The Technologies Used in Self-Directed Mathematics and Statistics Learning

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ABSTRACT

In this digital age, digital technologies are used every time and everywhere by many people in everyday life. The application of these digital technologies has transformed the education sector. Students have gradually changed from learners who are teacher-centered to student-centered who are internally motivated knowledge seekers, perhaps with the help of digital technologies usage. Within this context, self-directed learning (SDL) has become an essential educational practice, particularly in mathematics and statistics courses, which often require students to engage in independent problem-solving and conceptual understanding outside the classroom. Hence, this paper examines the types of digital technologies most frequently used by university students in self-directed mathematics and statistics learning using descriptive statistics. The study is based on data from 478 diploma students at a Malaysian public university who enrolled in accountancy and business management programs. Findings indicate that the most digital devices used by students as communication tools and social networks was smartphones compared to computers either laptops, tablets, or desktops. Communication tools, social networking platforms, and internet search engines are the dominant technologies supporting students' independent learning among the fourteen categories of digital technologies assessed. The result also shows that the technology familiarity among students was high for web-based technologies such as Google Docs and Canva. These findings have important implications for educators and institutions seeking to enhance digital literacy and strengthen the integration of academic technologies into teaching and learning practices.

Keywords: digital technology, self-directed learning, mathematics/statistics learning, descriptive statistics

INTRODUCTION

The rise of digital technology has transformed education sectors including higher education which enable students to learn beyond traditional classrooms environments. Even though this generation had grown up with latest and high-end digitalized technologies, a few researchers such as Brown and Czerniewicz (2010), and Helsper and Eynon (2010) argued that it was not the generation that matters in describing young people of today but other more important factors such as the availability and usage of technologies, prior experience, self-efficacy, and education using the technologies.

The widespread of technology use among university students has made them use the technology in their self-directed learning. Self-directed learning (SDL) allows learners to take their own initiatives and the accountability for things that will happen which permit them to choose, organize and evaluate their personal learning activities that can be done at any time, at any place, and accordingly at their own convenience and pace (Saeid and Eslaminejad, 2017). In self-directed learning, learners have the control of themselves to learn. Many students gravitate digital technology as communication and social tools, but the extent to which these tools contribute to meaningful SDL remains underexplored. Furthermore, most of the research studies have focused on the overall self-directed learning using technologies, but this present study will focus on the digital technologies most frequently used by students in their self-directed mathematics and statistics learning.

Students were also unfamiliar with educational technologies. According to Ng (2012), students were unfamiliar with educational technologies could be due to the inconsistent and/or lack of integration of digital technologies

into their learning at schools and at the university levels. Previous studies had shown that students were not inclined to use digital technologies for their academic purposes but rather they used the technologies for non-academic purposes such as for social, personal, and leisure activities (Littlejohn et. al, 2010; Corrin et. al, 2010; Yot-Domínguez and Marcelo, 2017 & Ramírez et. al, 2021).

Research Questions

What digital devices and internet services do students most frequently have unlimited access to for academic purposes?

What types of digital technologies do university students use in self-directed learning for mathematics/statistics courses?

How do students' familiarity with academic digital tools differ from their familiarity with non-academic digital tools as supporting tools learning for mathematics/statistics courses?

LITERATURE REVIEW

Christine (2017) as reported, according to "European Framework for the Digital Competence of Educators" (DigCompEdu), digital technology is defined as any product or service that can be used to create, view, distribute, modify, store, retrieve, transmit and receive information electronically in a digital form. Digital technologies are divided into three main categories (i) digital devices (eg personal computers, mobile devices, tablet PCs, digital whiteboards, projectors, cameras, electric/electronic circuits, and detectors), (ii) digital resources that consist of computer networks (eg internet), software (eg programs, apps, virtual environments, and online games), and online services (eg websites, social networks, online libraries), and (iii) digital content (eg files, information/data) based on this framework. In mathematics education, students can use technical aids such as content-specific software, digital materials, and digital devices with mathematical facilities (Cevikbas et. al, 2023). A study by Akinoso (2018) showed that the use of multimedia positively influenced the academic performance of students in mathematics.

Self-directed learning (SDL), defined as the ability of learners to plan, implement and evaluate their own learning activities, is increasingly facilitated through technological tools (Knowles, 1975; Candy, 1991). Mathematics and statistics subjects often perceived as difficult, hence digital technologies provide learners with opportunities to access resources, collaborate with peers and reinforce understanding through interactive platforms. Rashid and Muhammad Asghar (2016) showed that use of technology has a direct positive relationship with students' engagement and self-directed learning and according to Al Zahrani et. al (2021), self-directed learning using technology has become the new normal for college and university students. Fahnoe and Mishra (2013) reported that self-directed learners became knowledgeable about related resource selection as well as the management and appropriate usage of the information from opportunities and abilities of technology-enhanced learning environment. This was supported by Rashid and Muhammad Asghar (2016) who found that learners using technologies such as email, smartphone, internet, and social media had positive impacts on their levels of self-directed learning. Ng (2012) showed that by making use of unfamiliar technologies in their learning, students could learn easily to create useful artefacts provided they had some degree of digital literacy and the opportunity to use the technologies for meaningful purposes. This suggests that students' self-directed learning skills could be enhanced by exposing them with unfamiliar technologies.

METHODOLOGY

This study involved 478 diploma students enrolled in accountancy and business management programs at a Malaysian public university. A structured online survey was distributed to participants who taking either mathematics or statistics courses, randomly using cluster sampling technique. The survey included 14 categories of digital technologies measured on a five-point scale (1 = never, 5 = very often). Descriptive statistics were used to analyze the frequency of technology use, with categories defined as high (3.51–5.00), moderate (2.51–3.50), and low (1.00–2.50) adapted from Yot-Domínguez and Marcelo (2017). This method allowed for the

identification of the most frequently used technologies supporting self-directed mathematics and statistics learning.

RESULTS AND DISCUSSION

Access to digital technologies for academic purposes

As shown in Table 1, 80.5%, 63.6%, and 28.5% students had unlimited access to smartphones, laptops, and tablets respectively. Result showed that they had access to laptops and tablets more than desktops. Majority of the students (59.4%) have unlimited access to the internet via wi-fi while only 15.1% and 23.2% students have unlimited access via fixed broadband and mobile broadband respectively.

From the findings, it indicates that the use of smartphones as communication tools and social networks was more frequent than the usage of computers either laptops, tablets, or desktops. The possible explanation is smartphones are more accessible and of unlimited access to students. Earlier study by Rung et. al (2014) showed that smartphone skills significantly helped students to learn more independently while Shooriabi and Gilavand (2017) found that students surfed course-related websites on the internet and shared notes with each other were the most frequent used activities when using smartphones for learning purposes. However, the findings of this study did not coincide with Yot-Domínguez and Marcelo (2017) who studied on university students' self-regulated learning using digital technologies and found that of all technologies analyzed, internet information search and instant communication tools were used more frequently compared to social networks.

Table 1 Type of digital devices and internet services access to for academic purposes

Type of digital devices and internet services	Access to technology (%)				
	Not sure	No access	Very limited access	Limited access	Unlimited access
Desktop	5.4	42.5	10.9	16.7	24.5
Smartphone	-	0.8	3.8	14.9	80.5
Laptop	-	1.9	9.2	25.3	63.6
Tablet	5.0	39.5	10.0	16.9	28.5
Fixed broadband	14.2	49.2	9.8	11.7	15.1
Mobile broadband	13.2	42.7	9.0	11.9	23.2
Wireless Fidelity (Wi-Fi)	2.7	13.2	5.9	18.8	59.4

Type of technologies used in self-directed mathematics/statistics learning

Types of digital technologies used	Mean	SD	Mode	Degree of frequency usage	Minimum	Maximum
Internet (eg search engines)	4.18	0.830	5	High	1	5
Social networks (eg Facebook, Instagram, X, TikTok, etc)	4.24	0.916	5	High	1	5
Communication tools (eg WhatsApp, Telegram, etc)	4.59	0.672	5	High	2	5
Storage tools (eg Google Drive, Dropbox)	3.70	1.039	4	High	1	5

Repositories (eg UFuture, Google Classroom)	4.15	0.902	5	High	1	5
Online discussion tools (eg Webex)	3.21	1.181	3	Moderate	1	5
Assessment tools (eg Quizizz)	3.65	1.050	4	High	1	5
Real-time chat (eg Facebook Messenger, Microsoft Teams)	2.96	1.295	3	Moderate	1	5
Online calendar tools (eg Google Calendar, Doodle)	2.91	1.103	4	Moderate	1	5
Mobile apps	3.59	0.642	3	High	1	5
Multimedia resources (e.g. videos on lecturers' presentations, mathematics/statistics apps on related contents, podcasts)	3.27	0.926	3	Moderate	1	5
Computer (e.g. laptop, tablet)	3.59	0.914	4	High	1	5
Digital camera	3.24	1.378	5	Moderate	1	5
File/data/information (eg Wikipedia)	3.51	1.194	4	High	1	5
Overall	3.63	0.657		High	1	5

Table 2 Descriptive statistics of digital technologies used for self-directed learning

As shown in Table 2, it is revealed that on average, students do use digital technologies in self-directed learning and the level of usage is at high level (mean = 3.63, SD = 0.657).

Among the 14 technologies assessed, nine of these reached an average level of high frequent use, five of these reached an average level of moderate frequent use, and none reached a level of low frequent use. The top three most frequently used technologies were: communication tools such as WhatsApp or Telegram (mean = 4.59, SD = 0.672), social networks such as Facebook, Instagram, Twitter, or TikTok (mean = 4.24, SD = 0.916), and internet search engines such as Google or Bing (mean = 4.18, SD = 0.830). Other high-frequency tools included repositories such as UFuture (the university learning management system) or Google Classroom (mean = 4.15, SD = 0.902), cloud storage platforms such as Google Drive or Dropbox (mean = 3.70, SD = 1.039), and assessment tools such as Quizizz (mean = 3.65, SD = 1.050).

Digital technologies with level of moderate use were storage tools such as multimedia resources like videos on lecturers' presentation, mathematics/statistics apps on related contents (mean = 3.27, SD = 0.926), digital camera (mean = 3.24, SD = 1.378), online discussion tools such as Webex (mean = 3.21, SD = 1.181), real-time chat (mean = 2.96, SD = 1.295), and online calendar tools such as Google Calendar (mean = 2.91, SD = 1.103). These data suggest that students use high frequency of smartphones compared to laptops, tablets, or desktops

and among the computers used, laptops ranked the first, followed by tablets, and then only desktops (refer to Table 2). On average, frequency use of all types of digital technologies was higher among students attending statistics classes (mean = 3.66, SD = 0.625) compared to students attending mathematics classes (mean = 3.57, SD = 0.708), however the differences were not significant ($t = -1.440$, $p > 0.05$).

From Table 2, students reported that on average the frequency use was 3.63 (SD = 0.657), a high level of frequency use implying that students frequently used some types of digital technologies for their self-directed learning.

One of the purposes of the study was to determine the digital technologies use in self-directed learning. It was revealed that students did use digital technologies in their self-directed learning, and the level of usage is at high level.

Comparison of students' familiarity with academic and non-academic digital tools as supporting tools in self-directed mathematics/statistics learning

Table 3 Students' familiarity with some selected digital technologies

Digital technologies	Mean	SD	Mode	Minimum	Maximum	Familiarity with the technology	Category of digital technologies	Mean (Familiarity level)	SD
Google docs	4.23	0.807	5	2	5	High	Web-based technology	2.78 (Moderate)	1.080
Mathematical websites	2.27	1.168	1	1	5	Low	Web-based technology		
Graphing calculator	2.32	1.200	2	1	5	Low	Web-based technology		
Jamboard	2.18	1.116	1	1	5	Low	Web-based technology		
Canva	4.46	0.778	5	1	5	High	Web-based technology		
Prezi	1.94	1.077	1	1	5	Low	Web-based technology		
Dropbox	2.05	1.099	1	1	5	Low	Web-based technology		
Mathematical apps	3.15	1.126	3	1	5	Moderate	Non-web-based technology	2.85 (Moderate)	0.230
Statistical apps	2.85	1.175	3	1	5	Moderate	Non-web-based technology		
Movie maker	2.59	1.232	2	1	5	Moderate	Non-web-based technology		
Photoshop	2.81	1.137	2	1	5	Moderate	Non-web-based technology		
Web Quest	2.02	1.065	1	1	5	Low	Technological concept	2.51 (Moderate)	0.315
E-portfolio	2.52	1.212	2	1	5	Moderate	Technological concept		
Podcast	2.69	1.128	2	1	5	Moderate	Technological concept		
Wiki	2.83	1.203	2	1	5	Moderate	Technological concept		
Blog	2.74	1.132	2	1	5	Moderate	Technological concept		
Cloud computing	2.25	1.113	2	1	5	Low	Technological concept		
Overall	2.70	0.752	2.24	1.24	5	Moderate			

Table 3 shows a list of some selected digital technologies categorized as web-based technology, non-web-based technology, and technological concept. These technologies were selected from a list of items that were discussed and used in mathematics/statistics courses. The web-based technologies surveyed were google docs, mathematical websites, graphing calculator, jamboard, Canva, Prezi, Dropbox, and non-web-based technologies were mathematical apps, statistical apps, movie maker, and Photoshop. The technological concepts covered were web quest, e-Portfolio, podcast, wiki, blog, and cloud computing.

Familiarity was based on whether they have heard about the technology and they have very frequently or frequently used it (high familiarity: mean score 3.51 – 5.00), whether they have heard the technology but

sometimes used it (moderate familiarity: mean score 2.51 – 3.50), or whether they have heard the technology but never used it or never heard the technology (low familiarity: mean score 1.00 – 2.50).

Only two technologies with high familiarities, eight technologies with moderate familiarities, and seven technologies with low familiarities. Digital technologies with high familiarities were google docs (mean = 4.23, SD = 0.807) and Canva (mean = 4.46, SD = 0.778) while the technology with moderate familiarities were mathematical apps (mean = 3.15, SD = 1.126), statistical apps (mean = 2.85, SD = 1.175), Photoshop (mean = 2.81, SD = 1.137), podcast (mean = 2.69, SD = 1.128), wiki (mean = 2.83, SD = 1.203), blog (mean = 2.74, SD = 1.132), movie maker (mean = 2.59, SD = 1.232), and e-Portfolio (mean = 2.52, SD = 1.212). Digital technologies with low familiarities were graphing calculator (mean = 2.32, SD = 1.200), mathematical websites (mean = 2.27, SD = 1.168), cloud computing (mean = 2.25, SD = 1.113), jamboard (mean = 2.18, SD = 1.116), Dropbox (mean = 2.05, SD = 1.099), web quest (mean = 2.02, SD = 1.065), and Prezi (mean = 1.94, SD = 1.077). The overall mean familiarity of the technologies was 2.70 (SD = 0.752) indicating the familiarity of the technologies was at moderate level ranging from 1.24 to 5.00. Overall, students were moderately familiar with the surveyed web-based technologies (mean = 2.78, SD = 1.080), non-web-based technologies (mean = 2.85, SD = 0.230), and technological concepts (mean = 2.51, SD = 0.315). Table 3 presents the results.

Hence, technology familiarity among students was high for web-based technologies such as Google Docs and Canva. The plausible explanation is these technologies were being used regularly by their lecturers in the class learning sessions and they tried to use the technologies in their self-directed learning. However, for other surveyed web-based technologies such as mathematical websites, graphing calculator, jamboard, Prezi, and Dropbox, the familiarity for these technologies were low. For example, students were more familiar with Microsoft PowerPoint than Prezi for preparing presentations. Lecturers should use mathematical websites and graphing calculator in the class learning session for mathematics and statistics to encourage and to scaffold students' usage of these technologies in their self-directed learning. According to Ng (2012), if students were given the opportunity to engage with a purpose for adopting digital tools, they were able to use the tools to create meaningful products following their needs.

CONCLUSION

As a conclusion, this study found that communication tools, social networks, and internet search engines are the most frequently used technologies in self-directed mathematics and statistics learning. These findings highlight students' reliance on accessible, everyday tools for academic purposes, while the use of formal academic platforms remains secondary. Recommendations include integrating popular communication tools into formal instruction, strengthening students' digital literacy and designing interventions that encourage the use of academic technologies. Future research could explore the strategies of self-directed learning using digital technologies, difference of socio-demographic effect the strategies of self-directed and learning outcomes.

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