A review of tertiary formative assessment using digital technology in the past decade: what has been facilitated?

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Abstract

Assessments serve a pivotal component of any teaching and learning system, especially when they motivate and enhance better teaching and learning. Together with the seamless permeation of digital technology in universities, formative assessment(FA) using digital technology has been increasingly used at the tertiary level of educaiton in recent years. FA using digital technology plays an important role in the quality assurance of teaching and learning (and hence assessment) in nuniversities. How has the emerging digital technology efficiently served and enhance the formative teaching and learning in universities in the past decade? This study explores this issue by conducting a systematic review of peer-reviewed empirical papers on formative assessment using digital technology in universitites over the past decade. It is found that mainly four major aspects of FA has been facilitated by the emerging digital technology applied in higher education in past ten years.

Keywords: formative assessment; digital technology; higher education.

1. Introduction

Assessments serve a pivotal component of any teaching and learning system, especially when they motivate better teaching and learning, help to improve the educational system, assist the teachers to ameliorate their teaching practice, and change how we approach education. The P21 framework (Partnership For 21st Century Skills, 2009) and ATCS framework of 21st century skills (Griffin et al., 2012) emphasise the move towards formative assessment (FA) as a means of teaching because of the powerful positive effects it has on students' learning. In recent years formative assessment has been increasingly used at the tertiary level of educaiton.

Among this trend, digital technology has become a popular part of university lecturers' FA practice and important section of university students' learning experience in the 21st century (Henderson et al., 2017; Scott et al., 2018; etc). For the millennium generation, the internet is their way of daily life and learning, offering them the non-stop and closely engaging social space in their university life, rather than simply mechanical functional tools.

Given such a significant role of digital technology in university formative teaching and learning, How has the emerging digital technology served and facilitated formative teaching and learning in universities in the past decade? This study aims to answer this problem by conducting a systematic review of peer-reviewed empirical papers on formative assessment using digital technology in higher education over the past decade and discuss the positive impact of these studies over this time period.

Systematic qualitative review (Green et al., 2006) is employed to produce an analysis of the literature in three major steps (Galvan, 2006): searching, reviewing and writing the literature review. The data were retrieved from the databases using major search engines in education (e.g., Elsevier, ERIC, EBSCOHost, and SAGE), focusing on the key words (formative assessment) and (digital technology Or technology) and (university Or higher education). The time period is 2011-2021. The search is further limited to focus on peer-reviewed empirical studies that explicitly applied the digital technology in FA at the tertiary level. Ultimately, 49 papers were selected as key papers for the review. Some relevant review papers on FA and digital technology in higher education are also included to provide a complete picture of the literature.

2. An overview of tertiary FA using digital technology

Given the main target of this paper is the facilitative impact of formative assessment on the university lecturers' instruction in essence, Black and Wiliam's (Black & Wiliam, 2009) definition of formative assessment is adopted in this research:

"Practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited." (Black & Wiliam, 2009, p.9)

This definition highlights an important feature of FA as a part of the actual teaching and learning process. The ultimate aim of FA is to better the teaching and learning. This echoes the purpose of mastery learning in Bloom et al's conceptual framework (1971).

There have been some empirical studies and review papers on tertiary FA using digital technology in the past decade. Webb et al (2018) identified three major aspects of FA processes that can be particularly facilitated by digital technology (p. 441):

1) datafication of learning

2) feedback & scaffolding

3) peer assessment & peer feedback

One problem with Webb et al's (2018) classification is the overlapping and over generalisation of the FA aspects, especially the overlapping of the second and the third aspects. What's more, new breakthrough of digital technology has occurred very swiftly each year and sped up new applications rapidly since 2018. So the digital technology employed in tertiary FA now is quite different from that of four or five years ago. Some digital technology used in FA four years ago may not be in use now, while some new functions of other digital technology has been developed and is now more popular. The implication for the researchers is that there is a need to speed up the relevant theoretical and empirical studies that deal with formative assessment. This paper provides this systematic review to identify the FA processes currently promoted by digital technology.

Henderson et al (2017) investigated the university students' perception of the usefulness of digital technology in their learning. Based on the survey results of 1658 undergraduates, they identified 11 benefits of digital technology that are especially useful to the university students' learning (p.5):

Organizing and managing the logistics of studying

Flexibility of place and location

Time-saving

Reviewing, replaying and revising

Researching information

Supporting basic tasks

Communicating and collaborating

Augmenting university learning materials

Seeing information in different ways

Cost saving

Despite the obvious facilitation of digital technology on university students' learning, Henderson et. al. (2017) noted on the other hand that digital technology did not completely alter the nature of university teaching and learning. This justifies that the focus of our research on the tertiary FA using digital technology should be on tertiary education rather than the digital technology alone. Another issue is that their research targeted at the university students' learning in general, not addressing specifically the tertiary FA. So an unclear picture still remains as to what aspects of tertiary FA has been facilitated by the digital technology. But despite this, the study serves as a helpful reference as a strong contention of this paper is that tertiary FA is an integral part of university learning.

Given the above mentioned, a systematic qualitative review has been conducted of 49 papers and four major aspects of tertiary FA using digital technology have been identified: emerging intelligent personalised FA, dataficated formative learning and management, multi-media feedback, and swift communication in FA.

2.1. Emerging intelligent personalized FA

Artificial Intelligence in Education (AIEd) is a newly emerging and promising procedure that has been used in digital technology in higher education in recent years. Some researchers predict that AIEd will grow by 43% from 2018 to 2022(EDUCAUSE, 2018), and as a direct consequence there will be a direct influence on teaching and learning in higher education. Some emerging AIEd have been applied to personalize tertiary FA in the past decade. DeMara, et al (2020) use data mining to generate personalised learner remediation groups for their complementary peer formative learning. Hooshyar et al (2016) online used an FA quiz of tic-tac-toe for self assessing formatively individual student learning in a flowchart-based Intelligent Tutoring System (FITS).

Conejo et al (2016) conducted a technology-enhanced FA of university students' plant identification with Siette, a domain-independent intelligent online evaluation system for mobile devices, to support the whole cycle of FA in a biology course. Utilising a reusable item bank, an authoring tool and options to analyse assessment results to generate statistical information, Siette enables the different question types, selection criteria, and scoring procedures to provide tailored questions for each individual student according to their location on a developmental continuum of learning. The students in turn use the mobile

device to position or scan a QR code attached to a plant in a arboretum or herbarium. Then Siette will offer the student some detailed feedback including correct answers accordingly after the FA questions.

In their review of research papers on AIEd from 2007 to 2018, Zawacki-Richter et al (Zawacki-Richter et al., 2019, p.1) identified 4 areas of AIEd applications in higher education institutional and administrative services:

> profiling and prediction
>
> assessment and evaluation
>
> adaptive systems and personalisation
>
> intelligent tutoring systems

Apart from the assistance and facilitation effects of AIEd, Zawacki-Richter et al (2019) also pointed out that a significant problem wit the research is that there is a dearth of critical reflection on the risks of AIEd, the weak application of pedagogical theories, and the need for future investigation of ethical and educational aspects of AIEd application in higher education.

2.2. Dataficated formative learning & management

Thanks to the emerging digital technology, various forms and scales of FA and management have emerged during the past decade. Not only the feedback in the forms of words and verbal signals are dataficated via digital technology, but also voice (Gleason, 2013), 3D visual images (Yoders, 2014), podcast (Forbes, 2011), online actions such as Wikipedia editing (Ng, 2018), etc. Datafication of formative learning and management for the traditional small-sized courses has been extended to include unprecedented large courses of thousands of students at the same time in online platforms such as Moocs (Xiong & Suen, 2018), and even the whole university campus (Lafuente, et al., 2014) being dataficated.

2.3. Multi-media feedback

With emerging digital technology, new forms of feedback have become available in the past decade. Apart from the traditional words and verbal signals as the forms of feedback, new forms such as visual portfolios, in which the learners self-select the images that they produce during their daily activities on the high-fidelity 3D human heart simulator for the undergraduate level health care sciences students (Yoders, 2014), screen-captured digital video feedback (Jones, et al., 2012), or online Skinquizition gaming with audience response systems such as TurningPoint (Schlegel & Selfridge, 2014). Mobile electronic devices including smartphones, tablets, laptops are also used for formative tasks and feedback (Wijtmans et al., 2014).

2.4. Swift communication in FA

Traditionally, swift communication among participants in FA, especially in large classes seemed to be impossible for university lecturers a number of years ago. But with digital technology, the participants can now have access to swift communications and better collaboration even in large classes. Tempelaar et al (2015) examined the use of e-tutorials in a large introductory quantitative methods module in which 922 students were enrolled. This module blended face-to-face problem-based learning with e-tutorials. It is found that computer-assisted FA seemed to best predict students who were under-performing. Besides enabling timely feedback, the user-intensity data and learning dispositions from the e-tutorial systems are worthwhile sources for lecturers' feedback as well.

Fernández-Ferrer& Cano (2016) investigated university students' use of Twitter to create their personal and unique social networks during formative learning. Their results show that the microblog social network tool facilitated the students' motivation, involvement and learning perception, but no significant improvement was identified in their achievement. It is noted that future research needs to examine the effects of self-regulating feedback and the influence of the application of social network tools on the learners' self-regulating capacity.

In conclusion, based on our systematic qualitative review on the 49 key papers, it is found that emerging digital technology has been applied in tertiary FA in the past decade and has had an increasing influence on university education. Four major aspects of tertiary FA have been facilitated by digital technology: emerging intelligent personalized FA, dataficated formative learning and management, multi-media feedback, and swift communication in FA. On the other hand, it is also noted that application of digital technology in FA may not necessarily lead to the university students' improvement of learning performance. More research is needed to examine the factors of the students' self-regulation during the FA process.

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