THE CONFLICT BETWEEN EVOLVING TECHNOLOGY AND THE DIGITAL DIVIDE

Carla Coetzee
Tshwane University of Technology
South Africa

Abstract

The digital divide in higher education concerns digital literacy in addition to access to the Internet and digital devices. Higher education institutions often assume basic levels of digital literacy and access to high-end mobile devices, which creates conflict for lecturers that are expected to teach with technology. The challenge is in incorporating learning technologies that can bridge the digital divide. A preliminary review of the literature published in the last five years investigated teaching with technology and the realities of the digital divide. Classroom Response Systems (CRS) and videos were identified as potential candidates for implementation in resource deprived institutions.

Introduction

The exponential growth of knowledge and the rapid development of new, digital technologies are resulting in changes in the workplace, and consequently in higher education (Binkley et al., 2012). These fast-paced changes lead to inequalities in terms of access to technology and the Internet as well as inadequate skills to utilise technology, this phenomenon is referred to as the digital divide (Bornman, 2016). The evolving information society and technology create, and further enhance, these digital inequalities and exclusions (Robinson et al., 2015). Due to poverty and underdevelopment, Africa provides an example of an underdeveloped region. However, South Africa is regarded as one of the most developed countries in Africa in terms of Information and Communication Technologies (ICT) infrastructure (Bornman, 2016).

The nature of the information society of the 21st century means that individuals are required to adapt to rapid technological changes. It is therefore important that engagement with ICT must be improved across the entire spectrum of learners within higher education (Bornman, 2016), including those from both resource deprived and resource rich institutions. Higher education institutions need to be cognisant of these challenges when teaching students in the 21st century. In order to adapt to these demands and improve academic performance higher education institutions need to address (at least) the use of learning technologies which enhance the following:

- Development students' expert knowledge;
- Development of generic competencies for the 21st century; and
- Development of students' abilities to reflect on learning (Kong & Song, 2015)

The majority of students in the ICT Faculty at the Tshwane University of Technology come from rural (African) environments, where they received poor quality education (Spaull, 2013; Spaull & Kotze, 2015). In an effort to improve academic performance, the University's management promotes a blended learning approach by encouraging lecturers to augment classroom practices with technology (Jeffrey, Milne, Suddaby, & Higgins, 2014). However, the adoption of appropriate technology in teaching is delayed by infrastructure limitations which contribute to the digital divide.

The question addressed in the present paper is: *How can the perceived conflict between the use of technology and the digital divide be addressed?* This paper explores the conflict that arises, as exemplified within the South African context, when the use of technology in higher education learning environments is hampered by the lack of technological resources and skills.

Methodology

A preliminary literature review, which forms part of a larger study by the researcher, was done. Keywords such as digital divide, digital inequalities in South Africa, mobile learning, e-learning, blended learning, use of technology, benefits of technology and 21st century skills were used to search for relevant articles. Journal articles were retrieved from several academic databases via the library portals of the Tshwane University of Technology as well as the University of Pretoria. Articles were sourced, in the date range 2012 to 2018 to make provision for the rapidly advancing nature of technology. The articles were reviewed to explore and identify the key issues that might be relevant to the South African digital divide as well as the use of technology in different education environments, including resource-deprived and resource-rich institutions. After identifying key issues related to the conflict, possible, technological solutions are discussed that could address the digital divide preventing further disadvantages.

Aims and Objectives

The focus of the present paper is on identifying candidate ICT, which may be implemented for teaching and learning within resource deprived higher education institutions in order to help address the digital divide.

Preliminary Literature Review

The following sections summarise the key observations from the preliminary literature review.

The Digital Divide

ICTs and the prevalence of digital devices are spreading rapidly at an uneven pace (Rath, 2016, p. 75). Robinson et al. (2015) highlight the role of digital engagement in the workplace, in education as well in the health services. Robinson et al. argue the digital divide results from the following:

- The gap between users and developers in a technologically advanced economy.
- Inequalities resulting from a lack of technology engagement or digital skills that can hamper the efficient use of technology.

Robinson et al. (2015) also discuss the effects of life course, gender, race, economic status and health on the digital divide. They argue that the ability to efficiently handle the flow of information is only to the advantage of certain individuals, which in itself creates more inequality. Nyahodza and Higgs (2017) emphasise the fact that imbalances are caused by the socio-economic status of students in higher education, specifically referring to the levels of poverty in South Africa. In agreement with Robinson et al. and Nyahodza and Higgs (2017), Bornman (2016) points out that the digital divide is more than the lack of access to the Internet (infrastructure) and technology, her research also refers to the effects of gender, population group and educational levels on the digital divide.

Higher education institutions should utilise and apply new technologies in training to prepare students for technologically rich work environments. However, the reality is that digital inequalities exist on higher education campuses worldwide, and this needs to be addressed without creating more inequalities in terms of students' technological development and preparedness for the workplace (Binkley et al., 2012; Ricoy, Feliz, & Couto, 2013).

The Use of Technology in Higher Education

In a higher education environment, improving academic performance and student engagement have always been key objectives. Efforts to implement technology in meeting these objectives are well documented (Adedokun-Shittu & Shittu, 2015) and some of these technologies are:

- The Internet is part of the infrastructure that enables the use of technology (Sampath Kumar & Manjunath, 2013).
- Classroom response systems (Dunn, Richardson, Oprescu, & McDonald, 2013; Wong, 2016).
- Mobile phones and Tablets (Gan, Li & Liu, 2017; Hanbidge, Mackenzie, Sanderson, Scholz, & Tin, 2017; Hatun Ataş & Delialioğlu, 2018).
- Social media, i.e., Facebook and WhatsApp (Chiroma et al., 2017; Gachago, Strydom, Hanekom, Simons, & Walters, 2015).
- Videos (de Araujo, Otten, & Birisci, 2017; Long, Logan, & Waugh, 2016).
- Learning Management Systems (Wichadee, 2015; Zanjani, Edwards, Nykvist, & Geva, 2017).

It is clear from the technologies listed above that students are no longer restricted to traditional (printed) study material to help improve their academic performance (Sampath Kumar & Manjunath, 2013). The above listed technologies, individually and in combinations, could be used to create opportunities for students and lecturers to improve learning and student engagement. It is worth mentioning that the majority of the above, and many other, technologies are dependent on internet access (Sampath Kumar & Manjunath, 2013).

The Internet

New technology and improved broadband can be utilised to support education systems and the distribution of knowledge, widening the access to information to improve quality of teaching and learning (Broadband Commission, 2016). According to the International Telecommunication Union (ITU), in 2016 approximately 53% of South African households had access to Internet and 54% of South Africans used the Internet (Broadband Commission, 2016). In a local South African context, the General Household Survey of 2016 (Stats SA, 2018) indicate that only 9.5% South African households have Internet (at home). However 53.9% of households have access to the Internet via mobile devices (see Figure 1). The availability of mobile devices is empowering more people to access the Internet, but the digital divide is still evident, especially in rural South Africa.

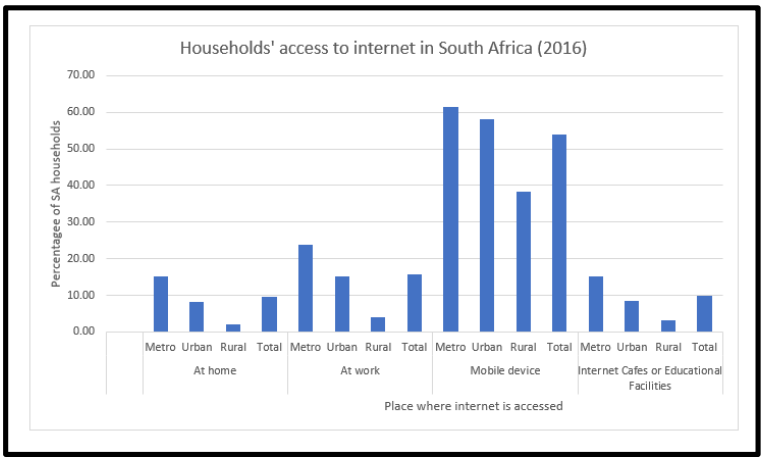

Figure 1. Households' access to the Internet by place of access and geo-type in South Africa, 2016 (Adapted from Stats SA, 2018, p. 51).

Higher education institutions in South Africa provide internet access to students in computer laboratories as well as Wi-Fi hotspots on campuses. Many universities in South Africa do not assume that students own smart phones, tablets or laptops and have access to Internet where they live (off-campus). Enforcing compulsory devices and internet access could contribute to the digital divide. At TUT a policy of supplying devices to students is being considered. The main concerns that were mentioned by stakeholders, staff and students are the determination of minimum requirements, cost (devices and mobile broadband) and security-threats. The challenge is to find a means of providing access to study materials and resources on campus and off-campus, that not only can improve student engagement and academic performance but also not impact the students and the institution financially.

In an effort to incorporate technology in the classroom, the review was focused on identifying technologies that could improve student engagement with mathematics specifically. Only two of these technologies are discussed in this paper, namely Classroom Response Systems (CRS) for formative assessment, and the use of videos to augment printed study material.

Classroom Response Systems (CRS)

Students must engage in their own learning to improve their academic performance, and success and the role of the lecturer is to motivate students and create an environment that stimulates learning (Dunn et al., 2013). Ivala and Kioko (2013) state that students who engage with their course work are motivated and interested in their studies. Lecturers could use rapid, formative feedback to embed assessment in the teaching and learning process to foster engagement. However, regular assessments in large classes impact the lecturers' workload considerably, and one of the solutions is the use of Classroom Response Systems (CRS) (Dunn et al., 2013). One of the most well-known, and popular solutions is Clickers™ (https://www.cmu.edu/teaching/clickers/; https://www.sun.ac.za/english/faculty/healthsciences/chpe/ultresources/clickers-audio-response-systems). Clickers™ are portable electronic devices that are used for polling and formative assessment and make use of radio-frequency or infrared technology to transmit and record student response during a lecture, typically in the format of multiple choice questions (Buil, Catalán, & Martínez, 2016; Dunn et al., 2013). The disadvantage of Clickers™ is the cost to the institution or the students, thus further contributing to the digital divide.

Several online, free, web-based CRSs are available; however, they require internet access and devices for each student in the class. Currently there is no internet access in lecture venues (at TUT), only in the computer laboratories. A few of the free, online CRSs are:

- Kahoot (www.kahoot.com)
- Quizizz (www.quizizz.com)
- Poll Everywhere (www.polleverywhere.com)
- Mentimeter (www.mentimeter.com)

In the search for a free, mobile application for formative assessment that does not require students to have internet access during lectures, Plickers™ was discovered.

Plickers™

"Plickers™ is a powerfully simple tool that lets teachers collect real-time formative assessment data without the need for student devices" (www.plickers.com). The mobile application is available for Android and iOS, the lecturer is the only one in the class that needs the application on his/her device. Plickers™ can be used for various activities, for example:

- Attendance
- Polling
- Formative Assessment

To use Plickers™, the lecturer creates an online account, which is password-protected, meaning access to marks and names of students is protected. The Plickers™ are used as an assessment tool that is especially valuable for formative assessment during contact sessions (Krause, O'Neil, & Dauenhauer, 2017, p. 34). After downloading and installing the application on his/her mobile device, the lecturer can compile multiple choice or True/False

questions on the online platform. The lecturer creates a class by assigning numbers to students and each student receives a unique QR™ code on a sheet of paper. Each QR™[1] code has a number and four sides marked A, B, C and D (see Figure 2).

During a class, the lecturer can project a question on the screen, and students are given time to provide the answer. When the lecturer prompts the students, the students respond by holding up their barcodes with their choice of answer at the top (turning the paper until the correct answer is in the top position). The lecturer then takes a picture of each row of students in order to scan the answers and the application on the mobile device records the answers. In doing so, the lecturer can immediately determine whether the class understands the concepts that were assessed. Records of individual students are captured and saved, and reports (.CSV files) can be exported to spreadsheets for grading purposes if needed.

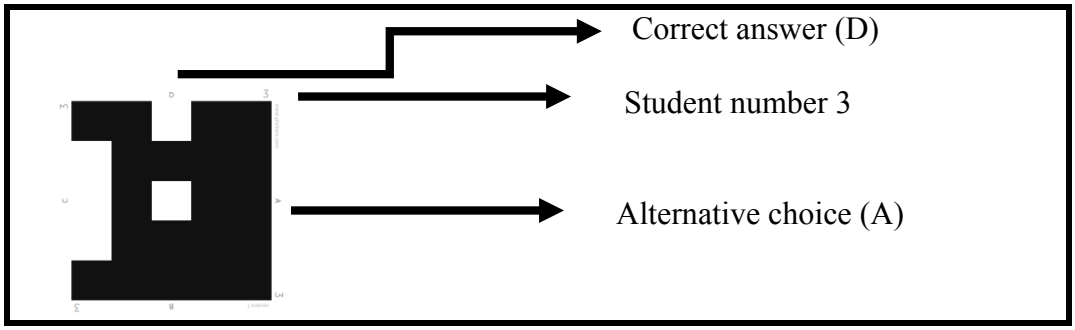

Figure 2: Plickers™ card example (www.plickers.com).

The use of Plickers™ is not limited to a specific location or venue, the only technological requirement is that the lecturer must have a mobile device that can connect to the Internet. Plickers™ therefore enables lecturers to utilise technology, encourage students to engage and do formative assessment without increasing the digital divide.

Videos in the Classroom and Beyond

Online videos have become popular, and numerous videos are accessed online on a daily basis, especially with the popularity and availability of mobile devices (de Araujo, Otten, & Birisci, 2017; Li, Liu, & Ouyang, 2016; Long et al., 2016). On YouTube alone, 300 hours of videos are uploaded every minute and 60% of people prefer these online video platforms to live TV channels (https://fortunelords.com/youtube-statistics/). Statistics indicate that more than 50% of YouTube views come from mobile devices (https://fortunelords.com/youtube-statistics/) which is attributed to the popularity of mobile devices: approximately 2.4 million mobile devices are sold per day (http://www.worldometers.info/). In a study done in South Africa, it was found that 84 % of undergraduate students had mobile devices in 2014 (Potgieter, 2015). The popularity of online videos and the availability of educational videos online have profound possibilities for teaching and learning environments. However, the challenge is once again to overcome the digital divide when utilising online videos in teaching and learning.

At TUT, for example the majority of students come from underprivileged environments, and, due to the cost of mobile data being quite high in South Africa, this further contributes to the digital divide. Although the students are comfortable with watching videos on their mobile devices (Hulsizer, 2016), making use of online videos to augment classroom teaching in mathematics at TUT has proven to be unsuccessful. This is due to the fact that students indicated that they cannot afford access to the Internet when they are not on the campus.

A local, South African solution called "Paper Video" has the potential to improve student engagement with mathematics content and to improve academic success in mathematics (www.papervideo.co.za). Paper Video is a set of mathematics videos based on examination questions for grades 8 to 12. Each question has a unique QR™ code and a 4-digit code which is linked to a video explanation of the solution (see Figure 3). The explanations are presented by a teacher with extensive experience and in a local accent and context. Each student receives a USB adaptor with a microSD card on which all the material is available; they only need to access the internet once to register their material. They insert the microSD card in their mobile devices, install the application and start watching the relevant videos. Students can also access the videos on a laptop or PC by using the USB adaptor. Students' mobile devices can now be turned into a teacher that can be accessed anywhere, anytime, without the need for internet access. However, the videos can also be accessed online where students have access to the Internet (https://papervideo.co.za/).

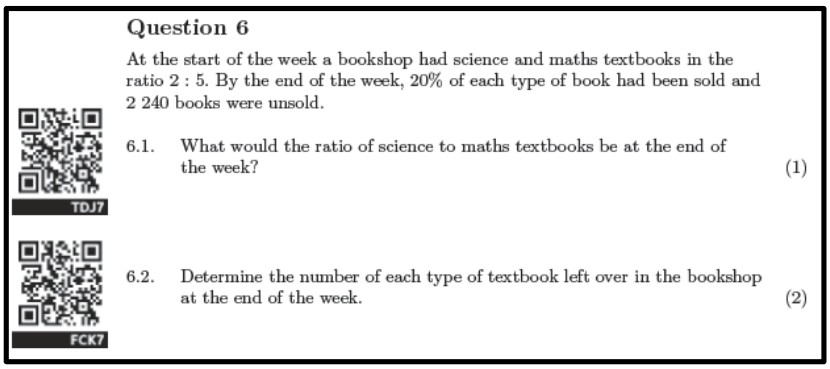

Figure 3. Paper video example.

The mathematics skills that the students need are addressed by the material of the grades 8 to 12 Paper Video Exam Papers. This range of Paper Videos, addresses the gap between school and university. The lecturer has access to an online dashboard to monitor the use of the resources.

In addition to making use of this technology and the microSD card, lecturers can also record their own videos and distribute them to students without the need for mobile data. Students can download them in the computer laboratories and watch them on their mobile devices anywhere and anytime, once again addressing digital inequality with technology, without widening the divide.

Conclusion

The digital divide is a reality in higher education which leads to inequalities caused by the pace at which technology evolve. Without disadvantaging students further, the digital divide can be addressed, even by making use of technology. There is a variety of offline mobile applications available to lecturers and students, many of which are free. Lecturers should explore mobile applications and online solutions that could improve students' engagement and academic performance without disadvantaging them technologically. The literature review conducted suggests both CRS and paper video technologies have the potential to enhance teaching and learning in mathematics without requiring internet access and specific devices. A pilot study to evaluate the efficacy of Paper Video in promoting blended learning is currently underway at TUT. The results of the pilot study will be used to inform decisions regarding its future implementation within the classroom.

Note

1. A QR™ code is a machine-readable code consisting of an array of black and white squares, typically used for storing URLs or other information for reading by the camera on a smartphone.

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Author Details

Carla Coetzee
CoetzeeC@tut.ac.za