

Role of Educational Technologies Utilizing the TPACK Framework and 21st Century Pedagogies: Academics' Perspectives

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Abstract

With the rapid development in information technology and the need to acquire 21st century skills, global trends in higher education are shifting towards using digital pedagogies. In light of this, Koehler and Mishra (2009) developed the Technological Pedagogical Content Knowledge (TPACK) framework to integrate technology with teaching. The framework has now been explored and implemented in various educational institutions. This study aims to collect academics' perspectives on various technologies and pedagogies used at the institute through the lens of the TPACK framework. A mixed-methods study, using a survey-based questionnaire, was undertaken to collect academics' perspectives. The study revealed a wide range of technologies and pedagogies being used to enhance 21st century competencies and skills. The TPACK framework provides a useful tool to gauge the learning environment and displays a complex interaction between technology, pedagogy and content knowledge specific to the learning environment. The results highlight the need to use technology for innovation and to renovate contemporary teaching practices for 21st century learning.

Keywords: TPACK, pedagogies, technologies, higher education, 21st century

Introduction

The last decade has seen an exponential increase in the use of information technology within the Higher Education (HE) sector. Most higher education institutions have incorporated teaching with technology to enhance the learning experience for students. New learning technologies are being implemented with the aim of enhancing student engagement and academic outcomes. With the development in information technology, current trends in HE are now embracing a wide range of technologies which include, but are not limited to, discussion forums, simulation, virtual reality, webinars, wiki space, Kahoot, as well as social media technologies.

Further, as a result of globalization in HE and the demands of current knowledge age, the needs of the 21st century learners have been changing. 21st century pedagogies have therefore stemmed from this need to provide learners with the opportunity to develop necessary competencies and skills to meet the current demands. Global trends in HE are therefore shifting towards digital pedagogies. According to Lai (2011) digital technologies can enhance learning experiences when used as a medium to support collaboration and construction of knowledge.

This paper reviews the TPACK framework as developed by Koehler and Mishra (2009). The TPACK framework was introduced with the aim of integrating technology into teaching. The framework involves a complex interaction among three major components: content, pedagogy, and technology. TPACK studies have been explored in various educational institutions to study the relationship between technology and pedagogy with opportunities, as well as challenges, having been identified in the process. The TPACK model has allowed for increase in both student engagement and collaboration, as well as flexibility in learning (Lye, 2013). Academics considered the TPACK framework as a heuristic for exploring the dynamic elements for effective teaching with technology (Glowatz & O'Brien, 2017). On the other hand, academics perceive limitations with specific tools in terms of design and usage and have raised concerns with use of TPACK framework in the context of specific tools such as social networking sites (Glowatz & O'Brien, 2015, 2017; Lye, 2013).

This study evaluates academics' perspectives on various technologies and pedagogies that are being used at the institute to determine whether they contribute to 21st century learning. The data would allow academics to rethink about digital technologies and how this can improve learning experiences.

Literature Review

Shulman (1986, 1987) described the categories of knowledge that a teacher requires to promote comprehension among students. In particular was the knowledge of content and pedagogy that blended together to create a flexible learning environment for diverse groups of students. The TPACK framework builds on Shulman's work to include technology for effective teaching and emerges from interactions among content, pedagogy, and technology Koehler and Mishra (2009).

Components of TPACK framework

The three main components of the framework are: Content knowledge, Pedagogical knowledge and Technological knowledge. See Figure 1.

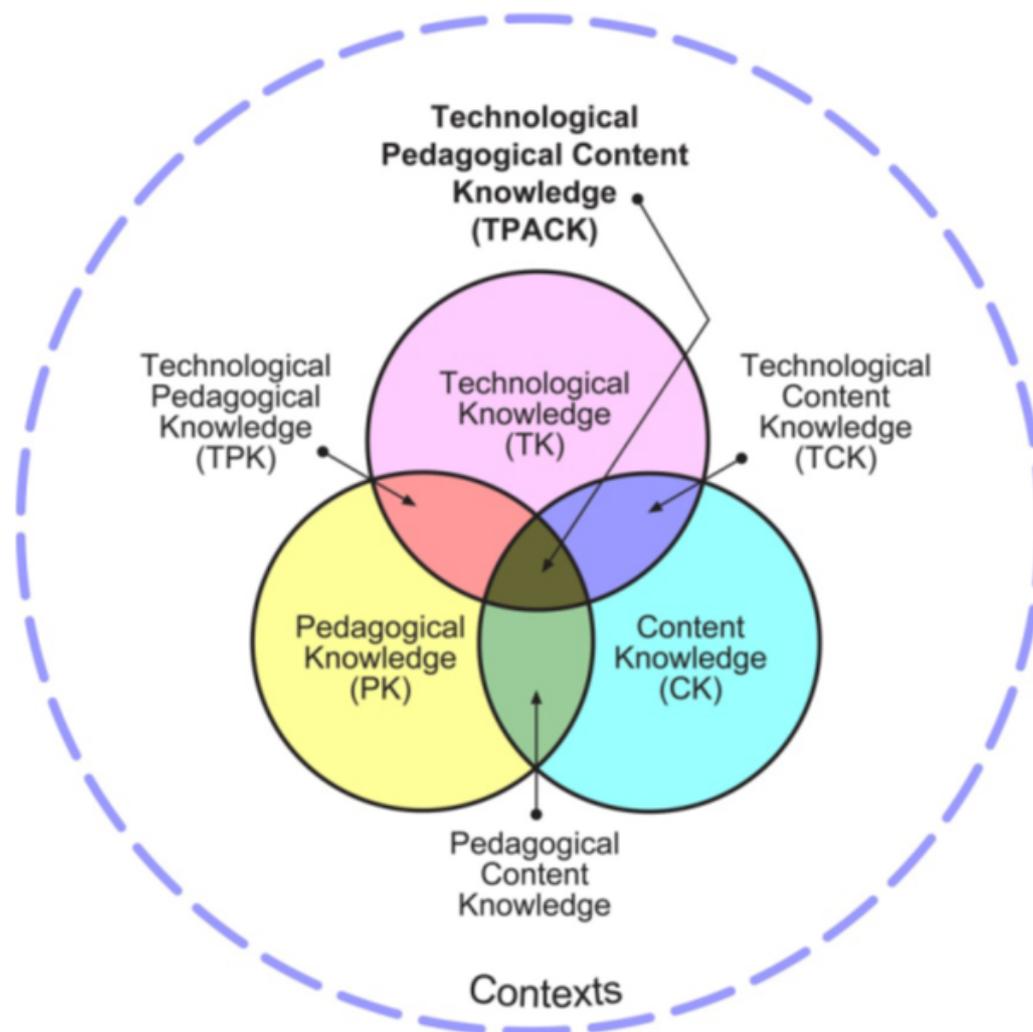


Figure 1. The TPACK framework and its knowledge components (Koehler & Mishra, 2009)

Content knowledge involves the lecturers' grasp on the subject content. This would include scientific facts, theories, evidence-based reasoning as well as discipline specific practices. Pedagogical knowledge involves lecturers' knowledge about teaching and learning. This includes ways of representing and formulating the subject content that make it comprehensible to others (Shulman, 1986). Technology knowledge involves understanding technology for information processing, communication, and problem solving (Koehler, Mishra, & Cain, 2013).

A complex interaction between the three domains gives rise to an additional three components: pedagogical content knowledge, technological content knowledge and technological pedagogical knowledge (see figure 1.) Technological content knowledge refers to lecturer's knowledge on use of appropriate technology in order to communicate the content material within specific discipline. Pedagogical content knowledge includes appropriate methods of teaching to convey a specific content. Here the teacher knows the subject matter and uses different ways of representing it. Technological pedagogical knowledge demonstrates how a particular technology enhances teaching and learning. Technology can be used differently to suit the context and purpose.

The framework has been implemented in various educational institutions with most of them reporting average levels of technology integration in their teaching and learning process. The studies have identified further need for improvement in technological, pedagogical and content aspects of teaching and learning skills (Benson & Ward, 2013; Lye, 2013). While some educators emphasize technology over pedagogy, others prefer pedagogical knowledge over technology for an effective TPACK implementation. In contrast, other studies have found improvement in students' knowledge and skills especially within the science domain (Sheffield, Eva, Gibson, Mullaney, & Campbell, 2015). In general most educators believe competency with TPACK as a core attribute essential for professional development in the teaching and learning environment.

21st Century

The need for 21st century learning and skills. Today's world faces challenges such as climate change, socio-economic inequality, unemployment, globalization, and cultural diversity. "The 21st century is volatile, uncertain, complex and ambiguous" (Acedo & Hughes, 2014, p. 504). Additionally, with the development in information technology there is a growing need to keep abreast with technology. Educators, therefore, highlight the importance of restructuring education system such as to prepare 21st century learners to face these complex challenges. Educators as well as the public support the notion that higher-order thinking skills are essential to face these complex issues and involve creativity, critical thinking, collaboration and lifelong learning (Acedo & Hughes, 2014; Sacconaghi, 2006; Scott, 2015)

21st century skills. The Framework for 21st Century Learning (Partnership for 21st Century Learning, 2007) identifies the skills, knowledge and expertise required by students in order to be successful in the current digital economy. The 21st century skills are categorized as: learning and innovation skills (creativity, critical thinking, problem solving, communication and collaboration); information, media and technology skills; and life and career skills. These are briefly described below (Applied Educational Systems, 2018):

Creativity: Allows students to review concepts from a different perspective which ultimately leads to innovation.

Critical thinking: A skill that allows students to analyze evidence and form judgement to solve problems.

Problem-solving: Refers to the ability to solve problems in an effective and timely manner.

Communication: A skill that allows students to effectively convey ideas amongst peers.

Collaboration: Collaboration means getting students to work together in order to find solution to a problem.

Information literacy: Understanding facts, figures, statistics, and data.

Media literacy: Understanding the methods in which information is disseminated.

Technology literacy: Understanding of the tools used to disperse the information.

Life and Career skills: Allows for personal and professional growth thereby leading to lifelong learning.

21st century pedagogies. Several educators have highlighted the significance of 21st century pedagogies (Acedo & Hughes, 2014; Breslow, 2015; Kivunja, 2014, 2015; Scott, 2015). These

are the pedagogies that develop higher-order thinking skills, metacognitive skills, and support deeper learning through collaboration.

Unver and Arabacioglu (2014) have reflected on inquiry-based learning (IBL) and problem-based learning (PBL) as pedagogies that can solve current age challenges through the acquisition of problem solving skills. The authors identify IBL as a learning activity whereby learners acquire knowledge from direct observations by using deductive questions. They further differentiate it from PBL as a learning activity whereby learners learn through investigation, explanation and resolution of meaningful problems. Similarly, Snow and Torney (2015) through their mixed-methods study suggest that inquiry-based learning has the potential to develop students' cognitive skills at a higher level thereby promoting problem-solving, critical thinking and leadership skills. Furthermore, empirical research on inquiry-based learning reveals enhanced academic performance and student engagement in students using this pedagogy (Summerlee & Murray, 2010).

Several researchers have reviewed collaborative learning as a pedagogy to facilitate learning (Beccaria, Kek, Huijser, Rose, & Kimmins, 2014; Fakomogbon & Bolaji, 2017; Scott, 2015). In particular, the study by Fakomogbon and Bolaji (2017) revealed that collaborative mobile learning through portable devices or smartphone could enhance motivation, academic outcomes, and engagement through sharing knowledge, group discussions, and group assessments with group members. According to Scott (2015), learners through collaborative learning participate in higher-order thinking such as managing, organizing, critical analysis, problem resolution, and creating new knowledge.

The availability of digital technologies has also generated informal ways of learning to support formal studies (Kwok-Wing & Smith, 2017). Digital technologies such as laptops, mobile phones, Google, iPads, tablets, as well as social networking sites such as Facebook and Twitter are quite popular among students and are being used to complement formal learning methods. Several researchers, therefore, are now investigating the role of informal methods within the learning space. Kwok-Wing and Smith (2017) suggest incorporating mobile and digital technologies in the formal courses in conjunction with more traditional methods of learning in order to cater for the diverse learning style of students. Kivunja (2015) recommends higher education institutions to utilize social media technologies as effective pedagogies to support effective learning, teaching and assessment in the 21st century. These technologies create opportunities for experiential learning. The author believes that experiential learning can be a very effective way for cognitive processing as it involves the reciprocal exchange of discourse amongst students so as to develop a deeper understanding of pedagogical content knowledge.

Yet another pedagogy that has been explored in higher education is constructivist learning which emerges from the concepts developed by pioneers, Piaget and Vygotsky. Constructivist learning allows for students to actively construct their own knowledge in order for learning to be meaningful and effective (Afify, 2018; Alt, 2017; Asiksoy & Ozdamli, 2017; Noel, 2015; Scott, 2015). Noel (2015) suggested use of blogs in education to create a constructivist learning environment that supports knowledge development through student engagement, reflection and collaboration. Asiksoy and Ozdamli (2017) in their study on education technologies for constructivist learning found that the most frequently used tool was the computer and the most common platform was learning management system. Additionally, Afify (2018) found digital concept mapping an effective tool in support of constructivist learning theory.

Scott (2015) believes the current educational system with fixed curriculum and delivery method obscures personalised learning and suggests the need to adopt personalised learning for 21st century education. This form of learning caters to individual needs of students and can be achieved by using flexible curricula and learning opportunities (Deed et al., 2014; Scott, 2015; Waldrip, Yu, & Prain, 2016). For students, this allows development of autonomy, motivation, and self-regulation (Deed et al., 2014; Scott, 2015). Emerging technologies such as mobile applications, e-portfolios, blogs, audios, videos allow implementation of personalized learning. The shift from traditional educational system to adopting more personalized learning would require a major cultural change in higher education institutions and involvement of various stakeholders.

Among recent trends in higher education, flipped learning is gaining much attention as a new pedagogy. In a flipped classroom, lectures are viewed beforehand whilst in the class students are engaged in more student-centered activities in collaboration with other students, and applying knowledge (Kyung Hye, Kwi Hwa, & Su Jin, 2018; Sletten, 2017; Zipp, Maher, & Olson, 2017). A flipped environment has the potential to improve student' motivation to learn, enhance self-directed learning skills, and promote reflection and critical thinking, thereby enhancing learning (Zipp et al., 2017). However, the flipped learning method has gained mixed review with some academics reporting success while others facing challenges. Further research in this area is being conducted to understand the applicability of flipped learning within higher education institutions.

Rationale

21st century pedagogies should rely on research based pedagogies and learning technologies through real world contexts. The rationale for this research was therefore to collect academics' perspectives on various technologies and pedagogies being used at our institute through the lens of the TPACK framework. The data collected through this study will provide a detailed snapshot of whether the technologies and pedagogies contribute to 21st century competencies and skills. As graduates from Endeavour College of Natural Health are natural health practitioners who would have to engage with the demands of the current knowledge age, they would need the competencies and skills to face such demands. Therefore this study will also help in providing data to the college for the development of appropriate skills.

Methodology

The study was conducted at Endeavour College of Natural Health which is a national provider of complementary medicine in Australia and the departments include Biosciences, Naturopathy, Nutrition, Acupuncture, and Myotherapy. This involved a mixed methods study using a survey based questionnaire. The mixed methods research design was considered for this study as the objective of the study was to gather qualitative and quantitative responses. The quantitative responses would gather information on the use of technologies and pedagogies with respect to frequency while the qualitative responses would gather information on academics' perspectives. The survey instrument covered technologies that were being used at the college and covered pedagogies that were discussed in the literature review. As the study aimed to gather academics' perspectives, all teaching staff were approached for this research. Participants involved permanent staff and casual academics across all departments as in figures 2 and 3. An estimate of 100 participants was made based on the current teaching capacity at the college. Ethics approval was gained from the Human Research Ethics Committee and Endeavour Research Committee. Once ethical approval was obtained, academics were

approached and provided with the link to the survey. An information sheet and consent form was included on the front page of the survey instrument. The survey outlined the aims and purpose of the study, including a description of what is required of the participant once e-consent is obtained. The information sheet also explained that the participation in the survey is voluntary and if they do not agree to participate they would remain anonymous. Those agreeing to participate would also remain anonymous. The survey comprised of five sections. Section A gathered information on participants' profiles. Section B gathered information on reasons for using technology, content taught using this technology as well as any perceived constraints. Section C explored the Pedagogical Content Knowledge component by framing the research question: How did this pedagogy help in teaching specific content? Section D explored Technological Content Knowledge by framing the research question: How did this educational technology/tool best suit to address subject specific content? Lastly section E explored Technological Pedagogical Knowledge by framing the research question: How did this technology enhance student learning?

Participants were provided with a list of pedagogies with a brief description for each. Following are the 21st century pedagogies identified based on the literature review:

Problem-Based learning - An approach where students acquire the knowledge through solving the problem. The aim here is to solve the problem. For example: Case studies.

Inquiry-Based learning - An approach where a problem/scenario is used to incite students to question context, to find information that supports underlying principles and to reflect upon the wider implications. The aim here is to raise questions.

Constructivist learning - An approach where students actively construct their own understanding/knowledge through student-student and teacher-student collaboration in order for learning to be meaningful and effective.

Personalized learning - Learning is personalized when learners are motivated to learn as they view the learning task as being engaging and meaningful. Pedagogies that cater for individuals.

Collaborative learning - A form of social interaction that allows students to share their ideas and learning experiences, thereby promoting learning performance of the group as well as of individuals. For example: group assessment.

Informal learning - As opposed to formal learning, informal learning is interest driven and occurring incidentally, done in one's own time or through participation in various social groups using digital and mobile technologies.

Flipped learning - As opposed to a conventional class, flipped learning is an approach where information is introduced to students before class using technology (such as mobile devices) thereby allowing more engaging learning activities during in-class time.

Data Analysis

Pedagogies and technologies were analysed with respect to frequency and qualitative responses. The data gathered by both research methods was brought together to reveal a complete picture. The integration occurred during the interpretation of qualitative and quantitative results. Subgroup analysis of qualitative responses was done. The responses to reasons provided for using particular technologies were grouped into following categories:

student engagement, improving retention, collaborative work, notification, flexibility, user friendly, assessment purposes, learning purposes, national consistency, and teaching purposes.

Results and Discussion

The findings from the survey analysis are presented in this section. The profile of the participants in the survey captures representation across both casual and permanent staff and the time period they have been teaching at the institute. 20 participants responded to the survey.

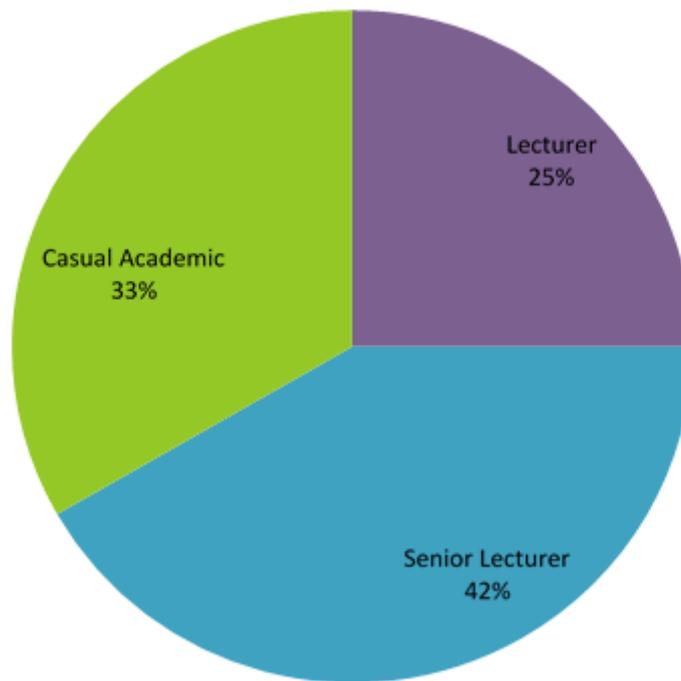


Figure 2. Position in college

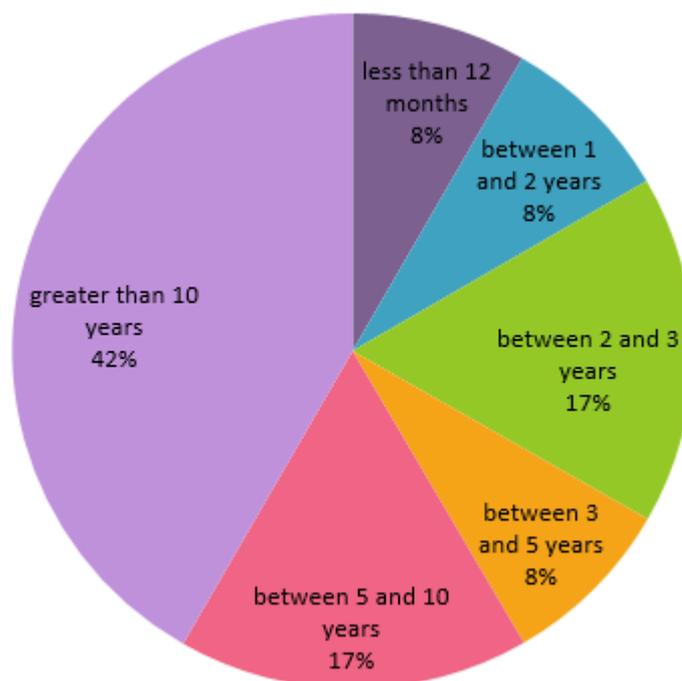


Figure 3. Duration of time teaching at college

Reasons for using particular technologies

Figures 4 and 5 review reasons for using particular technologies. The qualitative responses on reasons for using various technologies received from the participants were grouped into categories such as: student engagement; improving retention; collaborative work; notification; flexibility to students; user friendly; assessment purposes; learning purposes; national consistency; and teaching purposes. The results show that a discussion forum was highly rated by our participants and student engagement was a common reason for using various technologies. This finding is similar to that found in a research conducted by Glowatz and O'Brien (2017) where discussion forums in the form of the learning management system was widely used and student engagement appeared as the driving influence for using various technologies. Online quizzes were considered user friendly as they allowed for automatic grading thereby saving marking time. An online quiz, discussion forum and wiki forum were tools rated for assessment purposes. Additionally, YouTube, concept maps, virtual patient, screencast recordings, webinar, e Portfolio and Kahoot were the tools considered for teaching and learning purposes. These are the tools that allow for visual, kinesthetic, and auditory activities and therefore are important technologies to cater to different types of learners. Participants were also asked to identify any constraints in using technologies. The reasons were categorized as tools not being applicable to the discipline, logistic issues, and tools not suitable to the context. Participants also reported that students often preferred to contact the lecturer through email as opposed to making any posts on the discussion forum.

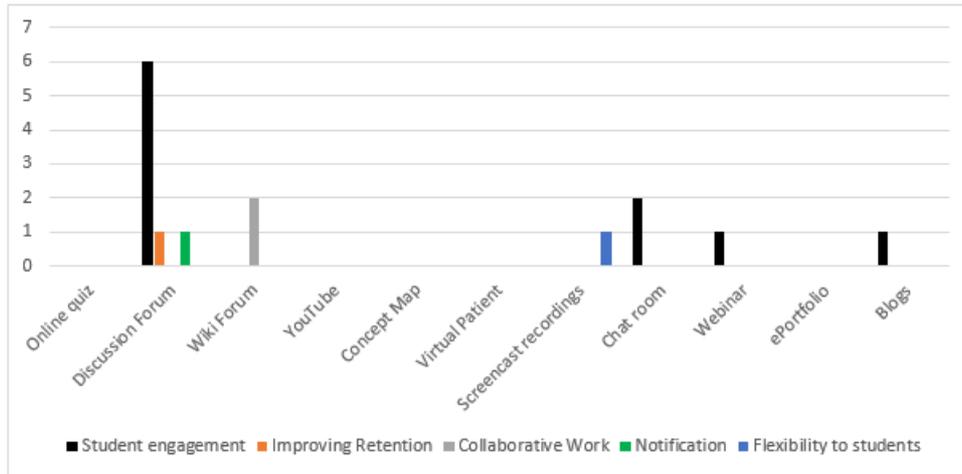


Figure 4. Reasons for using particular technologies

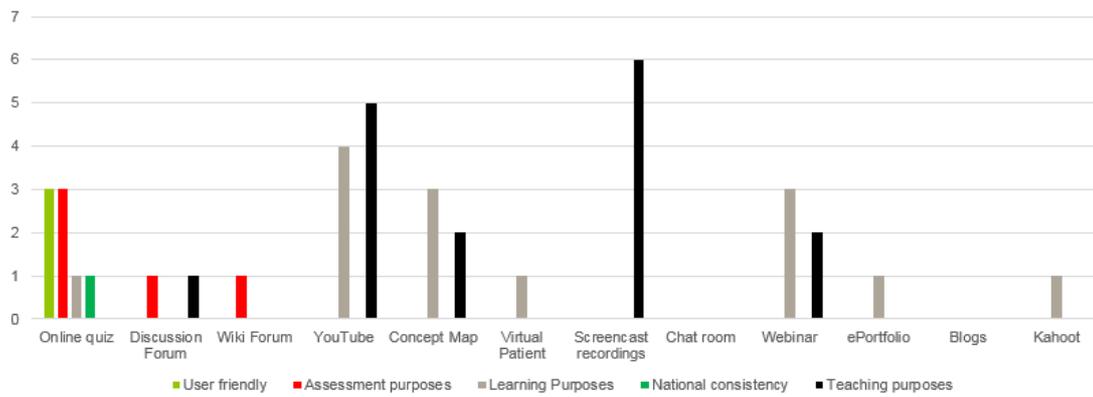


Figure 5. Reasons for using particular technologies

Pedagogical Content Knowledge

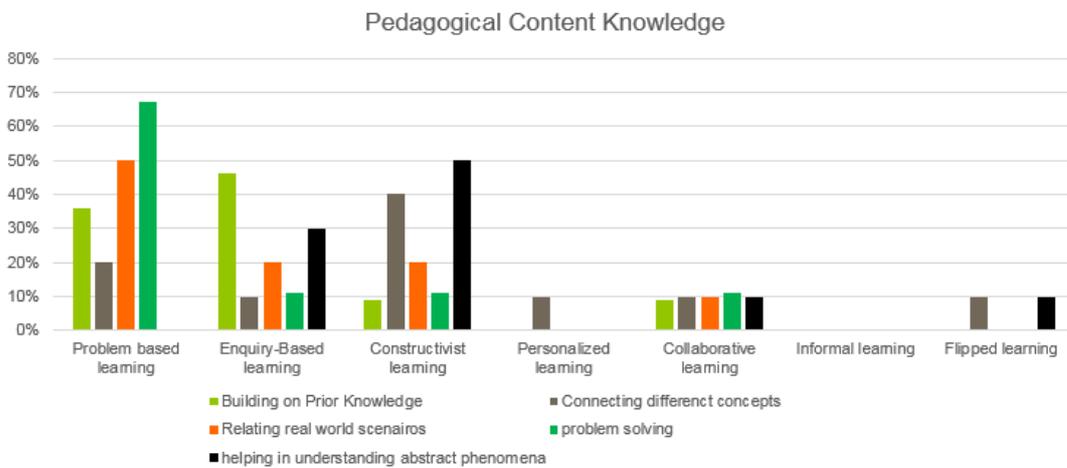


Figure 6. Pedagogical Content Knowledge

Figure 6 represents information on how the pedagogy helped in teaching specific content including whether it built on prior knowledge; related to real world scenarios; helped in understanding abstract phenomena; connect different concepts; and/or allowed problem solving. Participants were asked to rate the 21st century pedagogies to show how they helped in teaching specific content.

Our findings reveal that problem based learning, enquiry-based learning and constructivist learning were highly rated. These are the pedagogies that enhance deeper learning as opposed to superficial learning and promote higher order thinking skills. In contrast, collaborative learning had minimal rating. Other research (Dureta, Christley, Denny, & Senior, 2018; Fakomogbon & Bolaji, 2017; Kivunja, 2015) has shown positive correlation between collaborative learning and academic outcomes and also emphasized use of collaborative assessments. Scott (2015) believes that unless knowledge is created, communicated and shared through collaboration, this can stifle creativity and creativity is an important element of 21st century competencies. Our finding on collaborative learning therefore seems a concern. Our findings also show minimal rating for personalized learning and flipped learning. Besides, there has been significant research on use of social media platforms such as Facebook and mobile technologies as educational tools. These tools are also popular with students. However, our research has shown contradictory results with no rating for informal learning.

Technological Content Knowledge

The research question framed to address this component of the TPACK framework was: How did this technology/tool best suit to address subject specific content? Participants were asked to indicate how technology helped in understanding the content. Figures 7, 8, and 9 revealed tools used for understanding abstract phenomena, 3D concepts and accessing additional resources respectively.

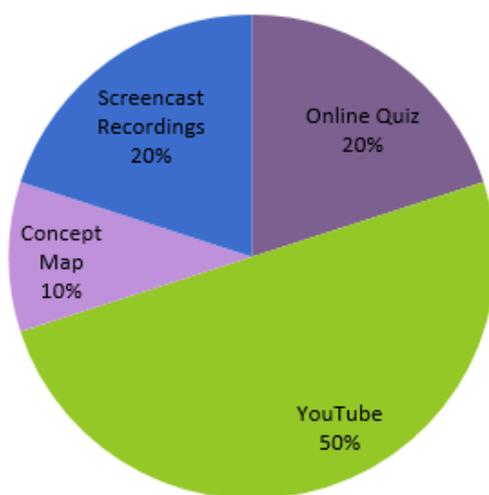


Figure 7. Helped in understanding abstract phenomena

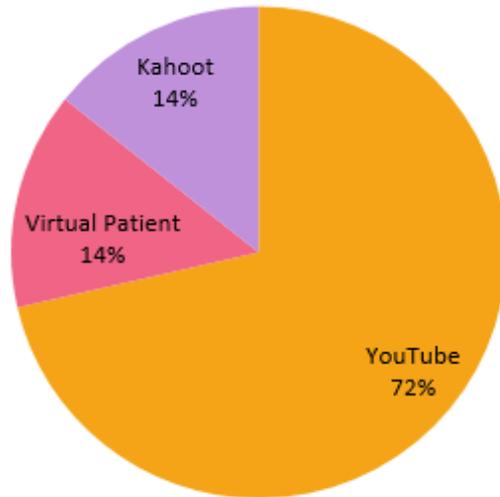


Figure 8. Helped in understanding 3D concepts

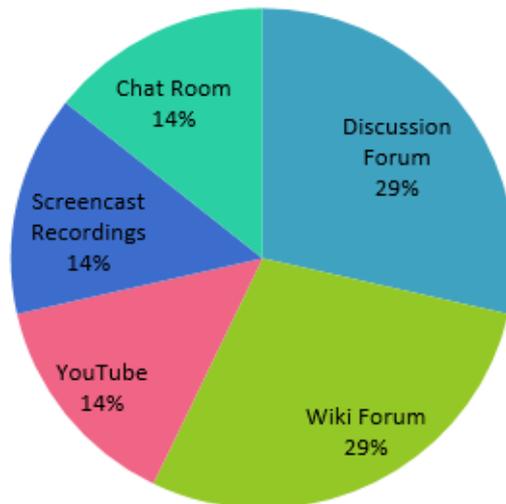


Figure 9. Accessing additional resources

Technological Pedagogical Knowledge

Figures 10 and 11 show responses to how the technology enhanced student learning.

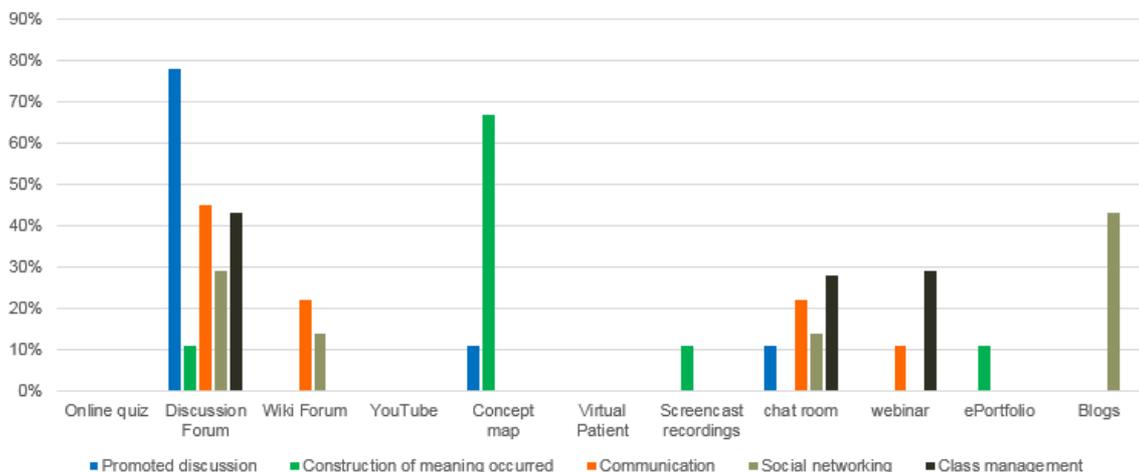


Figure 10. Technological Pedagogical Knowledge

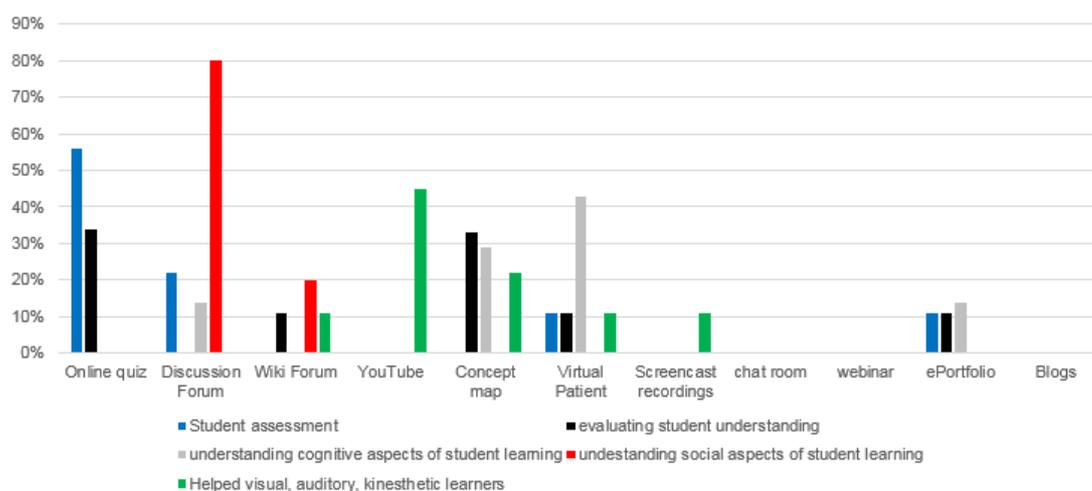


Figure 11. Technological Pedagogical Knowledge

Pedagogical knowledge encompasses knowledge of various teaching strategies; student learning processes, class management; evaluating student outcomes; and above all understanding cognitive, social, and behavioral aspects of student learning. Therefore, our participants were asked to rate various technologies against wide range of pedagogical criteria. While every technology had a specific role in enhancing learning environment, discussion forum was the highly rated tool and fulfilled a wide range of pedagogical criteria. This information could also be discipline specific as the technology tools are related to discipline specific pedagogies. As the majority of our participants belonged to the Biosciences department, there could have been an element of bias although similar findings are found in other TPACK related research. TPACK studies conducted over the period from 2002-2011 had science and mathematics as major subject domains where TPACK studies were explored (Wu, 2013) and this could mean that these are the areas just like Biosciences where technologies are widely embraced.

To summarise, the author identified several key observations relevant to each component of the TPACK framework:

- 1) Reasons for using particular technologies: A discussion forum on the learning management system was the most widely used tool and student engagement was the driving influence behind using these tools. Lecturers also used tools that cater to different types of learners and their learning styles. These perceptions relate to student-centricity and reflect on the innovative use of digital technologies to cater to different learners.
- 2) Pedagogical Content Knowledge: Lecturers embrace problem-based learning, inquiry-based learning and constructivist learning as pedagogies for 21st century learning. These pedagogies allow for engaging with the content at a deeper level and promoting higher-order thinking skills. Survey results reveal limited interest among lecturers in using collaborative learning, informal learning methods, personalized learning, and flipped learning. These findings generate the need to look at different ways of introducing personalised learning through informal methods. With the use of emerging technologies, cultural shift and flexible curriculum there is a potential to enhance 21st century learning. Providing learning opportunities to collaborate with others within problem-based learning and enquiry-based learning can eliminate the resistance towards collaborative learning to some extent.
- 3) Technological content knowledge: A wide range of technologies were used especially in understanding abstract phenomena which is central to Biosciences learning. A better understanding of how technologies can be used innovatively to suit other disciplines is essential.
- 4) Technological pedagogical knowledge: Participants used technologies to understand cognitive, social, and behavioral aspects of student learning. To that end, a discussion forum was commonly preferred. The knowledge of innovative technologies and pedagogies can help academics to improve student learning. Although technology has been related to functional fixedness, lecturers need to rethink innovative ways of using technologies to customize pedagogical purposes (Koehler et al., 2013).

Recommendations

This study captures academics' perspectives on various technologies and pedagogies used to enhance 21st century learning in higher education. It is worthwhile understanding the rationale behind this perspective. How do lecturers know that these technologies and pedagogies best suit to address teaching and learning purposes? Probably, this information can be derived from personal experience, student feedback, grades/course outcomes, and monitoring engagement analytics. Further research is recommended to evaluate how participants know technologies and pedagogies best suit the purpose. Additional perspective from students' point of view on technologies is suggested to complement the findings of this study.

Study Limitations

With a small number of participants completing the survey, the likelihood of generalizing the findings of this study is limited. Besides, the majority of the participants belonged to biosciences department thereby limiting interpretations to other disciplines. Time constraint could probably also have limited the participation of respondents as the survey was open only for one month duration of time. Despite these limitations, the results identify various

technologies and pedagogies for 21st century learning and consider the TPACK framework as an effective tool to develop teaching and learning skills.

Conclusion

This research investigated the role of technologies and pedagogies for 21st century learning from academics' perspectives. Our findings reveal a wide range of technologies and pedagogies are being embraced at Endeavour College of Natural Health. The TPACK framework provides a useful tool to gauge the learning environment. The framework highlights a complex interaction between technology, pedagogy and content knowledge and allows educators to use innovative technologies and renovation to contemporary teaching practices. The shift towards digital pedagogies in higher education is looking to contribute to the development of 21st century competencies and skills thereby preparing learners to face global challenges in the current knowledge age. The literature review showed some academics prefer technologies over pedagogies while others place pedagogies above technologies. This study supported the dynamic influence between the three components of the TPACK framework: content, technology and pedagogy. To educators, the TPACK framework serves as a lens through which teaching practices can be viewed and reflected upon thereby making the learning environment more conducive to student learning. This study provides the rationale for providing teachers with further training in the TPACK area.

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