithms that they were looking at a very surface level.” ~E4

Another educator used a visualization technology to help students understand algorithms:

“one technology I have been trying is Leap Motion. This is a sort of visualization tool that you can use to demonstrate certain complex concepts that are better [understood when] visualized.” ~E10

One educator suggested that an interactive programming environment that can show coding and the outcomes side by side was useful for computing teaching:

“students actually prefer this interactive programming environment. [it is] especially designed for Python and R, so you can write the code, explain the code and the functionality and why you write the code, the purpose of the code. So, you don't need slides anymore.” ~E5

Key finding and suggestion:

Technology can assist in delivering complex topics more effectively and comprehensively, enhancing the learning experience for students and facilitating seamless learning. We suggest that the educators' capability with and knowledge of technologies are an important factor in delivering these learning experiences.

4.4 Collaborative learning

The IT educators valued the importance of peer learning and collaborative learning and most mentioned that group projects and assignments are common in their teaching programs. However, a number of the educators mentioned challenges in facilitating students' in-class and out-of-class collaboration and these were mainly related to technology. One described a situation of concern:

“where it doesn't happen these days is: the students meet inside the classroom and work collaboratively, and then we use the technologies that [enable them to] get together and work with collaboratively [in their separate houses or apartments].” ~E2

Current technologies used to enable collaborative learning were not always satisfactory. Technologies, such as Google Folder did not facilitate seamless collaborative learning, rather, they encouraged cooperative learning where students work separately and combine their work later. As one educator explained:

“This year, we had everyone set up Google folders ... people were still doing a separate part and then matching everyone's components into a single piece. ... it wasn't ideal.” ~E2

Educators indicated that they were looking for technology solutions to facilitate collaboration:

“The game design class in which I'm doing another version of next year is very collaborative so I am interested in maybe looking at what technologies I can use to improve collaboration between the students.” ~E8

One educator proposed a solution:

“make a learning management system with built-in collaboration features.” ~E4

Another, gave some specific design ideas for a collaborative learning environment:

“The physical learning spaces and the way technology can be used within those learning spaces to facilitate group work, for example, people working on an assignment ... a collaborative environment with big screen ... they can see suitable stuff is going on. I'm interested in that sort of thing as well.” ~E6

Key finding and suggestion:

Facilitating seamless collaboration among students is a high priority in IT education programs. Collaborative learning is one of the important 21st century learners' skills [7, 23]. We found from our study that technologies are needed to facilitate seamless interaction and collaboration among students who often need to work together online.

4.5 Industry and real-world awareness

The importance of preparing students for a future working with technology was strongly expressed by the IT educators. A couple indicated that they wanted to use technologies in their teaching programs that were also used in industry in order to bridge students' learning to their future working environment. As one educator stated:

“I don't really want them using some system that is only used in a university. Working programmers have to collaborate too, so I like the idea that they're going to be using the same sort of tools that they will be using to collaborate ... out in the industry.” ~E4

Some educators saw value in explicitly linking what they were studying to real world applications:

“I want them to... always try to put what they understand happens in the real world, combine that with the theory and stuff that we covered in the class, so ... when someone is teaching Web design and development, then whenever they use a website [that] is very bad, they should reflect on it ... they should think about how the HCI is really bad.” ~E8

One educator took a broader view of the importance of technology and conveying that to their students:

“technology is really important in the world ... most solutions to problems now have some kind of IT component but I don't know if we [educators] really do that well enough and if we really get the students thinking about that.” ~E8

Key finding and suggestion:

Connecting learning to the real world requires a pedagogical design where real-world problems are used. Technology is a key component in enabling students to have authentic hands-on experiences of real-world applications. We propose that technology investments in facilitating learning will prepare the students to master skills that will be needed in their future careers, enabling seamless transition from educational to working environments.

4.6 Student attendance and engagement

The use of technology in lectures seemed to cause the most disruption to the students' learning. Most of the IT educators mentioned that they faced challenges with poor lecture attendance and engagement and this was often blamed on the recording of lectures which the university required to make available online. As a couple of educators explained:

“attendance in lectures is dropping because students can watch them online.” ~E8

“I'd say my experience of teaching in this faculty is that more and more it is a particular challenge to engage students. I wonder if you took away all the [online teaching material]... you would get greater student engagement - by kind of holding it back.” ~E1

Students not attending lectures was a problem to most educators who felt that lecture attendance was important. Some of the educators were reluctant to provide the entire lecture materials or lecture recordings online and saw this as the wrong use of technology.

“I think ... technology should not discourage [students] to come to the class.” ~E9

Some educators, however, mentioned different uses of technology to make students feel that attendance in class was worthwhile.

“We try to use technology to kind of facilitate a level of engagement.” ~E1

“If there are technologies that will create a more stimulating environment or more engaging environment, and that gives students a motive and they can see that it can help their learning process and engage them more ...” ~E8

“The basic idea is to try to use Leap Motion as a device to interest the students...to sort of to attract their attention.” ~E10

Key findings and suggestions:

Technology use in the lecture setting was controversial. The requirement from the university to provide all teaching resources on-line, especially lecture recordings, was seen as a discouragement to students to attend class. However, the impact on attendance had, in part, driven the use of technology to enhance in-class engagement and improve class participation. Technology was used to provide active learning experiences in order to increase the effectiveness of lecture time and encourage class attendance. The misalignment between the educator and institution motivations in using technology potentially hinders the facilitation of a seamless learning experience. We argue that if educators do not provide resources online this would impact the equality of learning access for students with economic and geographical difficulties in attending on campus. We propose that solution may lie in a focus on pedagogical design rather than the issues of attendance.

4.7 Learning needs and styles

Teaching students with different learning styles and learning needs was mentioned by a number of the IT educators' as problematic. A common issue mentioned was students' changing attitudes towards technology and their use of technology. A couple of educators explained:

“There's been a lot of discussion about how all students are learning in the modern world now. And so, in the past students would typically go to the teacher and asked for help, increasingly now students are going to their peers...like now I can Google search something.” ~A2

“These people who were growing up since early childhood with Wikipedia, with Google. They don't think that they should be sitting still and memorizing things..” ~A4

Several expressed a strong desire to accommodate the way students wanted to learn. As one educator suggested:

“Allow them to explore things... not necessarily the same way we do it... when I was at school, you listen to your teachers you took notes and hope for the best.” ~A7

They described how they used technologies to reduce these challenges. As one explained:

“I used online videos ... to help the students' who need visual learning ... for visual learners. So they can develop their skills.” ~E11

Key findings and suggestions:

Technology has the potential to bridge the seams caused by different learning styles and different needs of the learners. Humans learn in different ways and learning can be optimized by accommodating to their learning styles [20]. The educators who showed awareness of these issues also expressed their willingness to adapt to the needs of their students. We propose that a seamless learning environment should leverage technology to assist in accommodating different learning styles and students' needs should guide the design and use of the VLE and other technology so that learners can select the ways they want to learn and manage their learning in their preferred ways.

5. CONCLUSION AND FUTURE RESEARCH

Our qualitative study explored IT educators' experiences in facilitating learning in a TRLTE. The IT educators we interviewed used a variety of technologies across different settings and the study revealed many seams in learning situations.

Most of the seams were related to technology and pedagogy. Seams caused by technology were due to technology design and compatibility issues, which caused problems with seamless transitions across technologies and learning settings. Seams related to pedagogy included challenges in teaching complex topics, collaborative learning, lecture attendance, student engagement, real-world experiences and learning styles and needs. The seams cause us to ponder how successful TRLTes

are in facilitating seamless learning. However, most of the solutions suggested by the educators to facilitate seamless learning involved using technology. We found many cases where educators had turned to technology to remove the seams and provide their students with a more effective and satisfying learning experience.

Technologies seem to be a double edged sword in a TRLTE. The students' learning and educators' teaching activities are highly dependent on technology. Technology can support learning and enhance the students' learning experiences. However, technology can also be the source of seams in students' learning experiences. Technology was highly integrated in the TRLTE; however, the technology design and compatibility were the main hindrances to smooth transitioning across contexts.

The misalignment of motivations between educators and institution in using technology has impacted the educators in providing online materials to students. An important insight gained from this study is that universities may have to rethink their technology investment and engage with educators and learners to understand the causes of seams and gather feedback from technology integration experiences to assist their educators to facilitate successful seamless learning.

Our next steps in this research will explore IT students learning experiences to find out how seamless TRLTEs are from the learner perspective.

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