University Students' Engagement with Devices and Technology

A Comparison of Pre- and Post-COVID-19 Student Use

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Abstract: In this paper, through the replication of a pre-COVID-19 research project, we seek to test and compare first-year Australian university students' study and private uses of technology; compare the desires and capacities of different cohorts (Law and Justice vs Engineering) for technology use; and identify any impacts arising from COVID-19 to their learning experiences. Quantitative and qualitative data, collected by an online questionnaire, identified that, while some participants had more experience with different technologies, there were limited differences between the cohorts' willingness to use, and their use of, technology for study purposes. Concerns expressed by participants related to where, when, and for what purpose technology was used. Participants all had access to a smart phone, and almost all used a laptop for study purposes. The results suggest the combination of online or pre-recorded lectures and synchronous (either face-to-face or online) tutorials was the most favoured option. While participants were comfortable with the use of technology in teaching and learning, they were wary about using such tools for private communications; however, Zoom and Microsoft Teams, appeared to be in common use. The results confirm the need for a broader and more in-depth understanding of students' technology uses, needs, and desires.

Keywords: technology, digital literacy, COVID-19, e-learning, mixed methods

Introduction

This paper seeks to understand university students' current engagement with technology for study purposes in comparison with their private uses. Previously, when Queensland University

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of Technology (QUT) sought to harness expanding student use of smart devices for course delivery, a pre-COVID-19 study sought to gauge the effectiveness of QUT's law and justice students' use of technology for learning purposes (2013 Survey). Many other universities also were focussed on technology adoption to aid course content and information delivery, including by teleconferencing (Abbasi & Stergioulas, 2011); podcasts (Kidd, 2011); and other online systems (Jurado, Redondo & Ortega, 2012). The 2013 Survey confirmed QUT students' conservative use for study purposes (McNeill, Diao & Gosper, 2011); and a separation between personal and study uses (Dahlstrom, Walker & Dziuban, 2013; Cradduck, 2013).

Technology's use to enable university course content delivery, and of self-directed learning (Morris & Rohs, 2021), has increased. However, not all uses, or technologies, are effective in supporting learning (Hornik, Johnson & Wu, 2007); nor does "availability … translate to extensive use or access by students for learning purposes" (Bustillo-Booth, 2021). COVID-19 campus closures resulted in a shift to online learning. This created a new learning environment as many universities provided online learning for the first time, which constrained some students in their desire or ability to engage with academics and peers, and potentially impacted their learning (Yazgan, 2022). The need to engage more with materials also increased student workloads and adversely impacted upon time management.

The current study (2020-21 Survey), utilising constructs developed from studies found in the literature and the technology acceptance model ('TAM') (Davis, 1989; Davis, Bagozzi & Warshaw, 1989), builds upon the 2013 Survey. It engages in a cross-discipline comparison; and seeks to identify COVID-19's impacts on students' engagements, and whether they believed available technology was effective for remote and self-paced learning. It commences by overviewing relevant literature and describing the methodology. It then analyses 2020-21 Survey responses, presenting similarities and differences between cohorts; and comparing the law and justice (L&J) responses to 2013 Survey data. It closes by discussing implications for teaching practices.

Literature Review

The major themes in extant literature can be clustered into three main and interrelated categories. Noting the plethora of relevant discussion, the following engages with only some of the more recent literature, as directly relevant to our work.

The introduction and use of technology for teaching and learning

Technology use drives both innovations in technology, and the desire for more and better technology to use. Previous work considered student perceptions and uses (Nelson, Kift & Harper, 2005); managing technology distractions (Matthew, 2012); and the role of lectures in

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supporting students (Tanaka, 2012). More recently, Moreira & Rocha's (2017) special guest editorial on new technologies and the future of education and training identified mobility, wearable devices, and artificial-intelligence-driven Massive Open Online Courses (MOOCs), as key drivers of future improvements. They also identified teaching-learning process can become more reliable as new technologies for education and learning make access to information and communication more practicable. Souabni, Saâdi & Ben Ghezala (2019), who undertook a study into situation awareness from a ubiquitous learning system perspective, developed a multidimensional framework for situation-aware u-learning system that was used to evaluate research identified in the literature with the aim of improving outcomes. More recently, Peña-Ayala (2021) developed a learning design cooperative framework harnessing technologies to create a 21st century education setting. This showed improved balanced learning outcomes through framework use.

Yuan *et al.* (2021) extended the mobile technology acceptance model, by considering the influence of both pedagogy and technology on learners' compulsory m-learning experience response. Their results show learning content quality, user interface, and system connectivity affect the perceived usefulness of mobile learning, which in turn affects the experience response. Goksu's (2021) comprehensive bibliographic analysis, utilizing 5167 studies in the Web of Science database, found in the period 2015-2019 trend topics "were broadly that of educational technologies, and, more specifically, tablets, mobile phones, MOOCs and learning strategies" (Goksu, 2021). Successful research that featured prominently included augmented reality, higher education, and smartphone-oriented learning. However, as others considered, the move to online delivery during COVID-19 has had varied impacts on students' satisfaction with their courses (Alzahrani & Seth, 2021; Amponsah, 2021; Jiang *et al.*, 2021).

Attitudes to and acceptance by students of technology

The form of content delivery can also affect acceptance of the delivery mechanism. As McNeill, Diao & Gosper (2011) identified, students can be conservative in their use of technology. However, use is influenced by, and depends on, the purpose for that use. O'Sullivan (2018) used qualitative data from a small survey (88 participants) at an Irish university to attempt to identify platform preferences for academic reading, and how students' preferences were formed. While limited due to the number of participants, this identified there was a requirement to cater for a broad range of needs, including the continued provision of physical learning materials. In an empirical study of people between 16 and 24 years old, carried out to investigate the teaching of information and communications technology in universities as a cross-training curriculum topic, Picatoste, Pérez-Ortiz & Ruesga-Benito (2018) identified the necessity to provide self-training or informal personal training channels to meet their needs.

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Hamidi & Chavoshi (2018) carried out a study into the adoption of mobile learning in higher education. This aimed to evaluate the essential factors for the adoption and application of an education information system developed for the study. The factors identified were classified into seven categories – ease of use, trust, characters and personal qualities, context, perceived usefulness of using, behavioural intention, and culture of using a research model. Hamidi & Jahanshaheefard (2019) then considered student satisfaction, and internal and external factors. They noted universities are particularly interested in student satisfaction and, with a growing dependence on electronic learning, have raised the importance of mobile learning outcomes. They identified a strong link between mobile learning and positive student satisfaction.

Baragash & Al-Samarraie (2018) investigated different modes for delivering learning materials, and how peer connections related to higher education teaching and learning practices. An analysis of 196 questionnaire responses revealed student engagement in face-to-face learning positively impacts engagement when using learning management systems and web-based learning. Ifinedo, Pyke & Anwar (2018), studying usability factors on how undergraduates used Moodle in a blended learning environment, found, from 126 survey responses, usability factors have positive effects on student use.

Ali *et al.* (2020) studied the relationship between quality of life and access to information and communication technology by using simultaneous equation models. Their findings imply supply issues and demand strategies that include enhancement of digital skills and affordability should be emphasized by policymakers. Nam & Jung (2021) provide insights into users' digital content consumption trends by studying short-form digital content consumption, which is participative and multi-tasking. Laddering interviews were carried out and outcomes presented using a hierarchical goal map. This identified 14 goals (acquiring information, gaining insights, empathy, socialization, killing time, fantasy, fun, restorative, sharing information, escapism, curiosity, psychological stability, belongingness, sense of accomplishment) and four attributes (ubiquitous, trendy, entertaining, and concise) related to the 'snack culture'.

The effects of access and skills on student success

The ability to, and quality of, Internet access are equally important in determining student outcomes. In a study exploring Internet usage and communication competence, Lee, Park & Hwang (2015) found significant differences between consumer groups with "different network connection types across demographic lines, different levels of Internet usage, and different communication competences", with access and skill gaps being barriers to active engagement in online activities. These have an overlapping effect on the digital divide, the concept of

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unequal access to digital technologies and broadband, and how this affects digital competencies and choices (Horn & Rennie, 2018; Gunkel, 2003; Van Dijk, 2006).

Alam & Mamun (2017) studied the causal effect of household access to broadband Internet on individuals' labour market outcomes in an Australian rural and regional context, but found the causal effect was not statistically significant. However, in a study in rural Ohio, Khan *et al.* (2020) found demographics, Internet access, and digital skills can shape online contributions to the community, particularly for health, employment, education, and social media. Chakraborty *et al.* (2018) used a predictive model to measure the impact of fibre-optic broadband speeds on communities. They found it is possible to identify the differing economic impacts related to town size and local geographies as regards the broader benefits of broadband infrastructure. While each town is different, "broadband expansion" has "great potential to improve" economic conditions (Chakraborty *et al.*, 2018). People's attitudes, the Internet of Things, and skills are important factors affecting acceptance and use (de Boer, van Deursen & van Rompay, 2019).

Arpaci, Al-Emran & Al-Shafiri (2020) used a cross-cultural comparison of 380 Malay and 160 Turkish engineering students to study digital skills, knowledge management practices, and the acceptance by engineering students of MOOCs. This showed knowledge management practices, including access, storage and application, positively impact perceived usefulness; and knowledge sharing positively and significantly impacts perceived ease of use. Hampton *et al.* (2021) studied Internet access, digital skills, and media use related to rural student outcomes. They considered standardized exams ('SAT') outcomes, and a survey of rural Michigan students in grades 8-11; and found rural students with home broadband Internet access were more focused on schooling, completed homework more often, and achieved higher SAT grades.

Aydin (2021) undertook a study to identify the variables now causing the digital divide, utilising a sample of Korean and Chilean students taken from the participating countries of the International Computer and Information Literacy Study. The socio-demographic characteristics of the students was examined in the context of ICT literacy. This found two factors significantly affecting student outcomes were the parents' level of education (Chile), and Internet connection (Korea). As Arslantas & Gul (2022) confirm, for students with any level of impairment – visual considered by those authors – additional support may be required to enable the requisite level of digital literacy as well as access. Ensuring the educators have the necessary skills will be critical to supporting those students, as is the need to ensure adequate access; and for universities to enable students in their engagements with course material.

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Methods

This is a mixed methods study, involving a literature review and analysis of quantitative and qualitative survey data (Leech & Onwuegbuzie, 2009; Creswell & Plano Clark, 2017). The ultimate structure of the study utilised the technology acceptance model ('TAM'), a theory modelling interaction between users and technology, including how users come to accept technology and put it to use (Davis, 1989), with a focus on the effectiveness of the technology during COVID-19 to carry out remote and self-directed learning.

Charness & Boot (2016) describe TAM as "one of the most influential models of technology acceptance, with two primary factors influencing an individual's intention to use new technology: perceived ease of use and perceived usefulness". Mois & Beer (2020) note TAM is "one of the most prominent models of technology adoption"; and Schöpfel & Azeroual (2021) posit it is the "most influential, most tested, and best-operationalized approach". TAM describes actual system use as the point where individuals accept and use a technology. Behavioural intention (BI) is the factor leading individuals to use the technology. Users' attitudes (general impression of the technology) (A) influences BI. Other influencing factors include social influence and organisational influence.

This study focuses on two TAM factors influencing technology acceptance and use:

PU: the degree to which a person believes using a particular system would enhance their job performance; and

PEOU: the degree to which a person believes using a particular system would be free from effort (Davis, 1989).

Procedure

The study sought to understand and correlate technologies' effectiveness to TAM PU. It was delivered in two overlapping stages:

Stage 1 engaged with relevant literature. This noted the over-riding emphasis promoting the notion that technology is important for improving student learning outcomes. However, this is predicated on the belief students' engagement with technology for entertainment and social media correlates with their desire to engage with technology for learning purposes.

Stage 2 delivered the 2020-21 Survey, sought to test extant literature, and to specifically address TAM PEOU. A questionnaire[i] was developed containing a mix of Likert-scale, multiple-choice, and open-ended questions. Key Survey was used for data collection. Recruitment emails were sent in approximately semester week four, and reminder emails sent

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approximately five to six weeks later. Incomplete surveys, where participants did not click to submit, were excluded from analysis.

The 2020-21 Survey replicated and expanded the 2013 Survey, by including many of questions it asked; and delivering it to the same cohorts at QUT; and by including questions relevant to Internet access and different cohorts at RMIT University (RMIT). The 2013 Survey, delivered during July-August 2013, sought to test assumptions about student's technology engagements (Prensky, 2001; Barnes & Tynan, 2007). Results, while constrained by limited participants (98; only 92 were usable for current purposes), were consistent with then extant literature.

Participants

Potential participants were identified by enrolment status. The selected cohorts were QUT's law and justice students; and RMIT's law and engineering students; who were in their first semester of university study in semester 2 (July to November), 2020 or semester 1 (February to June), 2021. For analysis purposes, noting similarities between law and justice (L&J) programmes' delivery methods, responses from those participants are considered collectively. During the project, QUT's students were able to attend campus and had the option of in-person classes; RMIT's students were unable to attend campus due to lockdowns.

In 2020-21, participants identified as being female 51%, and male 46%; with 3% preferring not to identify. L&J students were predominantly female (74%) and Engineering students were predominantly male (72%). The L&J participant demographics were similar to 2013 participants: female 70%; male 28%; with 2% choosing not to identify (Table 1).

Table 1. Participant Demographics

	Female	Male	Prefer not to identify
2013 Survey	70%	28%	2%
2020-21 Survey			
L&J	74%	24%	2%
Engineering	25%	72%	4%
Total	51%	46%	3%

Data analysis

The data from the two deliveries was combined and analysed on a question-by-question basis. Responses from the L&J and Engineering cohorts were compared against each other. Due to the limited number of survey responses, and the resulting small differences between cohorts, the Kolmogorov-Smirnov test (Chakravarti, Laha & Roy, 1967) was used to compare distributions of results.

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Limitations

The project had five limitations.

Limitation 1: The project originally was to be undertaken in a normal environment: RMIT's students would be on campus; and QUT's students would be a mix of on-campus and online, thus providing distinct responses from on-campus vs online cohorts for analysis purposes. COVID-19 lockdowns resulted in most participants being 'online' for the project's duration. This impacted data available for comparison.

Limitation 2: QUT's university-wide organisational restructure, resulted in one internal cohort not receiving invitations to participate in the 2021 delivery. This reduced the number of potential participants.

Limitation 3: It appears the invitation link was 'shared' with non-eligible students. Twelve participants identified as not undertaking any eligible degree and were excluded. This reduced the responses available for analysis.

Limitation 4: Only 115 usable responses (of 127) were obtained. The low response rate impacts data reliability. However, as reflected in extant literature (O'Sullivan, 2018; Ifinedo, Pyke & Anwar, 2018), a low response rate is still meaningful in furthering our understanding of relevant issues.

Limitation 5: The universities' normal delivery methods, which may attract students, may have influenced participants' experiences. QUT's delivery has always included distance or online delivery. RMIT's delivery has included using online materials.

2020-21 Findings

The analysis of the 2020-21 Survey is grouped according to the devices owned or accessed; participants' technological background; devices used in lectures; devices used in tutorials; study and personal uses; and COVID's impacts on lectures and tutorial formats. Qualitative responses are analysed separately.

Devices owned and/or accessed

To understand engagements, we sought to understand what devices participants owned or had access to, and which they would be prepared to use for their studies. All owned a mobile phone (Q7. Do you own a mobile phone?). Two participants – one L&J, one Engineering – indicated they did not own a smart phone (Q8. Is your mobile phone a smart phone?) but had access to a smart phone (Q10). We also asked what other smart devices participants owned or had access to, and which they used for study or learning:

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- Q9. Do you own any other electronic/smart devices?
  Tablet/iPad, Laptop, Desktop, iPod (with Internet), Other
- Q10. What are all the electronic/smart devices you have access to?
  Tablet/iPad, Smart phone, Laptop, Desktop, iPod (with Internet)
- Q11. What electronic/smart devices do you use for study/learning?
  Tablet/iPad, Smart phone, Laptop, Desktop, iPod (with Internet), Other

Almost all owned a laptop. The two students (1 L&J; 1 Engineering) who reported not owning a laptop, each had access to both a laptop computer and a desktop computer. Ninety-three percent of participants (L&J 90%; Engineering 96%) reported using a laptop for study or learning. Although all had access to a smart phone, only 47% (L&J 50%; Engineering 43%) used it for study or learning. Participants reported using a Tablet/iPad for studying or learning 21% (L&J 11%; Engineering 10%); and a desktop computer 30% (L&J 35%; Engineering 25%).

We also asked about device preferences:

- Q37. If you had access to a smart device, would you use it for study/learning purposes? Yes–always, No–never, Sometimes, Maybe, Unsure
- Q38. If you had access to an electronic/smart device for study/learning purposes, which device would you prefer to use?
  Tablet/iPad, iPod (with Internet), Desktop, Laptop, Other

Participants used a device always or sometimes for study, if one were available. In total, 72% (L&J 76%; Engineering 67%) said they would always use a smart device and 25% (L&J 23%; Engineering 27%) said they would do so sometimes. These preference distributions are very similar (Kolmogorov-Smirnov statistic 0.08), with the perceived usefulness of smart devices largely supported by both cohorts (Figure 1).

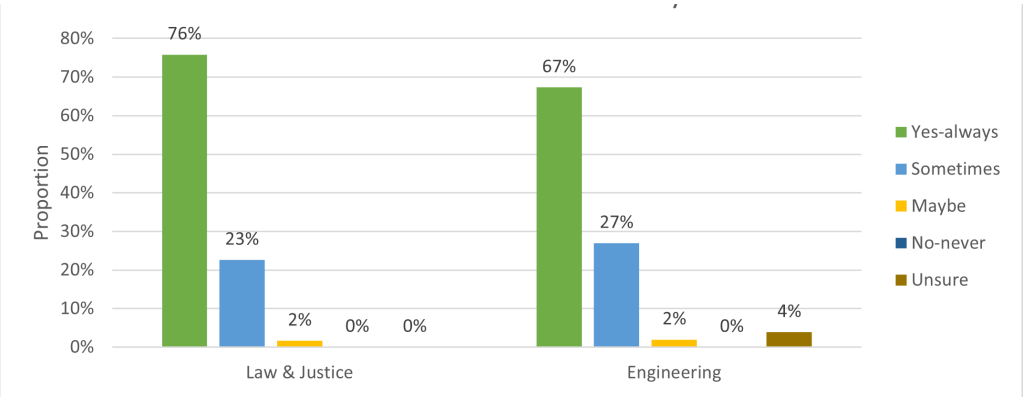

Figure 1. Preferences for use of smart devices for study

The laptop was strongly supported as the preferred smart device: 71% (L&J 76%; Engineering 66%). The desktop computer came next: 17% (L&J 15%; Engineering 21%), then tablets: 11% (L&J 10%; Engineering 13%). Again, the differences in preferences between the cohorts was

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small (Kolmogorov-Smirnov statistic 0.10). The results suggest the perceived ease of use of laptops and desktops – devices with large screens and physical keyboards – is greater than for other devices (Figure 2).

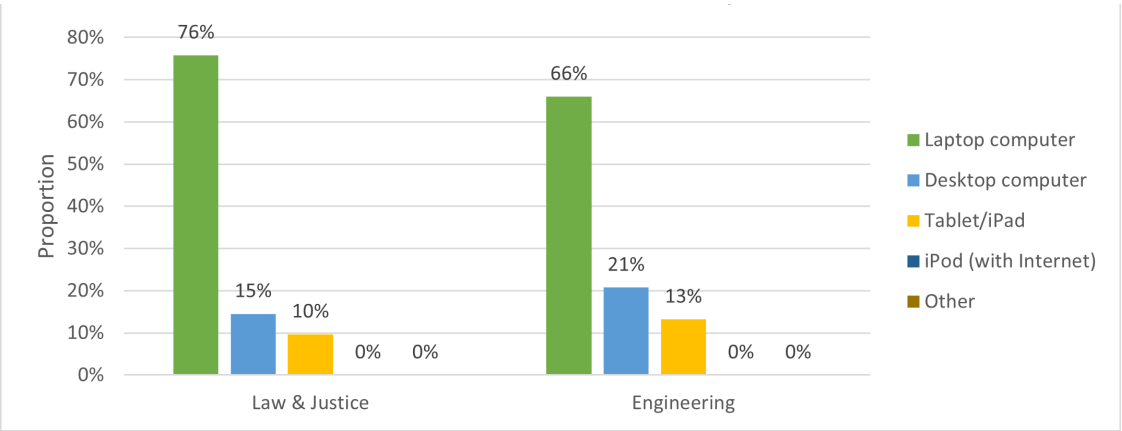

Figure 2. Preferred smart device for study

Students' technological backgrounds

To gauge prior (and recent) exposure to educational-related technologies, participants were asked to identify what they were doing on the same date last year. This was school 38%; university 23%; gap year 10%; working 25%; and other 4%. This is comparable to 2013 Survey participants (Table 2).

Table 2. Participant History

	School	University	Gap Year	Working	Other
2013 Survey	30%	27%	4%	27%	11%
2020-21 Survey	38%	23%	10%	25%	4%

To understand whether familiarity with a particular technology led to a more positive attitude towards its use, participants were asked about the use of smart devices in tutorials and face-to-face lectures:

- Q23. Please indicate the level to which you agree with the following statement – The use of electronic/smart devices in tutorials helps me understand the material presented.
- Q34. Please indicate the level to which you agree with the following statement – The use of electronic/smart devices in face-to-face lectures helps me understand the material presented.

For tutorials, the results are presented in Figure 3. Scoring the preferences numerically (*Strongly agree* = 2; *Agree* = 1; *Neutral* = 0; *Disagree* = -1; *Strongly disagree* = -2) and dividing by the number of responses gives very similar average results for L&J (1.12) and Engineering (1.12). Familiarity does not seem to lead to greater acceptance. The Kolmogorov-

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Smirnov statistic calculated from the L&J and Engineering preference distributions is 0.05, suggesting the two cohorts are quite similar.

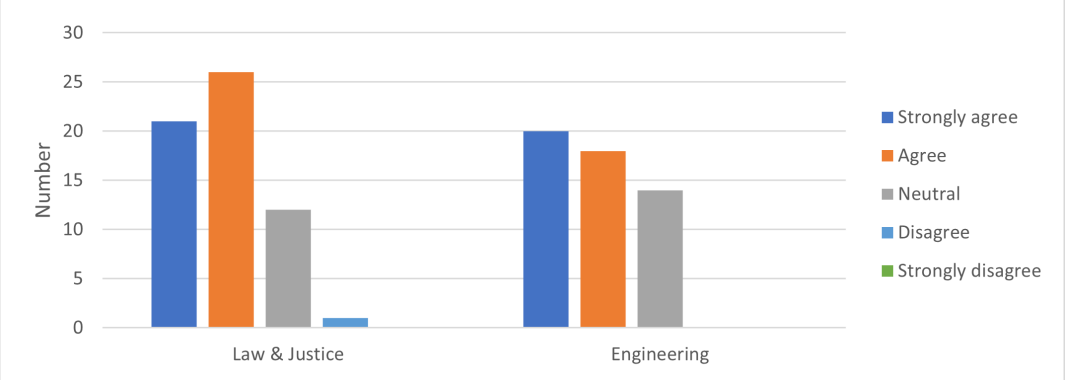

Figure 3. Strength of preference for use of technology in tutorials

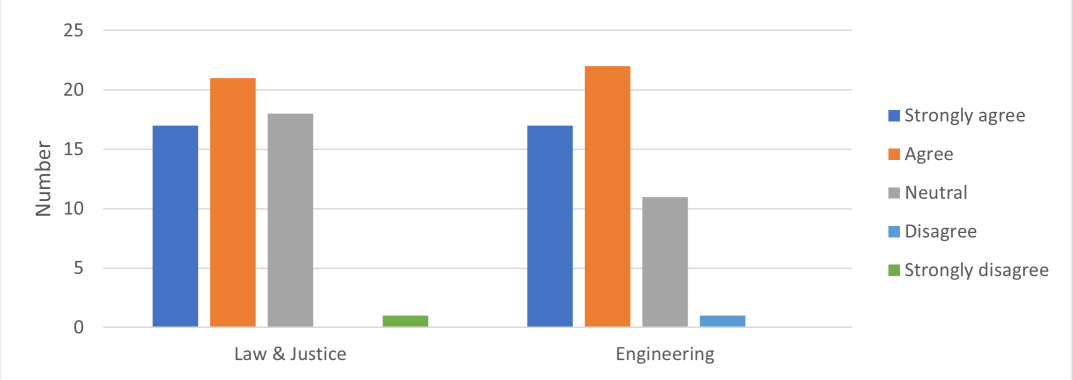

Figure 4. Strength of preference for use of technology in face-to-face lectures

The results for face-to-face lectures are depicted in Figure 4. Using the same scoring scheme gives more separated average results: L&J 0.93; Engineering 1.08. The Kolmogorov-Smirnov statistic between the L&J and Engineering distributions is 0.10, suggesting the cohorts are less similar in the lecture-preferences than in their tutorial-preferences case. The differences, however, may be influenced by course materials. The team's own experiences are that engineering lecture materials may more naturally lend themselves to more direct technological demonstrations, leading to increased technology use by lecturers.

Use in lectures

Participants were asked about their smart device use during lectures, and whether they took hand-written notes:

- Q27. In lectures, do you use your electronic/smart device for study/learning? Yes–always, No–never, Sometimes, Maybe, Not applicable (if not attending face-to-face lectures)
- Q28. Please indicate the level to which you agree with the following statement – I use my smart device in lectures for personal purposes.

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- Q29. In face-to-face lectures or in listening to lecture recordings, do you use electronic/smart devices and also make notes by hand writing?
  Yes–always, No–never, Sometimes
- Q30. [Only for those answering No to Q29] In face-to-face lectures or in listening to lecture recordings, do you only make notes by hand writing? Yes, No.

Most who attended lectures (16% did not: L&J 18%; Engineering 13%) reported using their smart devices for learning during the lecture. Of these 80% (L&J 82%; Engineering 78%) always used their devices in lectures for learning; with 18% (L&J 14%; Engineering 22%) using sometimes; and 2% (all L&J) not using. Device accessibility, however, may be distracting as 16% (L&J 15%; Engineering 17%) strongly agreed they also used devices for personal purposes; and 35% (L&J 39%; Engineering 30%) agreed (Figure 5).

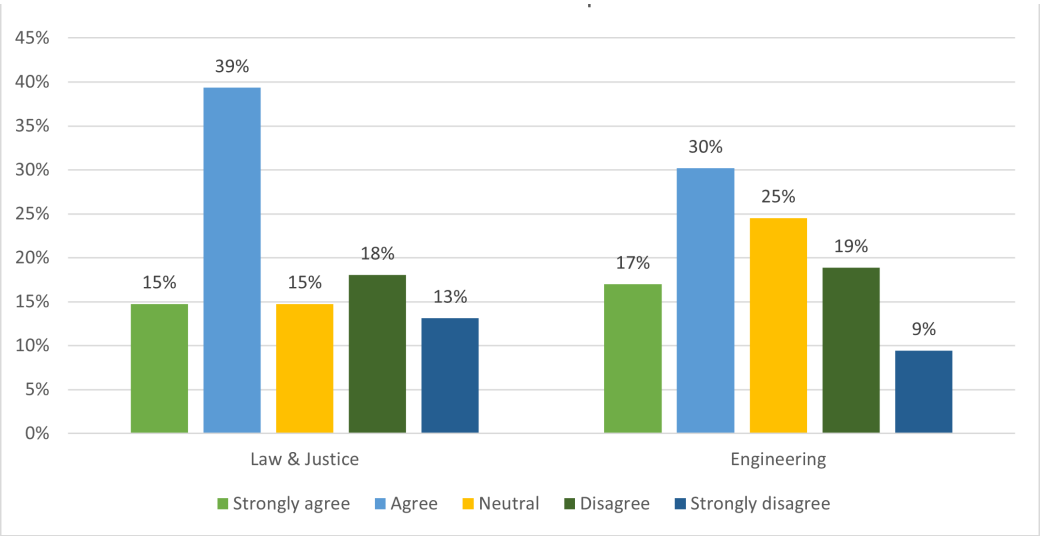

Figure 5. Use of devices for personal purposes in face-to-face lectures

While 23% (L&J 27%; Engineering 19%) said they used both devices and made notes by hand, none used handwriting alone. It appears handwritten notes are an adjunct to notes taken on a device.

Participants were asked to identify the devices and applications their lecturers used in face-to-face lectures:

- Q31. Do your lecturers use any electronic/smart device/s for teaching purposes?
  Yes–always, No–never, Sometimes, Not applicable (if not attending face-to-face lectures)
- Q32. What electronic/smart device/s do your lecturers use in class for teaching purposes?
  Tablet/iPad, Smartphone, Laptop, Desktop, iPod, None, Not applicable (if only listen to pre-recorded lectures), Other

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- Q33. What do your lecturers use the electronic/smart device/s to do in class? Powerpoint, Legislation, Blackboard, Canvas, Not applicable (if only listen to pre-recorded lectures), Other

Very few participants attended face-to-face lectures, and 37% (L&J 48%; Engineering 25%) reported only listening to pre-recorded materials. This reflects teaching rearrangements due to lockdowns. Where participants did attend, 95% reported lecturers used smart devices always or sometimes. The proportion was higher in Engineering (98%) compared to L&J (90%), presumably, again, reflecting the difference in material being presented. (Table 3).

Table 3. Proportion of Students Reporting Frequency of Use of Smart Devices by Lecturers

	Yes-always	Sometimes	No-never
L&J	81%	9%	9%
Engineering	93%	5%	3%
Total	88%	7%	6%

Laptop and desktop computers were very commonly used by all lecturers. Tablets were more frequently reported as being used by Engineering academics than L&J academics. iPods were not used (Figure 6).

PowerPoint use was a dominant use by lecturers: 89% (L&J 88%; Engineering 90%) reported lecturers using this application. Fifty-three percent of L&J students reported lecturers used devices to access legislation. The 3% of Engineering students reporting access to legislation may indicate access to engineering standards. The use of two main online teaching platforms, Blackboard and Canvas, was reported by 54% and 49% of students, respectively. The frequency of use was quite different between QUT and RMIT students, reflecting differing preferences in the two institutions' technology platform of choice (Figure 7).

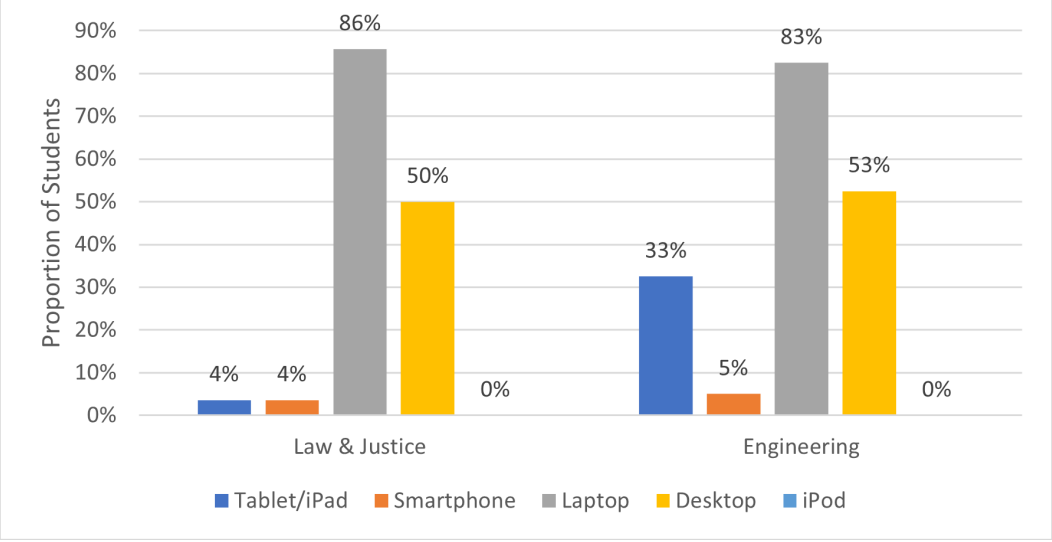

Figure 6. Proportion of participants reporting devices used by lecturers

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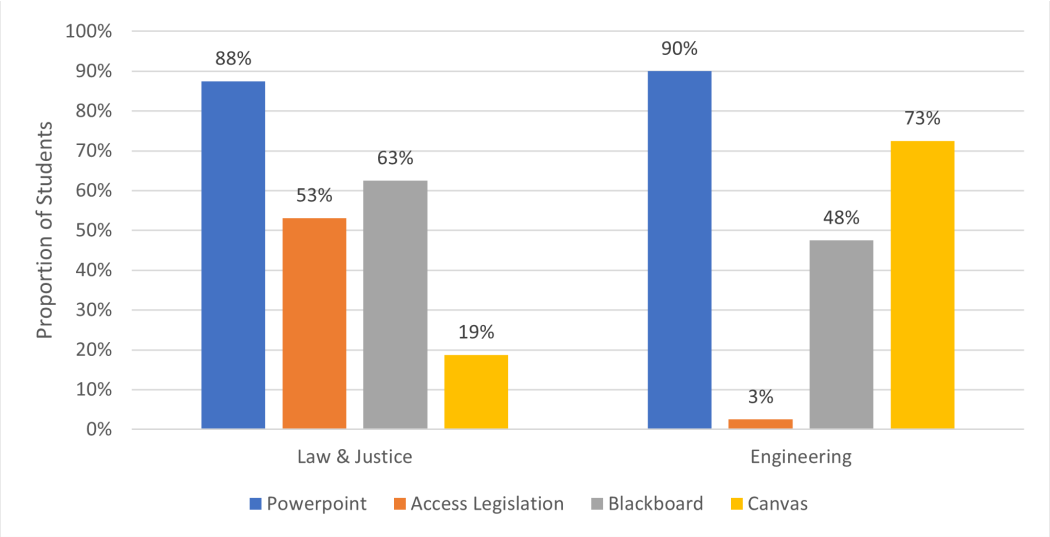

Figure 7. Proportion of participants reporting applications used by lecturers

Use in tutorials

It was assumed all participants were required to engage in tutorials. Participants were asked about device use in tutorials:

- Q16. In tutorials, do you use your electronic/smart device for study/learning? Yes–always, No–never, Sometimes
- Q17. Please indicate the level to which you agree with the following statement – I use my smart device in tutorials for personal purposes.
- Q18. In tutorials, do you use electronic/smart device/s and also make notes by hand writing? Yes–always, No–never, Sometimes
- Q19. [Only for those answering No to Q18] In tutorials, do you only make notes by hand writing? Yes, No.

For study purposes, 80% of students (L&J 79%; Engineering 81%) indicated they always used smart devices and 17% (L&J 15%; Engineering 19%) sometimes. Only 3%, all L&J students, indicated they never used a smart device in tutorials. The potential for devices to be distracting, while present, was comparable to lecture use: 14% (L&J 13%; Engineering 15%) indicated they strongly agreed, and 35% (L&J 34%; Engineering 36%) agreed, to use of smart devices for personal purposes in tutorials (Figure 8).

Handwriting notes in tutorials is slightly more common than in lectures: 30% (L&J 32%; Engineering 26%) indicated they never used both a device and handwriting and, of these, 15% (L&J 10%; Engineering 21%) used only handwriting. This means 4% of students (L&J 3%; Engineering 6%) use handwriting alone, as opposed to lectures when handwriting was never used alone.

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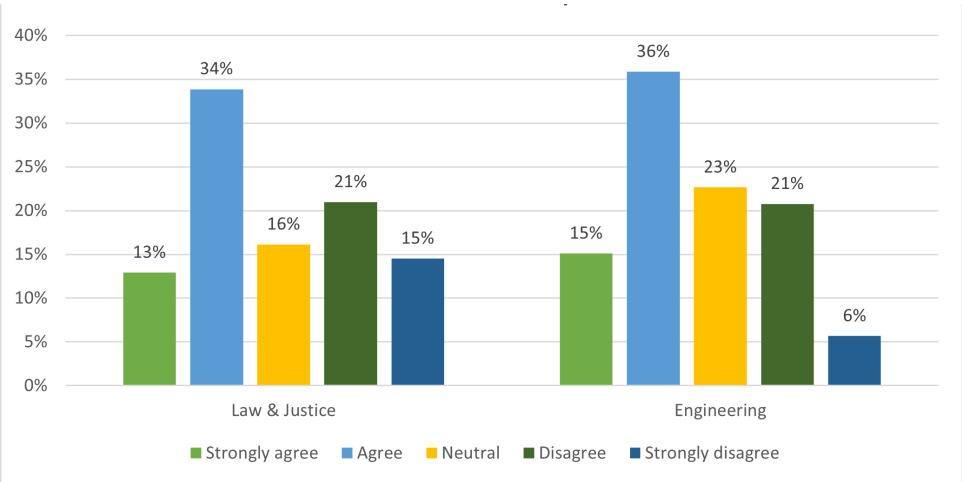

Figure 8. Use of devices for personal purposes in tutorials

Participants were asked how tutors used smart devices and applications in tutorials:

- Q20. Do your tutors use any electronic/smart devices in class for teaching purposes?
  Yes–always, No–never, Sometimes, Not applicable (if not attending tutorials)
- Q21. What electronic/smart device/s do your tutors use in class for teaching purposes?
  Tablet/iPad, Smartphone, Laptop, Desktop, iPod, None, Not applicable (if only listen to pre-recorded tutorials), Other
- Q22. What do your tutors use the electronic/smart device/s to do in class?
  Powerpoint, Blackboard, Canvas, Legislation, Accessing tutorial questions or materials, Not applicable (if only listen to pre-recorded tutorials), Other

COVID-related restrictions appear to have affected tutorial attendance: 10% (L&J 13%, Engineering 6%) reported not attending face-to-face tutorials. However, it must be noted many of QUT's first-year units provide students with the ability to attend a synchronous tutorial and access tutorial recordings. Participants who did attend tutorials, mainly reported tutors used smart devices always or sometimes (92%). The proportion was higher in Engineering (96%) compared to L&J (89%), again, presumably, reflecting the difference in material being presented (Table 4).

Table 4. Proportion of Students Reporting Frequency of Use of Smart Devices by Tutors

	Yes-always	Sometimes	No-never
L&J	65%	24%	11%
Engineering	80%	16%	4%
Total	72%	20%	8%

As in lectures, laptop and desktop computers were commonly used by tutors. Tablets were more frequently used for Engineering than L&J, and iPods were not used (Figure 9).

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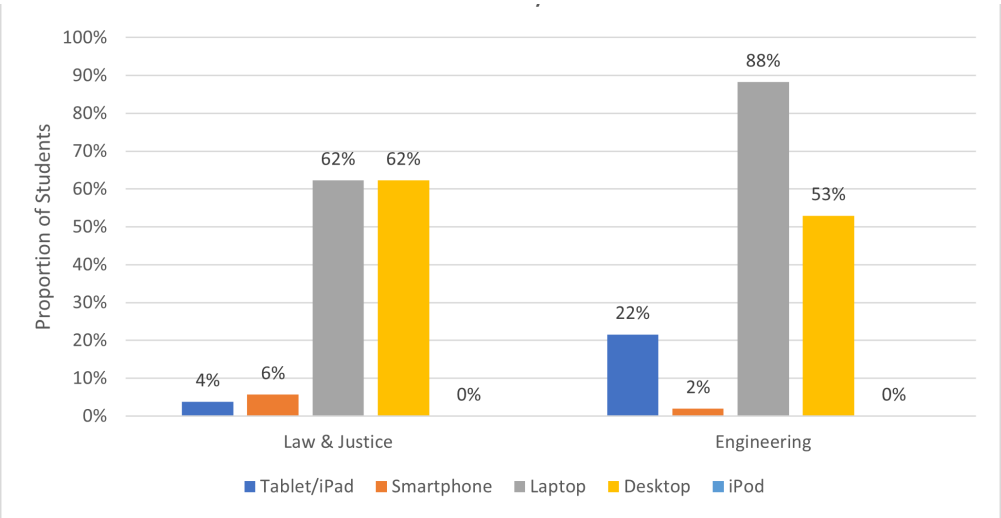

Figure 9. Devices used by tutors

PowerPoint was a dominant application: 80% (L&J 75%, Engineering 84%) reported tutors' use. The two main teaching applications, Blackboard and Canvas, were reported to be used by 48% and 43% of students, respectively. What tutors accessed differed: 60% of L&J students reported tutors used devices to access legislation. No Engineering student reported legislation access (Figure 10).

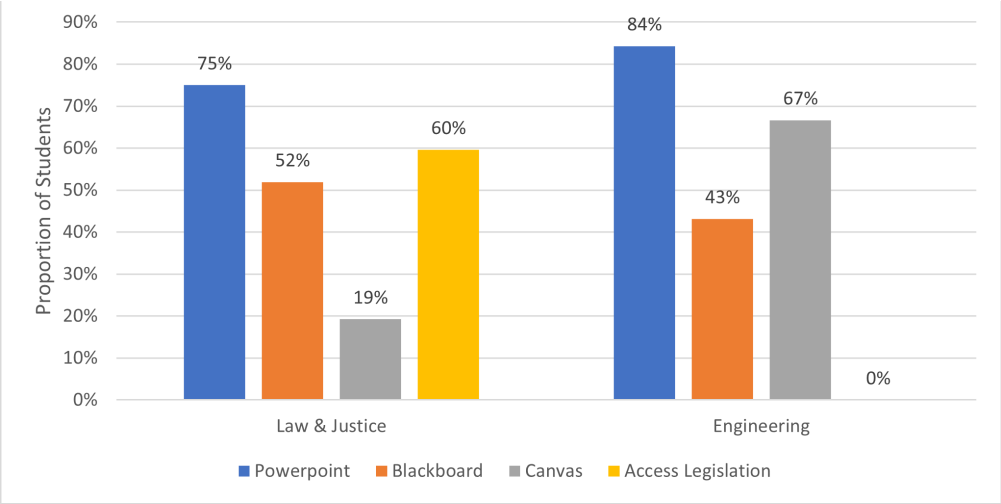

Figure 10. Applications used by tutors

Differences between study and personal use

We asked participants about the common applications used for teaching:

- Q40. I have used the following systems for study/learning purposes: Blackboard, Canvas, Echo360, Zoom, Collaborate Ultra, Teams, Other.
- Q41. I feel comfortable to use the following for study/learning purposes: Blackboard, Canvas, Echo360, Zoom, Collaborate Ultra, Teams, Other.
- Q42. I feel comfortable to use the following for private/personal purposes: Blackboard, Canvas, Echo360, Zoom, Collaborate Ultra, Teams, Other.

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- Q43. What additional support do you need so that you feel comfortable to use the following technology?
  Blackboard, Canvas, Echo360, Zoom, Collaborate Ultra, Teams, Other, No additional support required; I feel comfortable in using all of the above, Support required.

The responses uncovered significant differences between how the cohorts viewed these applications for study purposes and for private use (Table 5). For those who had previously used an application, there was a high degree of comfort with using the application for study purposes. Of the applications listed, the one providing least comfort was Microsoft Teams (78%). This suggests participants have become familiar enough with the main teaching applications to be comfortable with their use.

Table 5. Reported Comfort Levels in Using Apps

Application	Used App and Comfortable to use it for Study Purposes	Comfortable to use App for both Study and Personal Use
Blackboard	92%	25%
Canvas	93%	28%
Echo360	87%	22%
Zoom	86%	83%
Collaborate Ultra	91%	26%
Teams	78%	62%

Source: Column 2: Q40 & Q41; Column 3: Q41 & Q42

In contrast, engaging with the results for comfort to use the apps for both study and personal purposes, the number of participants who reported being comfortable with an app for both study and personal purposes is considerably lower. Zoom proved popular, as 83% of participants reported being comfortable to use it for both purposes, probably because it is the app of choice for social get-togethers during lockdowns. Microsoft Teams also rated relatively well (62% combined comfort level), probably because of its widespread take-up in the corporate environment.

The others – Blackboard, Canvas, Echo360 and Collaborate Ultra – all had combined comfort levels below 30%. The reasons for any difference in use between these tools was not explored in the survey questions. Although these also are collaboration tools, being more identified with the education environment, unlike Zoom and Teams, it can be speculated these are not recognized as being of use in other settings. There may also be an underlying perception that users are not as in control of their data and usage when engaging with those tools.

Two engineering students also reported using Discord, which is a relatively new collaboration tool.

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COVID's impacts on lecture and tutorial formats

Participants were asked about lecture formats:

- Q24. How do you usually attend lectures?
  I attend synchronous lectures, I listen to pre-recorded lectures, I listen to recordings of synchronous lectures, I do not attend lectures.
- Q25. Did you attend or listen to a lecture/s today? Yes, No.
- Q26. What was the format of that lecture?
  Synchronous online lecture, Synchronous face-to-face lecture, Pre-recorded lecture, Recording of synchronous lecture.

Only 3% (L&J 3%; Engineering 4%) did not usually attend lectures at all. For those who did attend lectures, there was a preponderance of listening to pre-recorded lectures (Figure 11). This may indicate a true preference for this presentation format, or it may be driven by convenience for the students, or it may indicate a COVID-19 effect.

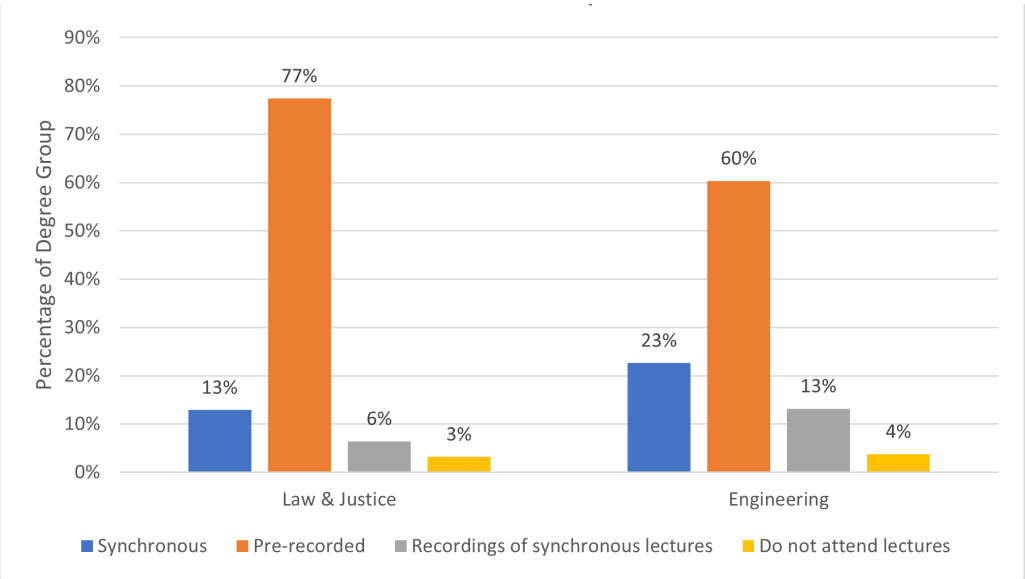

Figure 11. Reported lecture format usually attended

For those who attended one or more lectures on the day they completed the survey, the results were rather different (Figure 12). For L&J, there was mainly engagement with pre-recorded lectures. For Engineering, there was greater synchronous online attendance. This may indicate students prefer synchronous mode when it is online and convenient.

At both universities, because of COVID-induced rearrangements, there were few face-to-face lecture options available. L&J participants appeared to have preferred moving to only engaging with pre-recorded material, while Engineering participants showed a preference for the synchronous online format. However, comparisons with usual attendance should be treated with caution as participants had limited experience of university teaching.

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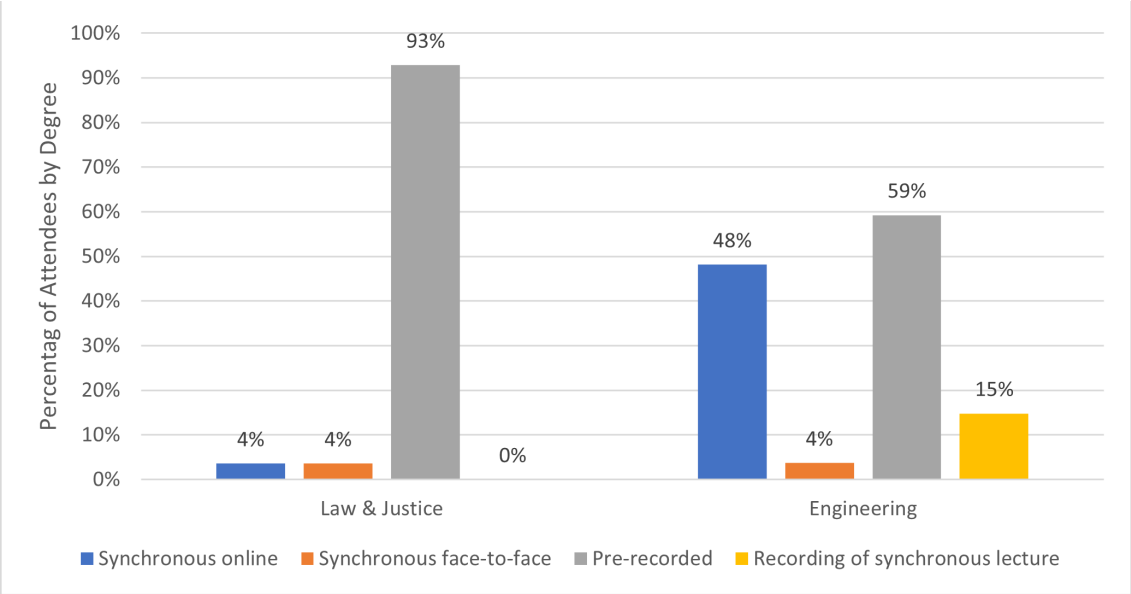

Figure 12. Reported format of lecture(s) attended on day of completing survey

We asked similar questions about attendance at tutorials:

- Q13. How do you usually attend tutorials?
  I attend synchronous online tutorials, I attend synchronous face-to-face tutorials, I listen to pre-recorded tutorials, I listen to recordings of synchronous tutorials, I do not attend tutorials.
- Q14. Did you attend or listen to a tutorial/s today? Yes, No.
- Q15. What was the format of that tutorial?
  Synchronous online tutorial, Synchronous face-to-face tutorial, Pre-recorded tutorial, Recording of a synchronous tutorial.

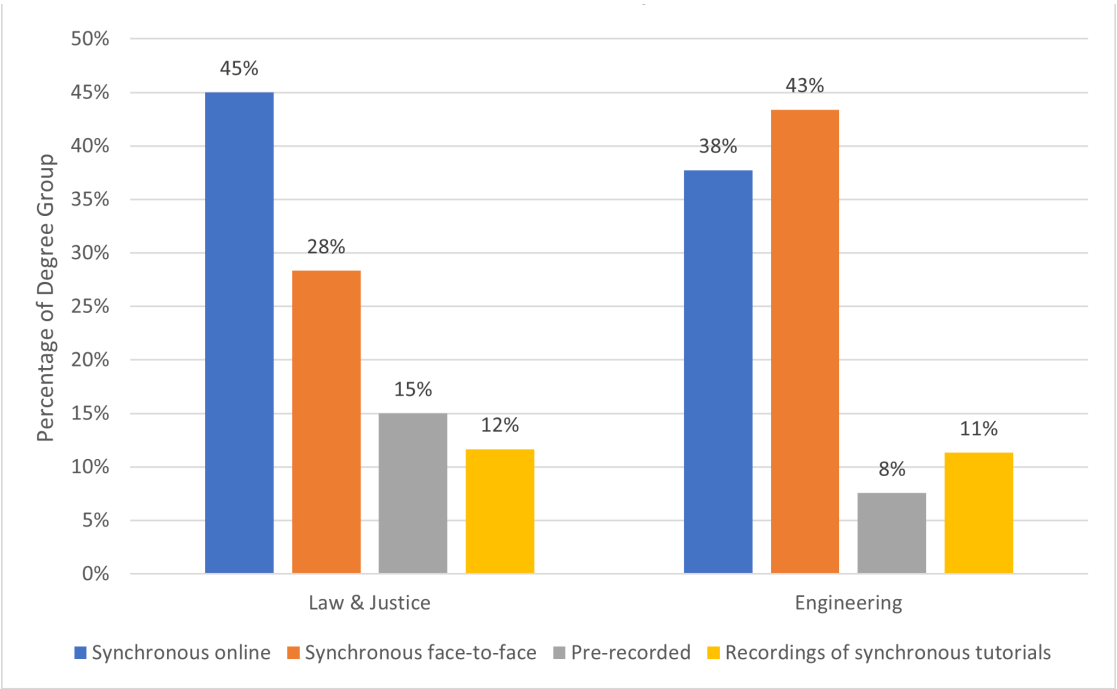

Figure 13. Reported tutorial format usually attended

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Two L&J students reported not attending tutorials, but most participants reported attendance, with a clear preference for (or, at least, practice of) a synchronous mode (Figure 13). The division between pre-recorded, and online or face-to-face, presumably depends on convenience and availability.

For those attending tutorials on the day of the survey, the results were relatively usual for L&J participants, but significantly more online for Engineering (Figure 14). Engineering participants had some face-to-face classes available, but many had converted to online.

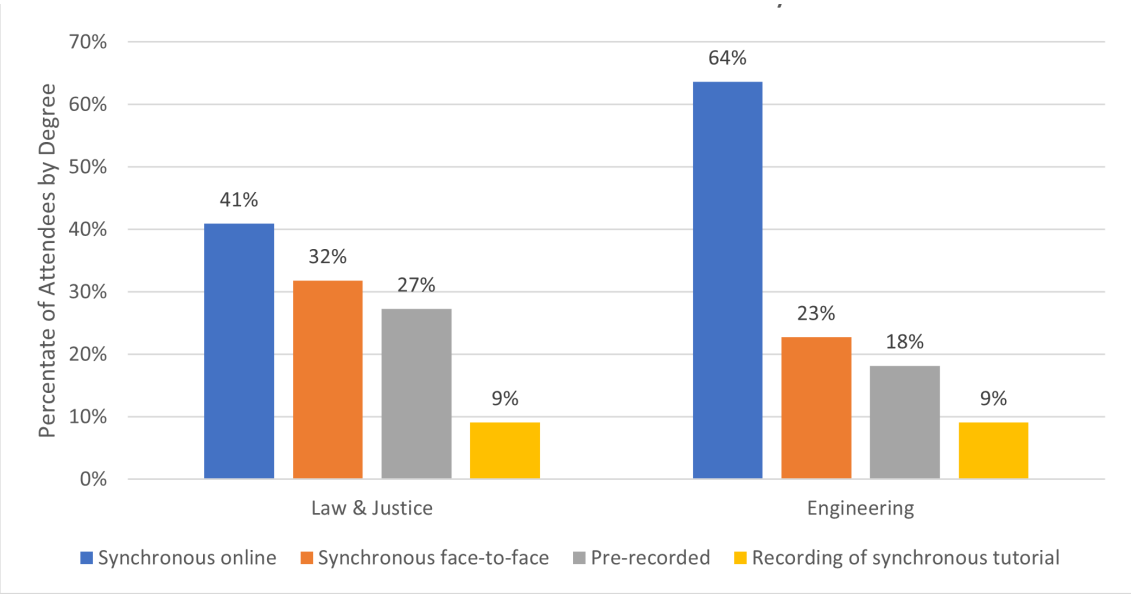

Figure 14. Reported format of tutorial(s) attended on day of survey completion

Overall, there is a common practice of listening to pre-recorded lectures, either out of study preference or convenience, with only 17% (L&J 13%; Engineering 23%) attending in some synchronous mode. In comparison, for tutorials the predominant practice remains a synchronous mode (77%), whether online or face-to-face. It appears also participants were able to move relatively easily to online format when the face-to-face option was suddenly taken away, as occurred when new lockdowns were announced.

Qualitative responses

Certain questions enabled participants to make free text comments: Q35, Q36 and Q37 yielded nothing useful, as most did not select the 'other' option; Q39 provided an opportunity for general comments; and Q43 specifically sought details of extra support needed for specific applications. Within the comments received, apart from general support for smart devices and technology, some themes were identified:

- Technology performance: complaints about slow Internet connections; complexity of or difficulties in using specific devices; and a lack of ability in tutors to use technology effectively.

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- Handwriting (perhaps triggered by earlier questions): comments both for and against the use of handwriting and the alternative of typing.
- Distraction: comments about how smart devices can also be used for personal purposes that may distract from study.
- Introductory guides: the need for, or the desirability of, how-to guides or introductory information on how best to use new applications.

One participant shared they had no hand function as the result of a spinal-cord injury, and, as such, was provided with a (human) notetaker by their university. The team thanks them for their openness. Their response is a salient reminder there will always be a proportion of students with limited physical ability to use smart devices, or interact with application interfaces, and for whom the human part of the technology equation is vital. In the broader context of engaging with available means to assist in "satisfying students' needs" (Chiu, 2021), it is important to remember that, for any student with any level of impairment, the additional support required will be more than merely digital (Arslantas & Gul, 2022).

Comparison to 2013 Survey

The 2013 Survey found all participants owned a mobile phone, with 95% of these being smart phones; and 89% owned a laptop computer, with 92% at least having access to one. However, while 89% of those participants utilised laptop computers for study purposes, only 43% engaged smart phones for this purpose. In-class use of devices for study purposes was limited (Cradduck, 2013). The combination of these results indicates the personal value of a device does not automatically correlate with its potential for enhanced learning.

There are clear differences between the 2013 and 2020-21 Surveys in preferences for using devices. On using smart devices for study purposes, the same question was asked in both surveys:

- Q37. If you had access to a smart device, would you use it for study/learning purposes? Yes–always, No–never, Sometimes, Maybe, Unsure

The difference in results, examined by engaging with L&J responses only, is shown in Figure 15 (cf. Figure 1).

These results reflect a shift in preference for use: in 2013, 89% of participants chose always or sometimes, which had increased in 2020-21 to 98%. The Komogorov-Smirnov statistic is 0.17, indicating the two distributions are substantially different. These results suggest the perceived usefulness of smart devices has increased over time.

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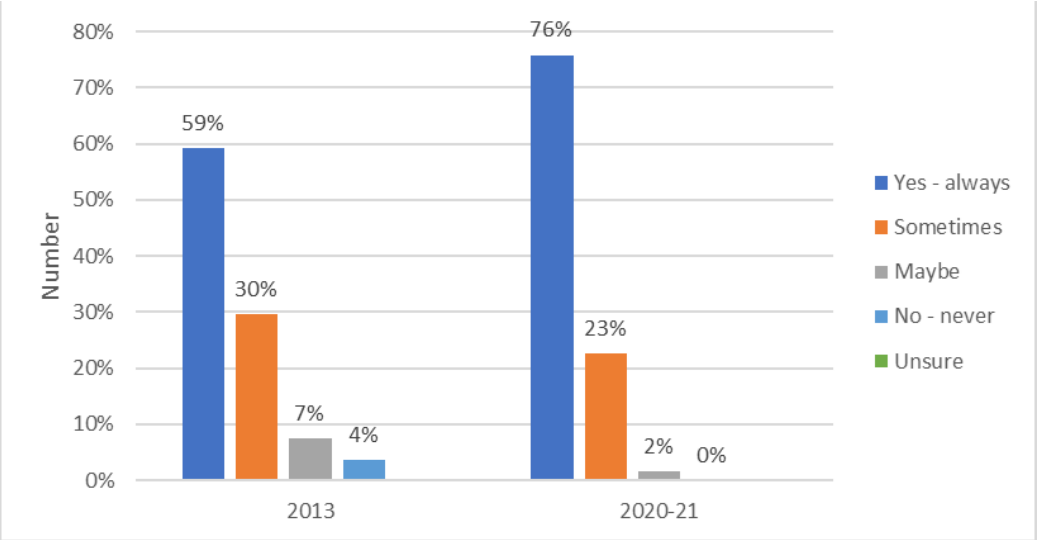

Figure 15. Comparison of L&J preferences for using devices for study

Concurrently, the level of scepticism appears to have grown regarding the perceived usefulness of academic use in lectures (cf. Figure 4). Both surveys asked participants:

- Q34. Please indicate the level to which you agree with the following statement – The use of the electronic/smart devices in face-to-face lectures helps me understand the material presented.
  Strongly agree, Agree, Neutral, Disagree, Strongly disagree

In 2013, 90% of participants strongly agreed or agreed to the proposition that the use of smart devices in lectures aids understanding; by 2020/2021, those responses had dropped to 67%. The Kolmogorov-Smirnov statistic is 0.25, indicating the two distributions are quite dissimilar. It appears familiarity in this case leads to greater discontent (Figure 16).

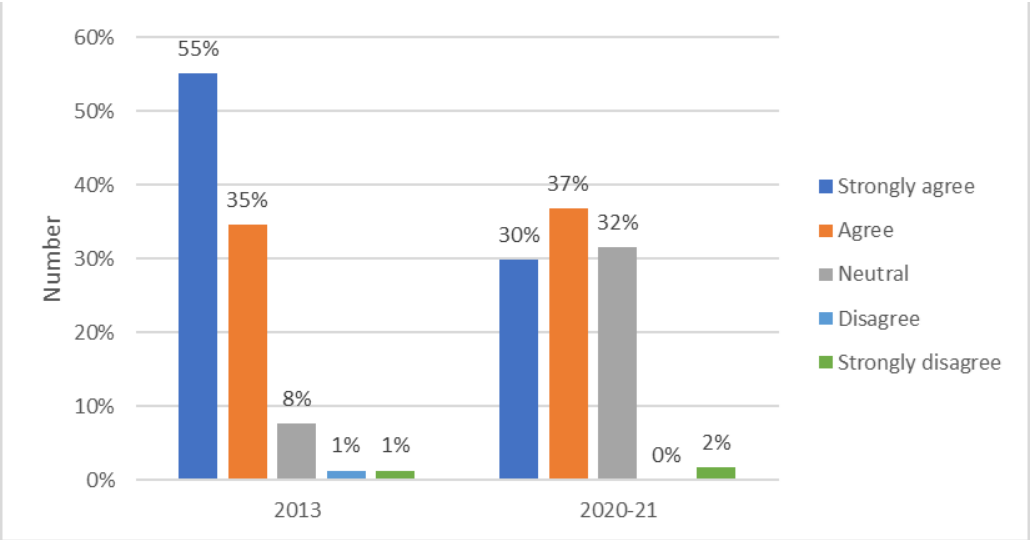

Figure 16. Comparison of L&J preferences for using technology in lectures

The picture is less clear in the perceived usefulness of using smart devices in tutorials. The comparative results for the same question about use in tutorials (Q23) are shown in Figure 17.

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There has been some shift towards greater acceptance: in 2013, 72% strongly agreed or agreed smart devices were useful in tutorials; in 2020-21, that proportion was 78%. The Kolmogorov-Smirnov statistic is 0.06, indicating the two distributions are quite similar.

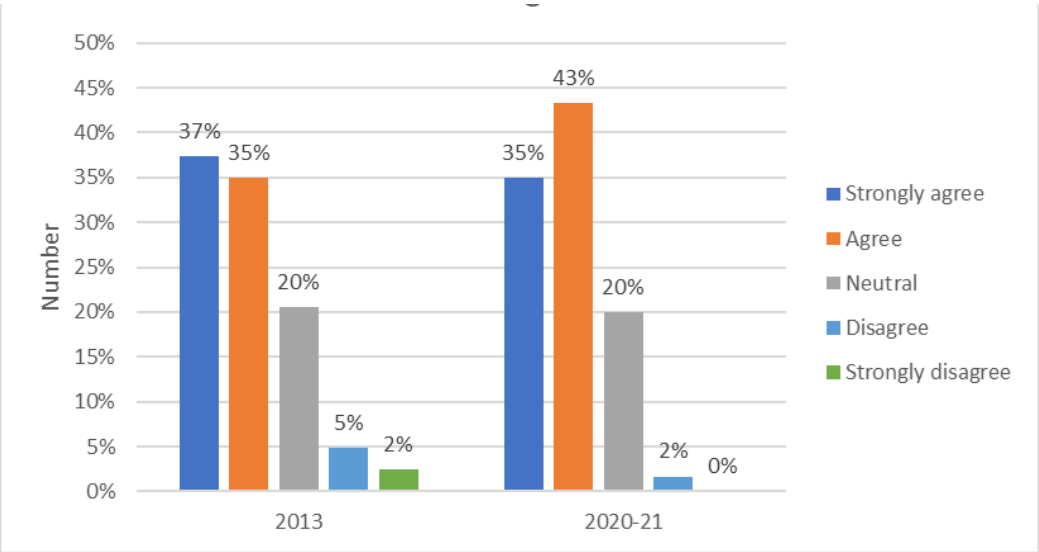

Figure 17. Comparison of L&J preferences for using technology in tutorials

Qualitative comments in the 2013 Survey support the quantitative findings, reflecting benefits gained from uses for learning purposes:

> "Using tablets are a great way to learn, especially in Lectures as you're able to view the powerpoint (if it's been posted) at your leisure and run over things there and then if you get confused, while also hand-writing notes".
>
> "Having a laptop and access to other devices makes it easy to access my learning resources".

This was consistent with 2020-21 Survey responses, which included:

> "Tablet is the best because you can both type and draw/handwrite digitally".
>
> "Research is easier and faster with an electronic/smart devices, and taking notes is also better through technology".

Other 2013 Survey participants identified concerns:

> "can often get distracted on the devices and therefore not pay attention to the lecturer or tutor and do not then fully understand the topic".
>
> "If cost of smart device and internet service is less expensive, I'll use more often and for wider purposes. Also concerned with battery life of device if used extensively."
>
> "I feel that it is imperative to write notes down while the lecture is taking place. My smartphone is too small to take notes on and my laptop too cumbersome. I will be

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> looking at purchasing a tablet form of technology for future study when the funds become available to me."

Some 2020-21 Survey participants identified similar concerns:

> "you have to be disciplined to not start using it for personal reasons and turn off notifications".
>
> "It'd be nice to have something to do handwritten working on. Taking photos of paper working is good and all, but it's stressful with a slow ass phone, that has issues with connectivity at times."
>
> "It's very hard as the screen is so small and requires holding the laptop for hours. Also the blue light... and there are often technological difficulties for the tutor. My classes are all around 5-8pm when my internet is slowest and it means that it frequently cuts out and I have to work out what I've missed."

Comparing 2013 and 2020-21 results indicates, while there were some concerns, smart devices support personal study and learning. Perceived usefulness in lectures and tutorials, however, is less clear. There is general support overall. However, support for using smart devices in lectures is waning, while, in tutorials, support is weakly improving. This warrants caution in introducing more technology into formal teaching, to best design the curriculum for engaged and enhanced learning purposes.

Discussion

The first research question sought to identify whether COVID-19 had changed students' engagement with technology when it is used for remote and self-paced learning. The 2020-21 Survey results reveal the answer is, overall, yes. In comparison to the 2013 Survey participants, proportionally more 2020-21 Survey participants identified as using devices for tutorial and lecture engagements. These results, however, are constrained by the fact that during COVID-19, when almost all university delivery was online, there was no alternative available.

The second research question sought to identify whether students believe available technology is effective for remote and self-paced learning. The results also reveal the answer to this question is yes. However, this also is qualified, as reflected in the qualitative comments, that some will require support in learning how to use the relevant systems; and others will require ongoing support (particularly regarding Internet access) in order to enable their use.

The 2020-21 Survey results highlight L&J and Engineering students appear equally engaged with their devices and technology for study and private purposes. There is a preference for listening to recorded lectures, but attending synchronous tutorials; and, not surprisingly,

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slow(er) Internet connections negatively affect students' ability to engage and therefore to learn. Importantly, perhaps arising from the universities' and or students' prior use/engagements with technology, issues relevant to emergency adoption measures in response to COVID-19, as seen in the impacts reported in other universities (Aguiler-Hermida *et al.*, 2021; Aguiler-Hermida, 2020), were not identified as being a concern for these cohorts.

What lessons can be drawn from these results for the approach to university teaching and learning? Although this is a modest project (O'Sullivan, 2018; Ifinedo, Pyke & Anwar, 2018), it spans two quite different disciplines, engages with university students facing differing direct impacts from COVID-19 (one university having to move completely online, the other being able to maintain a level of face-to-face teaching), and engages in comparison with data collected well before COVID-19 existed. The results from the 2020-21 Survey are consistent with extant literature, and also reinforce the 2013 Survey findings. As such, the current research adds to the literature and provides some useful general conclusions. The most obvious reflection is that most students now come equipped with at least the basic technology of a smart phone and a laptop computer. These devices, therefore, now can be assumed to be available; and, hence, are available to be used for learning purposes. Whether or not their use should be assumed for teaching is, perhaps, more problematical (McNeill, Diao & Gosper, 2011).

The 2020-2021 Survey results, however, show a clear difference in comfort levels for the use of certain applications for teaching or personal use. Applications that are not in widespread general use, such as Canvas and Blackboard, may be less acceptable if they intrude too much into students' personal activities.

On the other hand, the 2020-2021 participants appear to be confident in their ability to pick up and use new applications. No obvious skills gaps were identified in participants, with those who suggested support was required requesting a simple how-to guide to get them started. This suggests that less familiar applications should be able to be introduced with minimal guidance once trust in the application has been established.

Participants mostly all agreed technology has aided their learning in lectures and tutorials. There is some suggestion, however, that lecturers and tutors are not yet making the best use of available technologies. PowerPoint is a stand-out application, while specialized teaching applications are only identified in use by about half the students. While participants were reluctant to let teaching and learning activities intrude too much into their personal lives, they do let their personal lives intrude on teaching and learning, as a significant proportion reported using devices for personal matters during lectures and tutorials, which may be distracting from their studies. This is a feature to which pedagogy will need to adapt.

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There appears to be a clear, albeit not universal, acceptance of and engagement with synchronous online and recorded materials (Yazgan, 2022). As COVID-19 restrictions have lifted, this format may not be fully maintained in future. However, as students are discovering working from elsewhere is more convenient and efficient than attending campus, a level of pre-recordings is likely be a preferred option in the future. Importantly, for tutorials specifically, there is a clear preference for synchronous delivery, whether face-to-face or online. This supports the usual pedagogical view that interactions between students and with tutors is important for learning (Yazgan, 2022). Whether online or face-to-face tutorials are more effective is worthy of future study. Whether any continuation of online classes remains a reality only the future (and the constraints on universities) will tell.

Importantly, assumptions cannot be made about what any student's use will be, as the personal value of a device does not automatically correlate with its potential for enhanced learning. These findings reinforce the need to understand how students make use of technology for learning purposes, and to inform faculty staff on students' engagement of technology, to better design curriculum for engaged and enhanced learning purposes. Most importantly, the responses reinforce the fact each student is an individual deserving of individual attention and direct response to enable them in their engagements; and that students with any impairment will require additional support (Arslantas & Gul, 2022).

Conclusion

The 2020-21 Survey design was influenced by TAM (Davis, 1989), principally the two factors PEOU and PU. It was delivered across two diverse disciplines – L&J and Engineering – at two institutions to further understand student use of and preferences for smart, digital technology. Those results were compared with results from the 2013 Survey data.

Students by and large have embraced smart technologies, are confident in their use, and believe these add to the teaching and learning experience. In response to the COVID-19 crisis, Australian universities, including the two universities whose students were surveyed, generally had moved to online teaching. Participants seemed comfortable with this change, with the usual caveats about needing appropriate Internet connections and devices with suitable human factors. Synchronous tutorials, whether face-to-face or online, are still preferred, while there has been an acceptance of pre-recorded lectures.

In project planning it was expected students from a less technical background may be less enthusiastic about the use of technology in teaching. That expectation was not borne out, as data tended towards showing less technologically inclined participants were more enthusiastic about teaching technology. However, attitudes depended on where and when technology was

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used. There were, for example, greater privacy concerns when dealing with applications for personal use than in using the same applications for teaching and learning.

While most students can access smart phones and laptops, how much these devices should be used for teaching is still an open question. A more detailed examination of students' reluctance in certain engagements would be worthwhile. Indeed, as the whole landscape of students' background and familiarity with new technologies and applications is ever evolving, it would be beneficial regularly to survey students on experiences and attitudes to assist pedagogy to adapt and keep up with students' requirements and expectations. Future studies also could seek to understand the effectiveness of the various technologies used to deliver course materials to students, and students' perceptions of those technologies. This future work, for example, could expand from the current studies to understand the effectiveness, and responsiveness, of faculty members' in-class uses of those technologies through the lens of agentic engagement (Reeve, 2013).

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Endnote

[i] Ethics approval was obtained from QUT [approval number: 2000000531] and RMIT [approval number: 2020-23562-10938] prior to invitations to participate being sent. Potential participants were sent an invitation by their own university, and details were not shared. Participation was by informed consent and voluntary. Students self-selected to participate (or not); and were able to withdraw prior to submission. Consent was by clicking to submit.