A Three-Year Analysis of Engineering Students’ Readiness for Remote Learning and Its Relevance to COVID-19

A. Peramunugamage¹(✉) and H. A. Usoof²

¹ University of Colombo School of Computing, Colombo, Sri Lanka
anuradhashk@uom.lk
² University of Peradeniya, Kandy, Sri Lanka
hau@sci.pdn.ac.lk

Abstract. UNESCO is concerned about the impact of the COVID-19 pandemic on 1.5 billion learners worldwide. Future movers and shakers of our world are losing their valuable time due to the disruptions caused by this pandemic. Cannot they continue their learning activities from wherever they are? Technology provides teachers and students with several means to access a variety of educational resources. There has also been considerable growth in the adoption of technology within educational institutions in recent years. The world is standing on the threshold of the fourth industrial revolution, which is based on information and communication technologies. In keeping with this modern trend, data collection was done through the distribution of an online questionnaire among first-year undergraduates of the Faculty of Engineering at the University of Moratuwa (UoM) in Sri Lanka during 2017, 2018 and 2019. When preparing the online questionnaire, questions were taken from the Kirkwood & Price TEL Handbook. Results indicated that all the respondents were computer literate and of them, 80% owned computers at home. Therefore, higher educational institutions can arrange to take advantage of these capabilities to enhance the students’ learning by encouraging them to adopt collaborative learning methods. Further, this study shows that more than 95% of them access the Internet by using a smartphone, and as such, higher education institutions can arrange to exploit mobile technologies for engineering education, thereby delivering the maximum benefits to students. Based on the findings of this study, it does make sense to conclude that adopting meaningful technological interventions could result in significant and positive changes in the teaching and learning practices at UoM.

Keywords: Ownership of ICT · Student’s readiness · Online learning · TEL

1 Introduction

UNESCO is concerned about the impact of the COVID-19 pandemic on 1.5 billion learners worldwide [1]. Future workers of our world are losing their valuable time because of Covid-19. Cannot they continue their learning activities from wherever they are? Information and Communication Technology (ICT) has reached all corners of the...
globe and is increasingly being used for educational purposes [2]. The wide availability of mobile smart devices and accessibility to the Internet has made educational resources easily accessible to learners irrespective of time and space [3]. However, it is a hard fact that there are external and internal factors that militate against the successful application of technology for education [4]. In certain educational contexts and settings, students may not have the opportunity to use technology for their education, even though they may possess the knowledge and the skills to make use of such technology. Also, attitudes towards teaching and learning are critical factors that influence the implementation of educational technology. As a developing country we had difficulty coping with situations like a terrorist attack and COVID-19 and were forced to shut down all schools and universities for 2–4 months. Though all universities had mainly practiced face-to-face education until recently, now they had to do a sudden transformation to blended learning and distance learning.

Technology Enabled Learning (TEL) refers to the use of digital technologies that are applied to any kind of educational system to enhance the quality of teaching and learning. Kirkwood and Price [5] modeled the complexity of four interrelated factors that could influence the instantiation of effective institutional approaches to TEL, such as the teacher’s academic context, the student’s academic context, the departmental context and the institutional context. Of these contexts, our main concern is about the student’s academic context. Kirkwood and Price, discussing the framework of factors that influence teaching and learning with technology in higher education, mention five factors relevant to the student’s academic context; these are digital literacy, access to technology, learning practices, approaches to learning, and conceptions of learning & teaching.

2 Purpose

Technology provides teachers and students with access to a variety of educational resources [6, 7]. There has been considerable progress in the adoption of technology within educational institutions in recent years. The world is standing on the threshold of the fourth industrial revolution, which is based on information technology. To maintain the quality and the status of engineering graduates, the accreditation and assessment of academic programs play a vital role in engineering education. The engineering program is designed to cover six categories of courses: general engineering, basic mathematics and science, engineering proficiency, professional development, advanced mathematics and core education [8, 13]. Each of these categories provides the student with an essential component of their overall study program that makes sure the students are ready to work as engineers [14, 15].

Therefore, as a leading technical university in Sri Lanka we wanted to produce high caliber, well experienced engineers to serve society through enhancing the engineering degree program. We had to do this since the University of Moratuwa produces over 800 engineering graduates annually. This report marks the beginning of a journey to improve the quality of teaching and learning in the Faculty of Engineering at the University of Moratuwa, Sri Lanka. The faculty aims to (i) offer courses that integrate ICT for teaching and learning, (ii) enhance student engagement and the quality of
learning, and (iii) improve the ICT skills of every learner to prepare him/her to be a lifelong learner. The main aim of this study was to examine learners’ access to ICT resources, their skills at making the best use of ICT, and assess their perceptions about using TEL for their learning in the domain of TEL in engineering education and evaluate the preparedness of the system and stakeholders to continue education in a situation like COVID19.

3 Methodology

The data collection was done through an online questionnaire that was forwarded to all first-year undergraduates of the Faculty of Engineering at the University of Moratuwa (UoM) in Sri Lanka during 2017, 2018 and 2019. The questionnaire was designed to collect students’ demographic information as well as their opinions about instructional strategies and resources related to TEL environments. The demography related information was about accessibility to technology devices, gender and availability of the Internet. The online questionnaire included questions from the Kirkwood & Price TEL Handbook [5, 16]. Likert scales were used to collect the data for the statistical analysis. The objective of the Likert scale was to measure the extent of students’ experience and agreement with each item. The ordinal of Likert scales was adapted from Kirkwood & Price (2016). Students were given the chance to answer the online questionnaire during the Moodle introductory session that was held at the Faculty of Engineering soon after they entered the university. First-year students were selected, as they were new to the university environment after their Advanced Level exam-oriented education and had not been exposed to technology properly yet. Students were informed of the purpose of the study and were asked to fill in the questionnaire.

Students were given to understand that their participation was voluntary and they could opt-out of the survey any time they wanted. The data were collected anonymously using the voluntary sampling method. In all, more than 1500 responses were collected. The data were compared with that of 6 other countries, i.e. Bangladesh – the Ahsanullah University of Science and Technology [17]; Kenya – Jaramogi Oginga Odinga University of Science and Technology [18]; Malaysia – Universiti Malaysia Sabah [19]; Papua New Guinea – University of Papua New Guinea [20]; Samoa – National University of Samoa [21]; and Uganda – Uganda Management Institute [22].

4 Results and Discussion

The findings show that in every year the males dominated the sample. In the Sri Lankan context the engineering industry is always dominated by males. Annual reports of the UGC Sri Lanka show that more than 75% of the engineering admissions are comprised of male students. As shown in the bar graph of Fig. 1, in the years 2017 to 2019 the Male percentage lay between 70% and 80%.
4.1 Access and Usage of Technology

**Devices Owned by the Learners:** The study intended to find the availability of and access to technology. Questions were posed about the learners’ own devices, Internet facility on campuses and frequency of learners’ usage. According to the data, about 80% of learners possess laptops and 20% of them are planning to buy a computer within 12 months, while 44% have desktops at home and 95% of learners carry smartphones, as shown in Fig. 2 and Fig. 3. Learners have access to desktop computers at the university. However, the UoM currently does not provide laptops, smartphones or tablets for student use. More than 75% of the students use their own devices on campus, as seen from the results. The data implies that the use of smartphones for teaching-learning will benefit learners since there is a significant increase in the ownership of smartphones.
Access to the Internet: Internet access is a vital element of TEL, and as such it is important to determine how easily learners can connect to it. Learners access the Internet from various places. Nearly 90% of learners have Internet access at home while about 8% of learners use the office or cyber cafe to go online. There are a few students (less than 1%) who have access neither at home nor office nor cybercafe. Figure 4 shows that 95.16% of students had Internet access at home in the year 2019, which is higher than in the year 2017.
Sources of Internet Access: Web resources consisting of videos, web articles, teacher presentations and LMS tools were the main features of the TEL intervention. Therefore, it is essential to understand how students access the Internet. More than 90% of learners used their smartphones to access the Internet. Remaining students used the laptop for Internet access while less than 0.2% used the desktop computer, tablet or iPad for access as shown in Fig. 5. All the students used the Internet daily by using a smartphone (92.91%) or a laptop (6.76%) or a tab or desktop computer. However, it was established that 100% of the students had at least one device available for them to participate in TEL, though many had to depend on smartphones for various activities.

Comfort Level with Using Computer: The competency level of learners who use a range of computer skills was evaluated through a Likert scale ranging from 5 to 1, rated as 5- Exceptional, 4- Good, 3- Average, 2- Weak and 1- Very Weak. Results indicated that learners were very proficient in word processing, spreadsheets, PowerPoint, using search engines and email, with mean responses above the midpoint or average of 3. Learners were not as proficient in areas such as graphics editing, digital and audio editing, webpage design and LMSs as shown in Table 1. This indicates a need for building up more skills. 99% of students had a social media account. Students were asked to rank their preferences in different computer-related activities. It was seen that students were keen on search engines and email related activities. Moreover, more than 50% of students had used word processing, spreadsheet and presentation software. Further, the majority of students were not familiar with Learning Management Systems (LMS), video editing, web page designing, graphic designing, digital audio editing, and databases.
Further, students were asked what sort of Internet related activities they engaged in daily. It appeared that the majority spent more than an hour daily accessing the Internet. Around half of the students were members of various IT-based forums, such as mailing lists or discussion forums. The majority did not use these forums very frequently. Students were also not used to MOOCs. Most of them strongly agree or agree that the technologies they are using at the university will help them with studying, developing skills and preparing themselves for future job markets. Learners at the UoM are aware of the usefulness of technologies in their studies for accessing academic resources, sharing resources, communicating with their peers, collaborating and other tasks. They prefer to have access to educational resources and course-related information online. They also like to use social media to connect with other students and teachers. They like to search for and download videos, texts and audio files from the Internet. However, they do not seem to be aware of or care about copyright restrictions.

| Computer skills                        | Weighted average |
|----------------------------------------|------------------|
|                                        | 2017  | 2018  | 2019  |
| Word processor (e.g. Word)             | 3.54  | 3.35  | 3.46  |
| Spreadsheets (e.g. Excel)              | 3.16  | 3.02  | 3.19  |
| Presentation (e.g. PowerPoint)         | 3.36  | 3.11  | 3.21  |
| Email                                  | 3.64  | 3.58  | 3.74  |
| Search engines                         | 3.73  | 3.68  | 3.84  |
| Databases                              | 2.49  | 2.56  | 2.72  |
| Multimedia authoring                  | 2.17  | 2.33  | 2.51  |
| Graphic editing                        | 1.92  | 2.01  | 2.26  |
| Digital audio editing                  | 1.64  | 1.86  | 1.95  |
| Video editing                          | 1.76  | 1.98  | 2.05  |
| Web page design                        | 1.71  | 1.80  | 1.92  |
| Learning Management System             | 1.76  | 1.97  | 2.58  |
| Web 2.0 tools (wikis, blogs, social networking and sharing tools) | 2.24  | 2.26  | 2.58  |

4.2 Learners’ Perceptions of Using TEL

As shown in Table 2 learners were asked to rate how useful technologies are for their studies, regardless of whether they had used them or not. The question was to be answered by ticking a box on a 5-point Likert scale. Weighted points were given for each rating as 5- Strongly Agree, 4- Agree, 3- Neutral, 2- Disagree and 1- Strongly Disagree. The calculated weighted averages are displayed in Table 2 for the years 2017–2019. Results revealed that the markings for all statements were above average.
and highly positive, with mean responses above 4.0 in every year. Therefore, we can assume that learners are ready and feel motivated to work with new technologies or TEL. This is a very encouraging sign, as it means that learners are highly receptive to TEL and accept its potential value. Responses to question 5, “It allows me to collaborate with others easily, both in and outside of the campus” suggested that students were receptive to the idea of conducting their studies through PBL implementation and collaborative learning [23, 24].

Table 2. Learners’ perceptions of using TEL in the year 2017–2019 intakes

| Statements                                                                 | Weighted average |
|----------------------------------------------------------------------------|------------------|
|                                                                            | 2017  | 2018  | 2019  |
| 1. It will help me get better results in my subjects                      | 4.38  | 4.32  | 4.26  |
| 2. It will help me understand the subject material more deeply             | 4.38  | 4.31  | 4.40  |
| 3. It makes completing work in my subjects more convenient                | 4.27  | 4.22  | 4.37  |
| 4. It motivates me to explore many topics I may not have seen before       | 4.29  | 4.20  | 4.27  |
| 5. It allows me to collaborate with others easily, both on and outside of | 4.13  | 4.15  | 4.20  |
| the campus                                                                |       |       |       |
| 6. It will improve my IT/information management skills in general         | 4.30  | 4.31  | 4.27  |
| 7. It will improve my career or employment prospects in the long term     | 4.20  | 4.23  | 4.18  |

4.3 Learner Attitudes Towards Technology

Students were asked to respond to statements on their attitudes towards technology, using Likert scale items with 5- Strongly Agree, 4- Agree, 3- Neutral, 2- Disagree and 1- Strongly Disagree. The results are presented in Table 3 for statements framed in positive terms, with learners strongly agreeing and with mean responses higher than 3. Learners did not agree that online lectures would make them more likely to skip classes. It shows the average score for the statement “I am more likely to skip classes when materials from course lectures are available online” as 2.5, indicating that learners would not skip classes even if materials were available online. Therefore, we can see if they had TEL they would still be willing to have face-to-face lectures. Our previous studies showed that they liked even video recorded lectures [10, 12]. Learners strongly agreed that technology made them more connected to the university, teachers and other students. The majority of learners showed concern about privacy and cybersecurity issues, and about technology interfering with their concentration on their studies. Learners indicated they wished teachers to use and integrate more technology into their teaching.
5 Conclusions and Recommendations

Results indicate that all the respondents were computer literate and among them, more than 90% owned computers at home. Therefore, UoM can arrange to use these capabilities to enhance the students’ learning and encourage them to participate in collaborative learning. Further, this study shows that more than 93% of the students access the Internet by using a smartphone. Therefore, UoM can arrange to adopt mobile technologies for engineering education, as that will deliver the maximum benefit to students. However, students’ confidence with online tools and resources were perceived to vary, and the findings suggest that students need to be supported to develop skills to engage more effectively with the opportunities that e-learning offers. Further, most of the students are able to use word processors, PowerPoint, email and search engines. Almost all of the students have a Facebook account. Students’ previous experiences might offer a starting point for implementing technology into their

Table 3. Learner Attitudes towards Technology

| Statements                                                                 | Weighted average |
|---------------------------------------------------------------------------|------------------|
|                                                                            | 2017  | 2018  | 2019  |
| 1. I get more actively involved in courses that use technology             | 4.154 | 4.076 | 4.183 |
| 2. I am more likely to skip classes when materials from course lectures are available online | 2.716 | 2.898 | 2.546 |
| 3. When I entered college, I was adequately prepared to use the technology needed in my courses | 3.632 | 3.755 | 3.804 |
| 4. Technology makes me feel connected to what’s going on at the college/university | 3.808 | 3.970 | 4.176 |
| 5. Technology makes me feel connected to other students                    | 3.779 | 3.974 | 4.046 |
| 6. Technology makes me feel connected to teachers                          | 3.468 | 3.776 | 3.870 |
| 7. Technology interferes with my ability to concentrate and think deeply about subjects I care about | 3.462 | 3.708 | 3.642 |
| 8. I am concerned that technology advances may increasingly invade my privacy | 3.425 | 3.631 | 3.388 |
| 9. I am concerned about cyber security issues(password protection and hacking) | 3.620 | 3.833 | 3.915 |
| 10. In-class use of mobile devices is distracting to me                    | 3.294 | 3.469 | 3.340 |
| 11. In-class use of mobile devices is distracting to my teacher            | 3.450 | 3.610 | 3.648 |
| 12. Use of tablets/laptops in class improves my engagement with the content and class | 3.553 | 3.831 | 3.757 |
| 13. Multitasking with my technology devices sometimes prevents me from concentrating on or doing the work that is most important | 3.547 | 3.674 | 3.615 |
| 14. When it comes to social media (e.g. Facebook, Twitter, LinkedIn), I like to keep my academic life and social life separate | 3.566 | 3.783 | 4.000 |
| 15. I wish my teachers in the university would use and integrate more technology into their teaching | 3.744 | 3.944 | 4.019 |
learning. Based on the findings of this study, it is easy to conclude that some meaningful technological interventions could result in significant positive changes in the teaching and learning practices at UoM. Teachers could enhance the quality of their courses by improving content creation, content sharing and learner engagement. It was found that there is a need to ensure wider access to the Wi-Fi network on the university campus. Bandwidth should be increased so that learners and teachers have easy, uninterrupted access to educational resources, course-related information and various learning forums and social media.

Over the last three years (2017–2019) students at the UoM Faculty of Engineering became aware of the usefulness of technologies in their studies for accessing academic resources, sharing resources, communicating among their peers, collaborating, and other tasks. They prefer to have online access to educational resources and course-related information and also every one of them has a social media account like Facebook and the like to connect with other students and teachers. They prefer to search for and download videos, texts and audio files from the Internet. However, they are not well aware of copyright restrictions just as in some other countries like Bangladesh [17]; Kenya [18]; Malaysia [19]; Papua New Guinea [20]; Samoa [21]; and Uganda [22]. Moreover, learners in all of the above countries believe that integrating technologies enhances their level of engagement with their courses and helps them to connect with peers and teachers.

Furthermore, “Digital literacy is the ability to access, manage, understand, integrate, communicate, evaluate and create information safely and appropriately through digital devices and networked technologies for participation in economic and social life. It includes competencies that are variously referred to as computer literacy, ICT literacy, information literacy, and media literacy” [25]. The European Commission report (2013) has proposed a framework for the development of digital competence. It consists of five core areas: information processing, communication, content creation, problem solving, and safety [26]. In this study we can also find that the UoM engineering undergraduates possess at least basic digital literacy. By considering the above five factors undergraduates can be made competent enough to use digital technologies. Since they can search for data, information and content in digital environments by navigating efficiently, they will be able to create and update personal search strategies and interact with others through a variety of digital technologies. They can also understand what appropriate digital communication means in a given context. By sharing data, information and digital content with others through appropriate digital technologies, they will be able to create and edit digital content in different formats, express themselves through digital means, and have an understanding on how to protect devices and digital content, while guarding against risks and threats in digital environments.

By considering all of the above factors we can say that students are very optimistic about TEL implementation at UoM, with the majority of them indicating that enhanced digital skills would help them use technology for better learning. It is significant that the students are digital natives and use technology to a large extent in their day-to-day lives. However, students are not used to MOOCs and some have not heard of the term “MOOC.” Increased use of the currently available Moodle at UoM, awareness of Open Educational Resources (OER) and use of MOOC will need to improve. Using
technology for teaching and learning at UoM would help students become better learners, and prepare them for the challenges of the twenty-first century. By considering all the facilities available for the students at UoM it is quite feasible to plan and implement online teaching effectively in this pandemic situation as recommended by the Commonwealth of Learning and World Bank report [27]. Though we collected all of the above data before the outbreak of the COVID-19 pandemic, we found that even at that time the undergraduates were quite ready for the online teaching and learning activities. But it was the pandemic that provided the real impetus for students to start learning remotely by using Internet technologies. Since this study data shows that how these initiate, and the stakeholder preparedness made it easier for the students and staff to move from the blended environment to a distance learning scenario.

References

1. S Affairs: UNESCO COVID-19 Education Response Education Sector issue notes School reopening, pp. 1–8 (2020)
2. Kumi-Yeboah, A., Dogbey, J., Yuan, G.: Online collaborative learning activities: the perspectives of minority graduate students. Online Learn. 21(4), 5–28 (2017)
3. Sung, Y.-T., Chang, K.-E., Liu, T.-C.: The Effects of Integrating Mobile Devices with Teaching and Learning on Students’ Learning Performance. Comput. Educ. 94(C), 252–275 (2016)
4. Fisher, K.D.: Technology-enabled active learning environments: an appraisal. CELE Exch. Cent. Eff. Learn. Environ. 2010, 6–10 (2010)
5. Price, L., Kirkwood, A.: Using technology for teaching and learning in higher education: a critical review of the role of evidence in informing practice. High. Educ. Res. Dev. 33(3), 549–564 (2014)
6. Boz, B., Adnan, M.: How do freshman engineering students reflect an online calculus course? Int. J. Educ. Math. Sci. Technol. 5, 262–278 (2017)
7. Goodridge, W.H., Lawanto, O., Santoso, H.B.: a learning style comparison between synchronous online and face-to-face engineering graphics instruction. Int. Educ. Stud. 10(2), 1 (2017)
8. Prados, J.W., Peterson, G.D., Lattuca, L.R.: Quality assurance of engineering education through accreditation: the impact of engineering criteria 2000 and its global influence. J. Eng. Educ. 94(1), 165–184 (2005)
9. Marginson, S.: Higher education in East Asia and Singapore: rise of the confucian model. High. Educ. 61(5), 587–611 (2011)
10. Williams, P.J.: Technology education to engineering: a good move? J. Technol. Stud. 36(2), 10–19 (2010)
11. International Engineering Alliance 2018. WASHINGTON ACCORD. https://www.ieagreements.org/accords/washington/. Accessed 01 Aug 2018
12. The National Academies Press: Educating the Engineer of 2020 (2005)
13. Kamaruzaman, F.M., Hamid, R., Mutalib, A.A., Rasul, M.S.: Conceptual framework for the development of 4IR skills for engineering graduates. Glob. J. Eng. Educ. 21(1), 54–61 (2019)
14. Koc, E.W., Kahn, J., Koncz, A.J., Salvadge, A., Longenberger, A.: Job Outlook 2019, November 2018 (2019)
15. Engineers Ireland: Accreditation criteria for professional titles (2014)
16. Kirkwood, A., Price, L.: Technology-Enabled Learning Implementation Handbook (2016)
17. The Commonwealth of Learning: Report of the Baseline Study on Technology-Enabled Learning at Ahsanullah University of Science and Technology. Rep. Baseline Study TEL AUST, vol. 1, no. 4, p. 53 (2019)
18. The Commonwealth of Learning: Report on the baseline study of technology-enabled learning at Jaramogi Oginga Odinga University of Science and Technology. Rep. Baseline Study Technol. Learn. Jaramogi Oginga Odinga Univ. Sci. Technol. 1(4), 53 (2018)
19. The Commonwealth of Learning: Report of the Baseline Study on Technology-Enabled Learning at Universiti Malaysia Sabah, p. 74 (2018)
20. The Commonwealth of Learning: Report on the Baseline Study of Technology-Enabled Learning at the University of Papua New Guinea. Rep. Baseline Study Technol. Learn. Univ. Papua New Guinea is (2019)
21. The Commonwealth of Learning: Report of the Baseline Study on Technology-Enabled Learning at the National University of Samoa. Rep. Baseline Study Technol. Learn. Natl. Univ. Samoa (2017)
22. Resty, M., Umi, K., Sansa, J., Makerere, O.: Integration of Technology-Enabled Learning (TEL) at Higher education in developing countries: a case of Uganda Management Institute (UMI), pp. 1–18
23. Peramunugamage, A., Usoof, H.A., Dias, W.P.S., Halwatura, R.U.: Problem-based learning (PBL) in engineering education in Sri Lanka: a moodle based approach. Advances in Intelligent Systems and Computing. AISC, vol. 1134, no. September 2019, pp. 770–780 (2020)
24. Peramunugamage, A., Ratnayake, H.U.W., Karunanayaka, S.P., Halwatura, R.U.: Designing online learning activities for collaborative learning among engineering students. Advances in Intelligent Systems and Computing. AISC, vol. 1134, no. September 2019, pp. 101–110 (2020)
25. Vuorikari, R., Punie, Y., Carretero, S., Van Den Brande, L.: DigComp 2.0: The Digital Competence Framework for Citizens, June 2016
26. Editors, A.F., Punie, Y., Bre, B.N.: DIGCOMP: a framework for developing and understanding digital competence in Europe (2013)
27. WorldBank: The COVID-19 Crisis Response: Supporting tertiary education for continuity, adaptation, and innovation, April 2020