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Pharmacy students' experience of technology-enhanced learning during the COVID-19 pandemic

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ABSTRACT

Background: With the advent of the COVID-19 pandemic, pharmacy students and educators experienced an abrupt shift as programmes that were previously taught exclusively in-person were then predominantly taught online. This sudden change provided little time for students to prepare for the new learning environment.
Objectives: The study objective was to explore pharmacy students' experiences of technology-enhanced learning during the COVID-19 pandemic.
Methods: A cross-sectional survey was developed and distributed by email to all 3rd year ($N = 76$) and 4th year ($N = 68$) pharmacy students undertaking an MPharm programme in an Irish university.
Results: A total of 32 responses were collected, including 20 third year and 12 fourth year pharmacy students (response rates of 26.3% and 17.6%, respectively). The majority of respondents reported good or very good internet speed (71%) and stability (59%). Almost all were confident or very confident using Canvas (97%) prior to the onset of online learning. Respondents preferred engaging with other students in-person rather than online for coursework (68.8%) and learning new material (56.3%). Students favoured face-to-face delivery, with a recording of the session available online afterwards, for lectures (68.8%), workshops (50%) and tutorials (56.3%). Analysis of free-text comments indicates that respondents used recorded content to support exam revision and that a key drawback of online learning was social isolation.
Implications: Pharmacy students favoured a blended learning approach, with in-person learning being recorded to support study and revision. Students' experience of TEL during the pandemic should be considered in the development and ongoing review of pharmacy programmes.

Introduction

The delivery of higher education has changed radically in recent years. With the emergence of successful online teaching applications, the traditional approach of didactic lectures is under scrutiny, and a greater emphasis is placed on new teaching methodologies that are grounded in pedagogical theory.[1] Some authors have challenged the long-standing tradition of an educator in the classroom and teaching software has emerged to facilitate this. This new pedagogical approach may particularly suit independent learners[1] but is perhaps less appropriate for learners who are lower in the constructivist hierarchy.[2] In this context, the shift to online learning during the COVID-19 pandemic provided an ideal testbed to explore these issues, and to assess the role of Technology-Enhanced Learning (TEL).

Technology-Enhanced Learning describes learning that is enhanced, supported, mediated or assessed using educational technologies.[3] Teaching delivered in this way may be entirely digital or may be blended with traditional in-person learning.[4] A variety of technologies are available as educational tools and have been used successfully for many years in pharmacy education.[5] Recent reports of TEL use in pharmacy curricula include the use of TEL for lecture capture systems,[6] wet lab simulation,[7] feedback on pharmaceutical calculations assessment,[8] and virtual objective structured clinical examinations.[9] Advantages of the TEL approach include its flexibility, ease of use and variety.[5]

With the advent of the COVID-19 pandemic, pharmacy students and educators in many places experienced an abrupt shift as programmes that were previously taught exclusively face-to-face moved to online learning.[10–13] Many, but not all, undergraduate students are "digital natives", meaning they are the first generation of learners that did not need to adapt to new digital technologies.[14] However, previous work has shown that some students struggle with the use of technology for learning.[15] Poorly developed information technology (IT) skills, computer anxiety, and finding TEL more time intensive than face-to-face learning

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have been cited as reasons that students may find TEL challenging.[15] However digital poverty may also create a barrier for some students.[16] Digital poverty concerns exclusion of an individual or group from aspects of daily life through not having appropriate devices, software or internet connectivity and can impact many facets of life, including education.[17] The cost of internet services or devices, limited internet access, limited access to devices, and poorly developed IT skills have been described as factors that may create inequalities in access to, and benefit from, TEL.[15,16] The sudden change from in-person to online learning at the beginning of the pandemic provided pharmacy educators with little time to prepare students for the new learning environment or to take account of the challenges they may experience.[12]

Studies published prior to the COVID-19 pandemic have outlined the benefits and effectiveness of TEL in pharmacy education,[5,18] however we are still learning about the experiences of pharmacy students online learning during the pandemic.[11–13,19,20] Therefore, the objective of this study was to assess pharmacy students' experience of TEL during the pandemic, with an emphasis on confidence, skills and concerns during that time.

Methods

Ethical considerations

Ethical approval for this study was granted by the School of Pharmacy Research Ethics Committee in University College Cork, approval number 2021–009. All participants received information explaining the purpose and procedures of the study and provided informed consent.

Study design

A cross-sectional survey was developed to capture students' perceptions, attitudes and opinions of online learning during the academic year 2020/2021, during the COVID-19 pandemic. The questionnaire was designed based on previously published studies pertaining to students' perceptions of online learning[21,22] and was informed by the researchers' own experiences of TEL. The research team consisted of a pharmacy student, four lecturers in clinical pharmacy practice and an instructional designer. A draft of the survey was reviewed by five pharmacy students. The students' feedback was considered, and modifications based on this feedback were made to the survey. The final survey was approved by all authors.

Survey composition

The survey consisted of 16 questions comprising multiple-choice statements, *"select all that apply"*, Likert scale and free-response questions. Data collected included students' experiences with TEL prior to the onset of the COVID-19 pandemic, students' perceptions pertaining to their experience of TEL during the 2020/21 academic year, challenges faced by students while engaging with online learning and recommendations for improving future TEL experiences. Participants could skip questions if they wished. A brief explanation of the term Technology-Enhanced Learning was provided as follows: "*The term Technology-Enhanced Learning is used to describe learning that is enhanced, supported, mediated, or assessed using educational technologies. This can include the use of technology during face-to-face teaching, or the use of technology in blended and online teaching*".

The questionnaire consisted of two sections. The first section contained 12 closed questions. Firstly, participants were asked to give their consent to complete the survey and were then asked to select their year of study. Questions 3–5 related to the internet connection available to participants during the academic year of 2020/21. Question 6 pertained to participants' confidence with online technologies prior to the onset of the pandemic. Question 7 inquired about participants preferences relating to instructional methods for educational activities. Participant's preferences for future delivery of lectures, tutorials, workshops and practicals were examined in Questions 8–11. Participants' experiences of TEL were assessed in Question 12. The second section contained four open questions which were used to further explore participants opinions on TEL. It was estimated that the questionnaire would take 8–10 minutes to complete. A copy of the questionnaire is available in the Appendix.

Sample characteristics and data collection methods

All third year ($n = 76$) and fourth year ($n = 68$) pharmacy students undertaking the MPharm programme in the School of Pharmacy, University College Cork were invited to participate in the study. The survey was open for responses for a three-week period in November 2021. The survey was circulated by a member of the research team (MB) to students' institutional email addresses. A link to the online questionnaire, via Microsoft Forms, was provided in the email. One reminder email was sent to students within two weeks of initial contact. No honorarium was provided to participants.

Statistical analysis

Data were stored and analysed using Microsoft Excel. Descriptive statistics were calculated, and categorical data based on the Likert scale were analysed descriptively by calculating frequencies and percentages. As it was not compulsory to answer any survey question, other than the consent question, the percentages are calculated based the total number of responses to each question. The respondents' opinions and experiences were captured by utilising open text questions and were explored using thematic analysis.

Results

The email invite was sent to 76 third year and 68 fourth year pharmacy students. Thirty-two responses were received, 20 from third year students (response rate 26.3%) and 12 from fourth year students (response rate 17.6%), with overall response rate of 22.2%. For online learning, respondents most frequently accessed the internet using broadband supplied by a landline provider (93.8%) or using a mobile hotspot (78.1%). Very good or good internet speed was reported by 71.0% of respondents and very good or good internet stability was reported by 59.4% of respondents. Over half of the students (59%) felt very confident and 38% felt confident using the virtual learning environment Canvas prior to the onset of the pandemic (Fig. 1). However, 56% of respondents reported being unconfident or very unconfident using Microsoft Teams prior to the pandemic. Similarly, 57% reported being unconfident or very unconfident using Zoom.

Respondents reported that they preferred in person learning for engagement with other students for coursework (68.8%) and for learning new material (56.3%), however they preferred online methods for engagement with academic staff (59.4%) and a mix of online and in person learning for remembering course material (40.6%), Fig. 2. Third year (55%) and

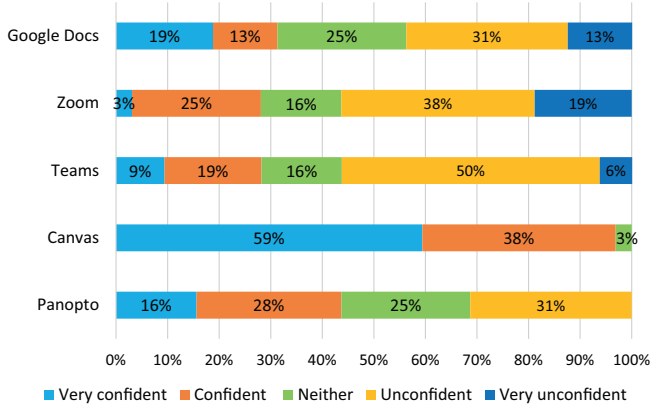

Fig. 1. Participant responses to question 6, "*Prior to the onset of online learning, how would you describe your confidence using the following technologies for online learning?*"

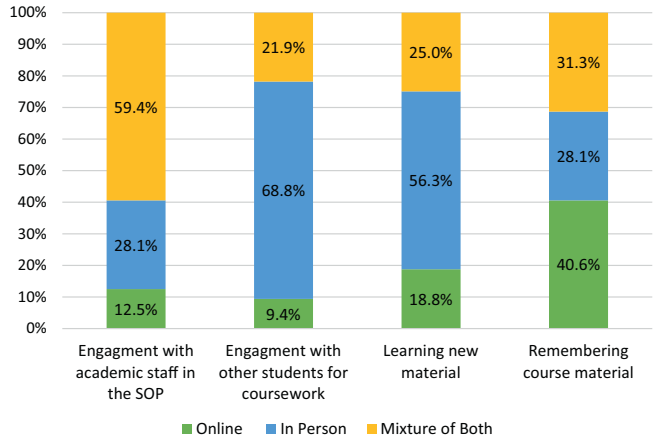

Fig. 2. Participant responses to question 7, *"What is your preferred learning method for each of the following?"*

fourth year (67%) pharmacy students preferred engaging with the staff in the School of Pharmacy using a blended approach and both third year (75%) and fourth year (58%) students preferred engaging with other students for coursework in person. Half of third year (50%) and two-thirds of fourth year (67%) students preferred learning new material in person. Just under half (45%) of third year students found that they retained new course material better by using a mixture of both online and in person teaching methods in comparison to fourth year students (50%) who had improved retention of new content when delivered in-person.

In terms of delivery of teaching in the future, the majority of the respondents (68.8%) prefer lectures to be delivered in person, with the recording available afterwards. Respondents prefer live workshops, with 34.4% preferring workshops delivered live in person and 50% preferring workshops delivered live in person, with the recordings available afterwards (Fig. 3). Similarly, 56.3% of respondents prefer tutorials to be delivered in person with the recording available afterwards. The majority of respondents (78.1%) prefer laboratory practicals to be delivered in person (Fig. 4).

Almost all respondents (97%) slightly agreed or strongly agreed that online learning aided in the development of their technology skills. The majority of respondents (94%) agreed that Canvas was the easy to use, while 88% agreed that Microsoft Teams and 65% agreed that Zoom was easy to use. Most respondents (72%) found recorded lectures easy to watch and 65% of respondents felt that videos and images made learning more interesting, however fewer (53%) agreed that videos and images aided their understanding of laboratory content. Overall, 50% of students agreed that online learning helped them to develop their understanding of the course material, however 44% of respondents disagreed with this statement (Fig. 5).

Twenty-six (82%) respondents provided replies to the open questions. Three major themes emerged from the data. Themes and sub-themes are outlined, with supporting quotes, in Table 1.

Discussion

This study used a cross sectional survey of pharmacy students to explore their experiences of TEL during the COVID-19 pandemic. The majority of students favoured a hybrid learning approach, in the form of face-to-face delivery of lectures, tutorials and workshops with a recording of the session available online afterwards for revision purposes. Students preferred learning new material and engaging with their peers for coursework in-person, however, they reported that they retained course material better when delivered online. Students reported that online learning aided the development of their technology skills but not their skills pertaining directly to the pharmacy programme. Drawbacks associated with TEL included difficulties associated with poor internet connection, time-management challenges, and potential social isolation.

The students who participated in this survey were in third and fourth year of a pharmacy programme when the survey was conducted in late 2021. The group of third year students had experienced just one full semester of in-person university education prior to the onset of the pandemic and consequent switch to online learning. Elements of TEL such as computer-

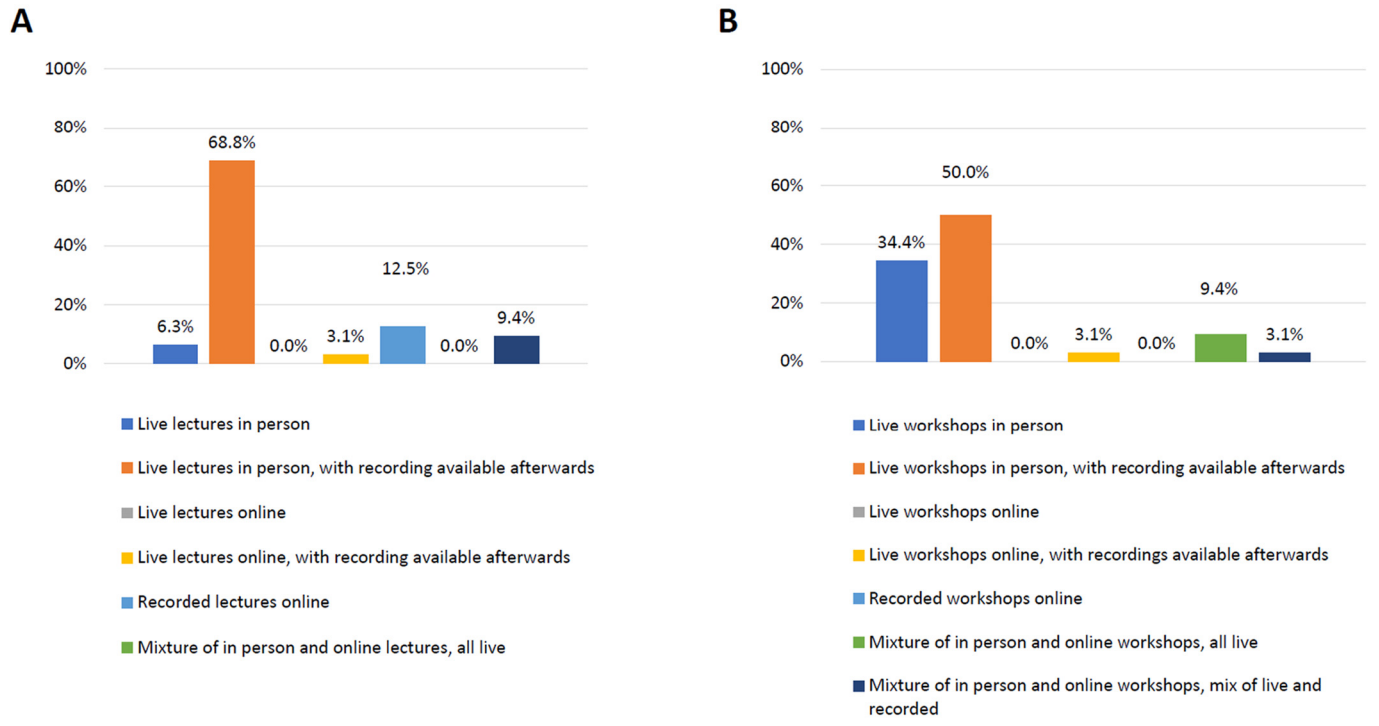

Fig. 3. Participant responses to (A) question 8 *"How would you prefer lectures to be delivered in the future"* and (B) question 9 *"How would you prefer workshops to be delivered in the future?"* Respondents chose one answer option from the list provided.

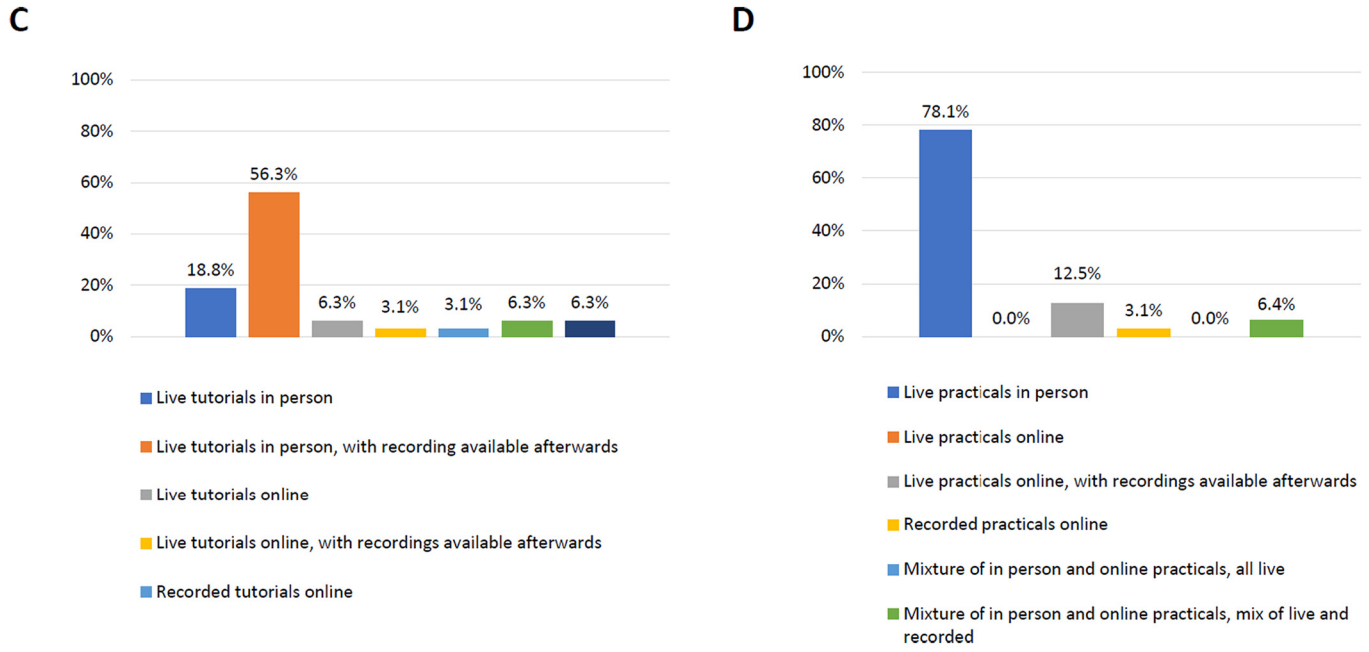

Fig. 4. Participant responses to (C) question 10 *"How would you prefer tutorials to be delivered in the future"* and (D) question 11 *"How would you prefer practicals to be delivered in the future?"* Respondents chose one answer option from the list provided.

aided learning programmes and shared online documents for groupwork were used in the programme prior to the pandemic, however at their early stage in the programme, the students included in this study were minimally exposed to these techniques. Therefore, the onset of online learning in March 2020 represented a significant change in the learning environment of these students. Almost half of third year students stated that they retain new course material better by using a mixture of both online and in person teaching methods, however 50% of fourth year students reported improved retention of new content when delivered in-person. This may reflect that third year students, with less experience of in-person learning in university, adapted to TEL and online learning to a greater extent than their more experienced fourth year colleagues.

The results presented here indicate that in-person learning is the preferred learning environment among the surveyed students. This aligns with a survey of medical students in the United Kingdom (UK), where students reported that they did not find online teaching to be engaging or enjoyable, and that it provided limited opportunities for students to ask questions of lecturers.[23] The in-person approach also allows educators the

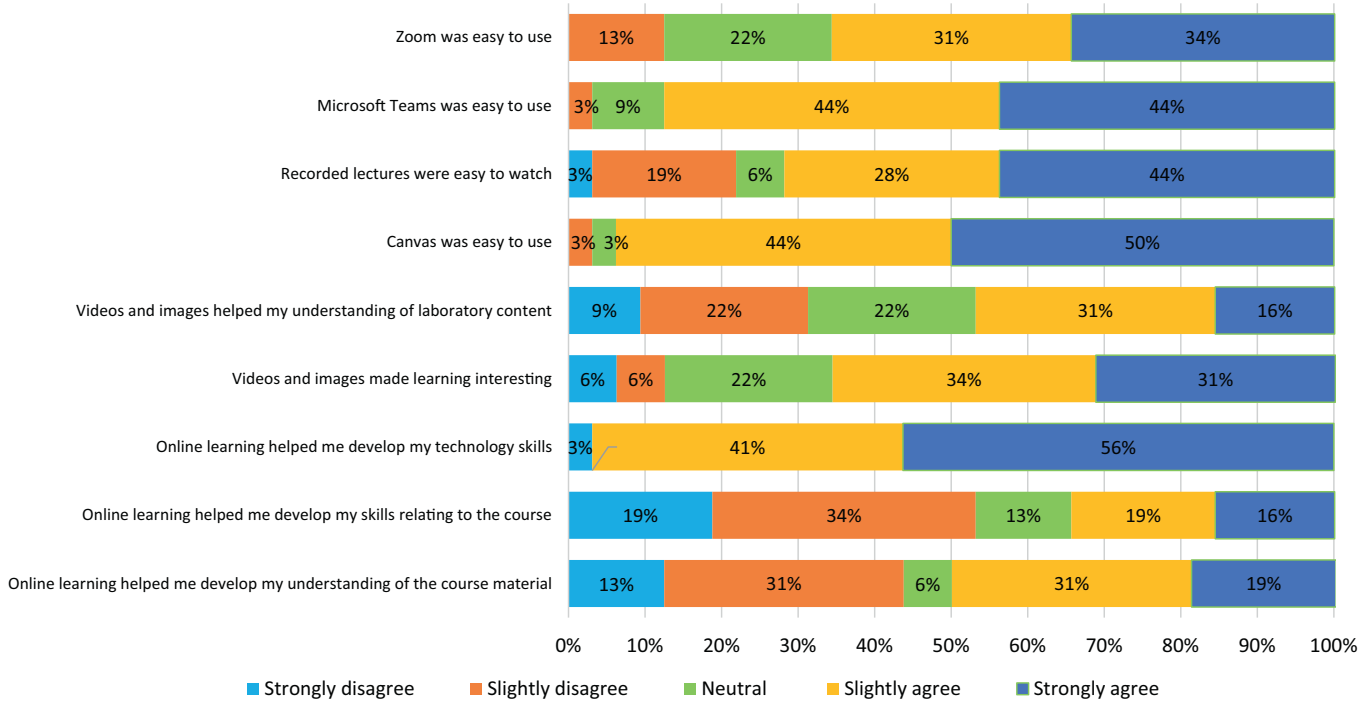

Fig. 5. Participant responses to question 12, *"Please rate your agreement with the following statements as they relate to your learning in the academic year 2020/21."* Respondents answered on a Likert scale from Strongly disagree to Strongly agree.

Table 1
Themes and subthemes identified in thematic analysis of open-text questions, with quotation(s) to support each subtheme. Participant number is indicated after each supporting quote.

Theme	Subtheme	Quotation
Positives of TEL approach	Revision	*"Having recordings of the lectures [was] very beneficial when it came to revision" P3*
		"…a very useful tool for revision and study" P5
	Time management/Flexibility	*"Lectures could be watched at any time" P32*
	Control of learning, Note taking and enhanced learning	*"I found huge value in having access to recorded material. I could work through it at my own pace, take far better notes" P5*
		"…found it helpful…to repeat sections of the lecture you found difficult you comprehend during the first sitting" P14
Drawbacks of TEL approach	Time management	*"Workload built up very quickly as lecturers may post two lectures in a slot that was timetabled for one… Impossible to stick to timetable." P11*
		"When the lectures were recorded, I found that it could take a very long time to watch them … dedicating too much time to each lecture and not getting through all of the material" P31
	Social interaction	*"It is important that the in-person aspect is not forgotten about, I felt quite isolated from my peers over the last year and a half and definitely depend on them both socially and academically" P11*
		"Very difficult sitting in front of a laptop all day and isolated from social interaction, therefore attention to the learning materials was limited" P15
	Practicalities of online material	*"Have the lectures live streamed and the recordings made available afterwards" P18*
		"I would have broken up the lecture recordings into shorter more bite-sized videos" P6
		"The [laboratory] practicals that were held online [were] less beneficial than… if they were held in laboratories" P14
	Internet connectivity	*"My internet connection was bad and the stream kept cutting out… I felt that I had missed out on some of the tutorials even though I had attended… it was out of my control" P23*
Future preferences for learning activities using TEL	Blended/hybrid approach	*"Keep recording lectures to listen back to them after the lecture" P17*
		"I like the hybrid of in person and online learning, both live and pre-recorded" P29
	In-person learning	*"Online lectures are absolutely no replacement for in person lectures… while recordings are great for revision, they are no comparison to having a lecturer standing in front of you explaining and teaching" P3*

opportunity to gauge student understanding from non-verbal cues.[22,24] In the current study, students preferred learning new material and engaging with their peers in-person. This reflects Essilfie and colleagues who found that online learning could not replicate the benefits and dynamic interactions of face-to-face learning.[25]

Students favoured the in-person delivery of lectures, tutorials, workshops and laboratory practicals, and reported that recorded material is beneficial for revision purposes. Just 40% of students reported that they remembered the course material better when delivered online in comparison to other methods of instruction. This accords with a study by Yu and colleagues who found that in an assessment of online team-based learning, students stated that online delivery did not aid their retention of knowledge.[10] Furthermore, Yu and colleagues reported that in the online learning setting students felt less engaged with the course instructor and with their classmates compared to in-person learning.[12] Faculty members were also surveyed by Yu and colleagues and their responses were strongly aligned with those of their students.[12] Lean and colleagues have reported that a conventional in-person classroom approach is superior to online learning for gaining a thorough understanding of pharmacy programme content.[24] Therefore, evidence suggests that a blended learning approach may be most beneficial for delivery of the pharmacy curriculum in the future.[10–12,21,23,26–28]

Almost all respondents agreed that online learning helped them to develop their technology skills, however most also perceived that online learning did not support the development of skills relating directly to the pharmacy programme. This finding is consistent with Chuang and colleagues who reported that the continued development of soft skills such as oral communication, empathy, reflective practice and problem solving proved challenging through online platforms during the pandemic.[19] In a nationwide survey of medical students in the UK conducted during the pandemic, 82% of respondents reported that they couldn't learn practical skills through online learning.[23] A systematic review published in 2014 found that when "traditional" learning was compared to online learning for health professions students, there was disagreement among studies examining students' skills acquisition from online learning, with just 6 of the 15 included studies demonstrating significantly greater skill acquisition among students assigned to online learning.[29] Kolb's experiential learning theory suggests that learners must integrate formal education with lived experience and ongoing reflection, in order to develop skills.[30] The switch to online learning, necessitated by the pandemic, may have led to teaching being delivered online that was not specifically designed for the online medium and this may have limited students' capacity for reflection and development.

The internet connection available to students is an essential factor for online learning. Although most students in the current study reported that they had an internet connection with good speed and stability available to them for online learning, it is necessary to consider the needs of the almost 30% who reported low internet speed and 40% who reported lack of stable internet. The quality of a student's internet connection will directly impact on their online learning experience. Students with a stable internet connection may have healthier attitudes towards TEL than those who do not.[31] In the current study, a number of students reported that technical difficulties during online workshops and tutorials posed an issue for them. This reflects other reports in the literature that found that one of the major challenges associated with TEL is technological difficulties.[10,12] These problems are intensified by digital poverty. Summers and colleagues demonstrated that in a UK university, economic disadvantage influenced student engagement during the pandemic, and that the pattern of engagement with learning materials changed between the pre-pandemic and peri-pandemic period.[17] Pre-pandemic, students from disadvantaged backgrounds tended to access course materials and view recorded lectures more frequently than those from more affluent backgrounds. During the pandemic, differences in recorded lecture views reversed with students from the most disadvantaged backgrounds watching significantly fewer recorded lectures than those from more affluent backgrounds.[17] Elsewhere, in a study of digital teaching innovations among nursing students in a UK university, an association was identified between ethnicity and understanding technology.[16] McAllister and colleagues noted the importance of considering digital poverty when developing technology enhanced learning interventions but also highlighted that as healthcare becomes more

digitised, healthcare educators must prepare their students for an increasingly electronic and technology-driven workplace.[16]

In addition to issues concerning poor internet connection, respondents found it challenging to manage their time appropriately when recorded lectures were not released according to the official programme timetable or when recorded lectures were longer than the allocated timetable slot. Students expressed that it was difficult to remain engaged with longer recorded lectures. According to Lean and colleagues, the face-to-face delivery of lectures may overcome these barriers.[24] In-person lectures allow students to remain focused for extended periods as they are more motivated to learn when given the opportunity to engage with the lecturer and to discuss ideas and concepts with their peers.[24,25] Research comparing longform didactic lecture recordings and shorter chunked recordings, showed greater student engagement with chunked videos that were between 3- and 17-minutes duration than with 60-minute videos.[32] Furthermore, students achieving higher grades had greater engagement with the chunked recordings.[32] Humphries and Clark concluded that among digital natives, chunked lectures may improve student attention, assist with time management and increase engagement.[32]

Almost 70% of respondents reported that they prefer in-person learning for engagement with other students for coursework. Participating students reported feelings of social isolation associated with online learning during the pandemic. Irish university students, when interviewed by RTE, the Irish public broadcaster in November 2020, described the transition to online learning during the pandemic as “lonely”, “overwhelming” and “chaotic”.[33] A survey of nursing students, conducted during the pandemic, found that online learning lacked feeling and was impersonal.[31] Elsewhere, a survey of physicians undertaking orthopaedic surgery education and conducted during the pandemic, found that the development of meaningful relationships with classmates was more likely to occur during face-to-face encounters.[25] As the current study was conducted during the pandemic, the isolation that many students felt at that time may have influenced their perception of TEL. It is important that future studies assess perception of TEL at a timepoint when students have a greater opportunity to partake in a combination of in-person and online learning.

This study was limited to a single School of Pharmacy in Ireland and to two study-year levels, leading to a small sample size which limits the generalisability of the results. That the response rate was low must also be acknowledged. This may be attributable to study time-pressures, the fact that some eligible students were on placement at the time of survey dissemination and potentially survey fatigue, given the number of surveys circulated to students by the School of Pharmacy and the University. Nonetheless, the survey instrument was well designed and tested, and the results align with the finding of work published by several other educators during the pandemic. These findings should be interpreted in the context of the study being conducted during the pandemic.

Conclusion

Pharmacy students favour a blended learning approach, with in-person learning being recorded to support study and revision. Students' experience of TEL during the COVID-19 pandemic should be considered in the development and ongoing review of pharmacy programmes.

Funding

No funding was received for this work.

Data availability

The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Author contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by ED and MB. The first draft of the manuscript was written by ED and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Declaration of Competing Interest

The authors have no relevant financial or non-financial interests to disclose.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.rcsop.2022.100206.

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