How have Covid-19-related changes to tuition modes impacted face-to-face initial teacher education students?

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In Semester 1 of the 2020 academic year, face-to-face higher education students in many institutions were instructed to not attend classes or lectures on campus soon after the semester commenced, due to precautions put in place to limit the spread of Covid-19 in institutions across Australia. To sustain education and course progression, students were rapidly transitioned to learning-platforms, and synchronous or asynchronous online instruction. Although this action was needed to help ensure undisrupted learning, little consideration was given to the impact this would have on the students who had chosen to study in the face-to-face mode. The instrumental case study reported in this paper sought to capture the lived experiences of students enrolled in initial teacher education (ITE) programs in mathematics, science, and technology (STEM) units in on-campus, face-to-face mode as they moved to emergency fully online instruction. An initial online survey, constructed in *Qualtrics* and using a 4-point Likert scale, was sent to these students in Semester 2, and this was followed by semi-structured interviews with those who indicated their willingness to participate. Thirty-two students participated in the survey and 11 in the interviews, and these data were examined through the lens of self-determination theory. The majority of participants preferred the face-to-face mode, yet some were surprised about the affordances of fully online. Although the respondent group was small, the insights gained are of interest to educators in higher education and have the potential to inform new ways of designing and delivering authentic and engaging online and blended learning in these programs.

Introduction

Ramifications of Covid-19

There is no doubt that Covid-19 has drastically changed lives. Many sectors across society were heavily affected, and no less within the education sector. UNESCO (2020) reported that as of 6 April 2020, 91% of learners in 188 countries were affected, representing 1.5 billion students. 'Social distancing' was introduced in an effort to reduce physical contact and thereby minimise community transmission that could develop quickly across a university campus (Weeden & Cornwell, 2020). There has been a significant reduction in face-to face-teaching, having been replaced with online methods as much as possible and aided by different technologies such as social media, virtual platforms, and video conferencing. This adoption of online learning under Covid-19 restrictions may now become a new normal, rather than simply an emergency response (Murphy, 2020). However, it is difficult to predict what the educational landscape will look like after the impact of the pandemic passes. Potentially, online learning could enable higher rates of accessibility to education, or perhaps alternatively, the social and mental health ramifications of the closure of educational institutions will prove too much of a challenge for some students to overcome.

Background

Movement to online learning

At the outset, it should be noted that online learning *during* the pandemic and online learning *prior* to the pandemic are essentially different (Bozkurt & Sharma, 2020; Gacs et al., 2020; Hodges et al., 2020). Effective online learning is a result of careful instructional design and planning, using a systematic model for design and development (Branch & Dousay, 2015). Online learning during the pandemic or indeed at any time of crisis, by virtue of its immediacy, does not have the same degree of intentional, considered planning (Hodges et al., 2020). In order to make a distinction between these two types of online learning, the terms *emergency remote learning* (Hodges et al., 2020)*, crisis-prompted online teaching* (Gacs et al., 2020), and *emergency eLearning* (Murphy, 2020) are being used in the vast body of Covid-19 associated literature. Gacs and his colleagues (2020, p. 382) argued that "planned online education has an intentional commitment and buy-in from most stakeholders", and that, at the outset, there is collaboration between subject-matter experts and instructional designers to maximise engagement and learning (Gacs et al., 2020). So, when students and educators are forced to adopt the fully online mode, there are many aspects of this transition that effect their feelings of autonomy, competence, and relatedness.

Few studies have been published in relation to the pandemic and its effect on pre-service teachers' achievement, engagement levels, self-efficacy, satisfaction, and demonstration of agency. Some have claimed a significant positive effect of the Covid-19 confinement on students' performance (Gonzalez et al., 2020), and others have reported on the challenges faced due to the movement to online learning as the only teaching method (Sahu, 2020). Teachers used, and continue to use, many different methods to deliver educational content to their students. These included recording and uploading their lessons online for students to access and utilising different platforms such as *Google Classrooms* and *WebQuests*. The gap in the research is the impact of emergency remote learning upon pre-service teachers who are destined to teach face-to-face in school classrooms.

Further, according to Toquero (2020), the majority of educators in higher education have not been prepared to deal with online education, especially with the rapid and urgent migration from face-to-face learning. Teachers may find it more difficult to switch modes of teaching without any opportunity for careful planning and well-thought-out practices. Bao (2020) acknowledged that an online course requires elaborate learning experience design, differentiated teaching materials, and technology support teams. However, staff members of universities may lack online teaching experience, and the rapid change to teaching in this mode may force rushed preparation, as well as limited provision of educational technology support. The forced transition, with insufficient lead time, may have resulted in the transfer of traditional teaching to the online modes, without considered planning to make best use of the new affordances, nor to avoid the pitfalls of incorporating the previous methods. With or without a pandemic, Murphy (2020) cautioned that there is a potential cost to removing face-to-face modes from the realm of normal educational discourse. These costs are most likely to undermine one or more of

the three basic needs as identified by *Self-Determination Theory*: autonomy, competence, and relatedness (Ryan & Deci, 2020).

Learning activities and course design

Learning activities and the design of course content can conceivably be modified to suit the expectations of remote, online learning. However, what is perhaps more challenging are the design of assessment items and the expectation of students to self-direct their learning, which may in turn require a more focused and direct supervision by teachers rather than direct instruction (Gonzalez et al., 2020). Furthermore, the challenge around expecting students to follow instructions and manage their access to online course materials as expected and intended may prove too difficult for some students (Gonzalez et al., 2020). Teachers may be expected to provide consultations and answer questions more frequently, and to use different methods to what they are accustomed to, such as *WeChat* or other social platforms outside of class hours (Bao, 2020). Additionally, Burgess and Sievertsen (2020) acknowledged that internal assessments may have simply been cancelled and viewed as less important. However, it is evident that online formative assessments, when utilised appropriately, are particularly effective, as frequent short practice tests and quizzes provide students with immediate feedback and explanations (Chen et al., 2018). The challenge of implementing the evaluative element of courses may prove difficult for teachers and students alike until new forms of assessment are developed and received with full acceptance by students – with both the students and educators becoming conversant with the new approaches.

Pre-service teachers, in particular, may believe that teaching preparation courses are or should be centred around social relationships, and therefore may hold an expectation that face-to-face classes are the most effective way to facilitate their learning. Wu and Albion (2019) stated that pre-service teachers showed higher rates of active engagement with hands-on activities that allow them to tinker, play, and build things. Practical activities and learning experiences are arguably an integral part of learning in a range of disciplines but particularly in science, technology, engineering and mathematics (STEM) subjects. Madden et al. (2016) looked more specifically at pre-service teachers of STEM subjects, and stated that STEM allows for more hands-on learning, rather than just memorisation. How pre-service teachers view the importance of STEM education effects the way they learn through inquiry, the design process, and their willingness for exploration (Wu & Albion, 2019).

Again, in reference to STEM subjects, active learning is key to pre-service teachers' success. For example, the implementation of dedicated software, solving real-world problems, and utilising case studies are especially relevant to active learning (Chen et al., 2018). Freeman et al. (2014) conducted a meta-analysis of 225 studies and concluded that active learning, particularly within STEM subjects, led to increased student academic grades compared to a traditional lecture format. Overall, STEM subjects are unique in practice, delivery, and assessment, and often involve inquiry-based activities (Crawford, 2012) and hands-on experimentation. Initial teacher education students need subject matter knowledge, pedagogical content knowledge, and expertise to innovate and deal

with STEM education in their own future classrooms (Abell, 2008). However, the move to online learning involves learning new skills, in addition to mastering the required content. Technology is a social cultural artefact (Williamson et al., 2020) that can be utilised to convey content as necessary even when the external environment changes

Students' lived experiences

As Chan et al. (2015, p. 96) explained, "lived experience has a temporal structure in that its immediate appearance can never be grasped; it is only as past presence that its vividness and entirety can be fully understood". The focus of this study was on the lived experience of initial teacher education (ITE) students displaced from their chosen mode of learning and instruction as they were required to study fully online. Students' immediate consciousness of engaging with emergency remote online learning, the nature of the experience, and the subsequent reflection and interpretation of this lived experience is explored through the study. As such, this research provides a lens through which universities may gauge the impact of the crisis management initiatives that were put in place in early 2020, and in turn may influence conversations about employing fully online and blended learning delivery modes regardless of the impact of crisis situations.

Research gap

Research to date on the impact of emergency remote online teaching on ITE students has not been framed in terms of the needs of these students, and this research contributes to the field by investigating ways in which these needs (autonomy, competence, and relatedness) are undermined or can be met. This has been examined through the self-reported lived experience of the participants.

Research questions

The study reported in this article focused on initial teacher education students who had chosen to study their STEM-discipline units (science, technology and mathematics) in the on-campus, face-to-face mode.

This research sought to answer the following questions:

1. How did students' lived experiences change as they shifted from face-to-face (F2F) to a fully online mode?
2. What learning activities and social interactions did students prefer?
3. What future direction would these students like to see Initial Teacher Education take in regard to delivery modes?

Theoretical framing

There are a small set of basic psychological needs that are considered to be essential to people's self-motivation and psychological well-being (Ryan et al., 2013), and if these are not met then there is likely to be resultant distress and deterioration in well-being. These

basic needs are: (1) autonomy (acting in accordance with one's goals and values), (2) competence (feeling able and effective), and (3) relatedness (feeling connected to others) (Peters et al., 2018). This is the essence of *Self-Determination Theory* (Ryan & Deci, 2000), and it is against these needs that the students' lived experiences in this study have been mapped. Self-determination theory enables us to understand factors that "facilitate or undermine intrinsic motivation, autonomous extrinsic motivation, and psychological wellness, all issues of direct relevance to educational settings" (Ryan & Deci, 2020, p. 1). Of particular interest and relevance in this study are the experiences that support or undermine these three basic needs, as outlined in Table 1. As Ryan and Deci (2020) pointed out, if any three of these needs are not supported adequately, potential damage to motivation and wellness are likely outcomes.

Table 1: How the three basic needs of self-determination theory can be supported or thwarted (based on Ryan & Deci, 2020).

Need	Supported by	Undermined by
Autonomy	Experiences of interest and value.	Experiences of being externally controlled.
Competence	Well-structured environments that provide achievable challenges, positive feedback, and opportunities for personal growth.	Poorly-structured environments that overwhelm the learner and leaves them doubting their ability to learn.
Relatedness	A well-developed learning community.	Disconnection and a sense of isolation.

Method

An instrumental case study (Yin, 2013) was employed to comprehensively examine the phenomenon of mandated alterations to the study mode of STEM subjects. A mixed methods approach was undertaken to collect general and specific elements of participants' lived experiences. An online survey was sent to all potential participants and after this, semi-structured interviews with self-nominated participants were conducted. This study was conducted within a methodological paradigm that combined elements of focus group case study design, informed by social constructivist theory. Creswell (2014) acknowledged that constructivist researchers generate a theory or pattern of meanings as data is collected. Both the survey and the semi-structured interviews were conducted in Semester 2, 2020 when F2F classes resumed on campus.

Participants

The researchers invited all students enrolled in Early Childhood, Primary, and Secondary Initial Teacher Education (ITE) programs in mathematics, science, and technology units in on-campus mode in Semester 1 at Curtin University, a globally recognised university in Western Australia (in the top 100 of *QS World University Rankings* by subject for education). Students were invited to participate in the study via broadcast emails outlining the nature and purpose of the research, sent out by our research assistant. The email

invitation included a link to the online survey, as well as the Participant Information Statement, and the Participant Consent Form.

Thirty students opted to participate in the online survey: 22 in the Bachelor of Education Primary degree and eight in the Bachelor of Education Secondary degree. There were no participants from the Bachelor of Education Early Childhood degree. Gender was not a demographic item on the survey, and ages ranged from 20 (greatest number of participants) to 42. Participants were asked to indicate the STEM unit that they wished to reflect on, and 60% were drawn from the third-year primary education mathematics unit, the next highest proportion (17.14%) from secondary mathematics curriculum and instruction unit, followed by 8.57% from a common first year technology unit. Six students participated in the semi-structured individual interviews, and one group of five students came together for an informal focus group interview, using the same set of pre-determined questions.

Data instruments

Data were collected systematically to ensure that it contributed directly to answering the research questions. The first data instrument was an online survey, designed by the research team, generated using *Qualtrics* survey software, with a 4-point Likert scale, from *Strongly agree* to *Strongly disagree*, and it also collected relevant demographic data. The survey items were developed by the research team to align with the three needs of self-determination theory (Ryan & Deci, 2020) – autonomy, competence, and relatedness – in order to answer research question 1. The survey items were piloted for clarity with a random sample of 10 ITE students. The students who participated in the survey were able to check a box and provide their student identification number to indicate that they would be happy to be contacted by our research assistant to organise a place, date, and time for a semi-structured interview. The semi-structured interviews sought to obtain more insights into the students' lived experiences and were conducted on campus face-to-face and audio-recorded. The interview questions were developed by the research team and sought to answer research questions 2 and 3.

In addition, *Blackboard* (BB) analytics (engagement with the BB site and final grades), and participation in discussion boards and collaborate sessions were also examined to determine changes in engagement over the first four weeks in face-to-face mode in comparison to the remaining eight weeks of the semester in the fully online mode. This examination sought to provide more information to answer research question 1.

Data analyses

The surveys were analysed using descriptive statistics (percentage frequencies) and were cross-tabulated based on demographic data. The semi-structured interviews were transcribed by an online service, and members of the team checked the transcriptions for accuracy. After the interview transcripts had been read a number of times by the team members assigned to the qualitative data analysis task, they met to develop codes and reach consensus. In the review of each participant's transcript, the "meaning units," the

words and sentences that conveyed similar meanings, were identified, and labelled with codes (Graneheim & Lundman, 2004). Assessing how these codes were potentially connected across the transcripts led to the identification of themes (Belotto, 2018). The team members verified these themes and selected evidential quotes to support each one.

Findings

Online survey data

Note that whilst 32 students commenced the online survey, not every participant responded to each section. The survey, with complete statements, is presented in the Appendix. Survey responses were also examined using cross-tabulations to investigate similarities or differences between courses, units, and ages. As there were no clear distinctions in any of the comparisons, perhaps due to the small sample size and homogeneity of the responses, these will not be presented in this paper. Table 2 shows the summary of the survey data.

Table 2: Summarised survey responses (n = 28)

Summarised statement	% SD/D	% SA/A
My participation increased	71	29
Achieved better online	75	25
Satisfied with learning experiences	43	57
Online easier than anticipated	39	61
Difficult to engage with STEM activities	21	79**
Learned best face-to-face	14	86
Isolated from peers	32	68
Isolated from tutor/s	32	68
Better time management online	43	57*
Connect and network better face-to-face	18	82
Questions answered better face-to-face	14	86
Prefer online to face-to-face	36	64
Face-to-face essential for my learning	14	86

* an unexpected outcome; ** direct bearing on the units investigated
SD=Strongly disagree; D=Disagree; A=Agree; SA=Strongly agree

The survey also had an open textbox for additional comments; these were initially categorised as *positive* and *less-positive* statements, and then collective themes were drawn from each set. Examples of positive and less-positive statements are presented in Table 3.

Semi-structured interview data

The interviews were transcribed by an online service, and the project research assistant checked for accuracy. Three members of the team studied the transcriptions individually and identified codes and initial themes. They then met to discuss these and to reach consensus.

Table 3: Positive and less-positive statements from the open-text box survey item

	Theme	Quote
Positive	Ease of migration	[University] already had a lot of online benefits, so the transition was easy from a student's perspective.
	Unforeseen benefits	Doing [subject] online with [tutor]was much less anxiety-inducing and I actually engaged so much more in the content and classes.
	Positive learning experience	[My tutor] was personable, welcomed all students into the collaborate sessions as they arrived, made it fun and was engaging in [their] delivery.
Less-positive	Dissatisfaction with the migration	Not only were the compulsory online studies demotivating and difficult to focus, but the overall poor management of new rules made it increasingly difficult.
	Difficulties with the online sessions	A lot of students would not respond, or not contribute to group discussions … and they would leave their microphone and camera off, making group collaboration and peer discussion quite difficult.

Five themes were identified from the interview transcripts:

1. Motivation,
2. Engagement or sense of community,
3. Online learning,
4, Online teaching and instruction, and
5. Opportunities associated with online teaching and learning.

Below are examples of the participants' lived experiences.

Motivation

Students reflected that moving to the fully online mode decreased their motivation to engage synchronously or asynchronously:

> … some days was just like "Ah well, I can just watch it online later … and double speed and get through it. (Student 6)

> My biggest [challenge] was motivation … it wasn't as motivating to just sit at home and do it. (Student 3)

Engagement or sense of community

Students confided that they missed engaging with their peers and tutors, and that the community relationship was difficult to emulate:

> Not many people or peers went into the online classes so there wasn't very much discussion within the collaborate classes. (Student 2)

> People were not confident to speak up or use their microphones. I prefer F2F because it's a relational thing. (Student 1)

Online learning

The students overall found the online learning to be challenging and reflected on changes in their own behaviour and that of their peers:

> [The learning experience] lost all of its personal touches and it was just a mess. (Student 4)

> Going online, it was like I completely changed… I didn't want to ask questions. I didn't want to turn on my webcam… I wanted to stay comfortable. (Student 2)

> It became dormant and very dark. (Student 3)

Online teaching and instruction

Students commented on the difficulties their tutors had with the move to the fully online mode:

> When the lecturer got used to it, her approach was much more positive. "This is the resource, let's do this together". (Student 1)

> It was really challenging for you guys as well … you're teaching to a blank room really. (Student 4)

Opportunities associated with online teaching and learning

Some students acknowledged positive aspects of their experiences:

> The only positive is that we got to be with our families and safe. (Student 7)

> One of the benefits is the ability to go back and if you are listening to it online after the fact, you can rewind straightaway, listen to it to really clarify something. Whereas if you are in class, if the teacher goes past something, you cannot be like 'what was that'? (Student 6)

Future-focused interview question

The final question of the interview was: *How would you like the School of Education to design units in the future?* This question was intentionally aligned to research question 3 and provided the interviewees an opportunity to voice their opinions of what would work best for themselves and for other students. In summary, the participants preferred the face-to-face mode, however, some, as indicated below, had ideas about better planning for fully

online and hybrid (or blended) approaches that could encourage more collaboration and engagement with the tutors and their peers.

Fully online approach

> Post a short video beforehand, and then the online tutorial would be discussions – send us off into little groups – then you'd still get social interactions with peers. (Student 6)

Hybrid approach

> If we were to blend [the learning] I think it would be a case of workshopping face-to-face to just have that relational part of it. But then go online and use a variety of technology … and train our lecturers and train us. (Student 1)

> I think it's mainly just doing a little bit of content before and then coming in and doing practicals as well. Maybe at the start you have a bit of a recap for those students who weren't able to watch the 15-to-20-minute little lecture. And then you can build from that rather than spend half an hour listening to someone get bored, lose out interest and engagement. Because I don't think that that's the way that we want to teach students anyway. (Student 8)

Learning management system data

The learning management system (LMS) used at the research site is *Blackboard*, and the features used most often by tutors and unit coordinators are the Discussion Board, Announcements, Grade Centre, and Collaborate Ultra. As the largest participant group were enrolled in the third-year mathematics unit, the research team decided to examine the student interactions on that Blackboard site. Week 5 became an additional non-tuition week and Weeks 8 and 9 were rescheduled non-tuition weeks. Assessment 1 (weighting 50%) was due at the beginning of Week 10, and Assessment 2 at the beginning of Week 15. There were 118 students enrolled in the unit, and the pass rate was 94%. Figure 1 shows the students' average unit accesses compared with their accesses for all units, and Figure 2 has the 2019 data for comparison. In 2019, the non-tuition weeks were Weeks 5 and 9, with Assessment 1 due at the beginning of Week 10 and Assessment 2 at the beginning of Week 14.

Whilst the peaks and dips of the unit accesses are similar in 2019 and 2020, that is to be expected as students typically access more frequently immediately prior to assessment submissions, access less frequently in the tuition-free weeks (unless an assessment is due the following week), and access very little towards the end of the semester. Perhaps what is of interest when comparing the graphs, remembering that they represent different cohorts of students, is what happened after the submission of the final assessment task in week 14, 2019 and week 15, 2020. In 2019, pre-pandemic, students continue to access the unit at quite a high level even after they have submitted their final assessments. This could be for a number of reasons: checking to see their results, checking for resubmission eligibility, submitting an Expression of Concern for their grade, submitting an extension, or submitting after an academic integrity case. In 2020, after the submission of the final assessment, there appears to be a rapid and continued decline in access – perhaps the

students were fatigued by the overall experience and no longer felt it necessary to access the site.

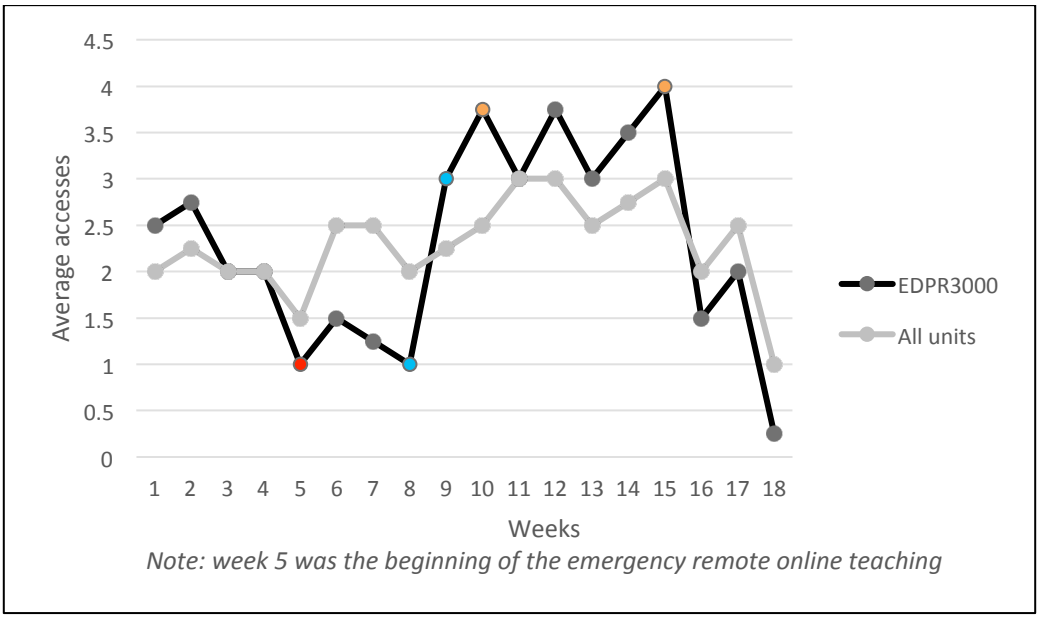

Figure 1: Students' average unit accesses for Semester 1, 2020.

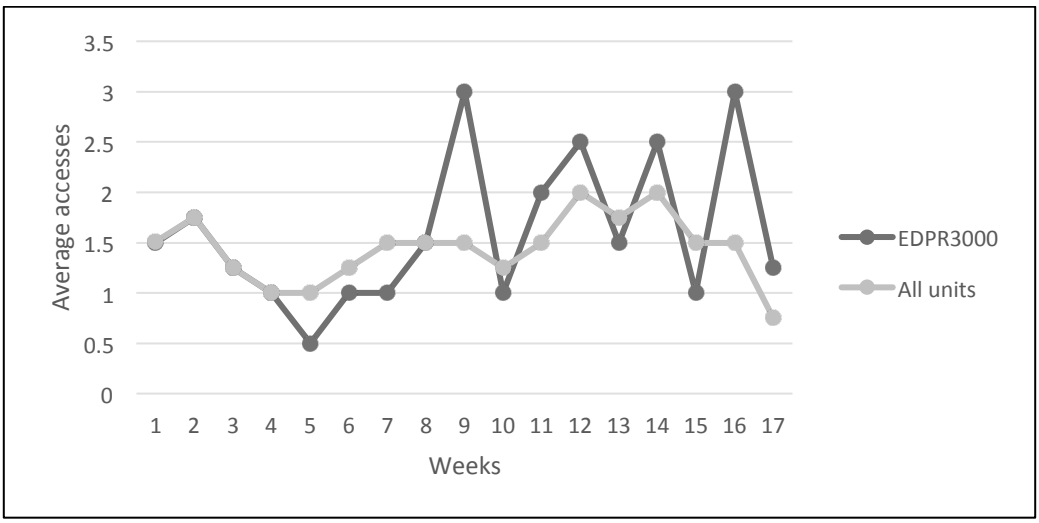

Figure 2: Students' average unit accesses for Semester 1, 2019.

Discussion

This section discusses the three basic needs of self-determination theory – autonomy, competence, and relatedness in relation to the participants' lived experiences, as reported in the surveys and interviews. In particular, the students who were interviewed reflected on losing motivation, losing their sense of community and connection, and losing agency in their learning. According to the survey responses, these participants unanimously declared that they much preferred the face-to-face experience and the real-time engagement of the physical classroom. However, consideration needs to be given to the nature of the online learning into which these students were thrust. As Gacs and his colleagues (2020) pointed out, this online mode was not a well-structured and planned online learning experience; rather, a triaged, emergency remote online version of what were carefully planned units designed for face-to-face delivery with the affordances offered by that mode. The speed of the transition from face-to-face to fully online perhaps had the greatest impact on the students' lived experiences, and most likely on their tutors as well.

Given time and support, the fully online versions of these STEM units could have been crafted to promote a community atmosphere and personal connections – two negatives of the lived experiences reported by the participants. The online environment was difficult for the students to navigate, and even more so as they did not establish their *presence* – by not using their microphones and/or not using their video camera, they became disembodied entities, unable to 'read the room' due to the lack of gestures, body language, a common physical experience, and facial expressions. This, more than any other factor, impacted their basic need for relatedness, and, as they confided, affected their motivation. Feeling disconnected also resulted in a further lack of communication by the students not wanting to contribute to the online chat function of Collaborate, due to a fear of being judged by what they write and the permanency of what they write.

In regard to the first research question *(How have students' lived experiences (e.g., participation, engagement, retention, satisfaction, academic achievement) changed as they shifted from face-to-face (F2F) to a fully online mode?*), the survey data and the interviews indicate that participation, engagement, and satisfaction changed markedly in negative ways. Although the participants all tried to participate and engage with the Collaborate sessions, their satisfaction with the delivery and interactions was low, as indicated in the interviews; however, as indicated in Table 2, the surveys showed that 57% were satisfied with the learning experiences and 61% reported that online was easier than they had anticipated. As this study focused on students enrolled in STEM-subject units, of interest is that 79% of the survey respondents felt that it was difficult to engage in STEM activities online (Table 2, row 'Difficult to engage with STEM activities'). This resonates with the findings of Chen et al. (2018) and will be an ongoing issue for lecturers and tutors in initial teacher education courses as they navigate online and blended spaces in the future. Retention was not revealed as a particular issue with the participants, and some of the participants commented that the experience had not impacted their final grades for these units, and the pass rate of 94% for the third-year primary mathematics unit seems to support this.

One unanticipated positive from the experience was that 57% of the survey respondents agreed that they were able to better manage their time in the online mode (Table 2). This was also reflected in the interviews – students were able to save time due to not having to commute to the campus and were able to channel the time they saved into various learning and assessment tasks. On the contrary, others who were interviewed reflected that, as a result of their reduced motivation, they made poor decisions about their use of time, succumbing to allure of social media and multi-tasking whilst being online for the Collaborate sessions.

Despite the affordances of their mobile phones to connect with their friends and peers, there was a pervading sense of isolation. The survey shows that 68% of the respondents felt isolated from their peers and tutors, and some of the interviewees remarked on the quietness and darkness of the online space. These students also commented on how they changed as a student, reflecting on their lack of confidence and the feeling of loss in regard to bouncing ideas off each other in real-time. This thwarts the basic need of competence (Ryan & Deci, 2020) and suggests students felt less capable and effective as learners.

Research question two *(What are the learning activities and social interactions that students prefer from the online mode over F2F?),* can be easily answered – "very few". One interviewee reflected that, as the Collaborate sessions were recorded, they could watch the recording if the live session was missed, or go to the recording to revise content, and they were able to pause and fast-forward as needed. Other than that instance, all other participants did not have any preferred activities or social interactions in the online mode.

The final research question (*What future direction would these students like to see the School of Education take in regard to delivery modes?),* did not receive a consistent response. Whilst 86% of the survey respondents agreed that face-to-face interactions were essential to their learning, and all interviewees stated that they would prefer face-to-face over any other option, 64% of survey respondents agreed that after experiencing fully online learning they preferred it to the face-to-face mode. This is even more unexpected as their lived experience was that of the triaged, emergency remote online version, which, for reasons already mentioned, is far from the online ideal. The interviewees provided suggestions on digital pedagogies, should a more online version of traditionally face-to-face units be on the future agenda of the School. They thought that a blended or hybrid approach was potentially the best option as it would allow them to have their basic needs of competence and relatedness supported by the face-to-face component, and the online aspect would support their need for autonomy, thereby potentially increasing the quality of their behaviour and achievement, and improving their wellness (Peters et al., 2018).

Reflections

The rapid switch to emergency remote online teaching in early 2020 had the principal goal of ensuring continuity of education whilst adhering to government directives to limit the spread of COVID-19 during the pandemic. As Hodges et al. (2020, para 13) noted:

> ... many of the online learning experiences that instructors will be able to offer their students will not be fully featured or necessarily well-planned, and there is a high probability for suboptimal implementation.

As higher education institutions implement strategies to reduce significant debt, resulting from the massive reduction of international, on-campus students, there is a strong call for extended use of fully online and blended modes of learning and teaching. It is crucial that following such a course of action does not replicate the deficiencies and limitations of emergency remote online teaching, but rather embraces the effective design features and affordances of well-planned online teaching and learning. Included in this consideration is the acknowledgement that online (fulltime or some of the time) modes need to be able to support the students instructionally but also with an investment in "an ecosystem of learner supports" (Hodges et al., 2020).

Student engagement and agency seem to have been adversely affected by the complex and challenging move to emergency remote online classes. Student engagement may be better when teaching content is divided into several small modules. For example, students may find attending online class modules lasting approximately 20-25 minutes (Bao, 2020) more acceptable rather than the traditional lecture format as common with face-to-face university classes. With the move to online learning, it is interesting to see how students facilitate and promote their own engagement with content and how they demonstrate agency. Student-student engagement will also need to be reimagined with the implementation of online discussion boards, tutorials, or smaller study groups within the structure of online learning.

It needs to be acknowledged here that there were some limitations to this study, although they do not necessarily lessen the validity or reliability of the findings. First, the number of survey participants was quite low given the number of students who were enrolled in the face-to-face mode of the STEM-subject units (e.g., in the third-year mathematics unit there were 118 students enrolled in the face-to-face mode, and only 21 of them participated in the survey). Further, given the time lag between the end of Semester 1 and the recruitment email for the survey (17 weeks), there is the possibility that the participants' recollections could be less authentic (changed over time and other experiences) than if they had been surveyed earlier.

Conclusion

Pre-service teachers faced novel challenges with the mandated move to fully online teaching formats. In this study, pre-service teachers indicated lower levels of overall satisfaction with the move to online classes due to the variation in course structure, assessment requirements, and a lack of peer-peer and student-teacher interactions, and it is to be remembered that these students were also dealing with the social, emotional, and psychological ramifications of the major changes in their day-to-day lives. Students found that other challenges, including being confined to their home, with the added expectation to self-manage their discipline content, learning materials, and personal learning environment (Bao, 2020), in addition to completing course work and assessment tasks.

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Appendix: Online survey

Research question	Survey statements 4-point Likert scale	Semi-structured interview questions
1	• My participation in my unit/s increased during the online mode. • I felt that I achieved better in my unit/s in the online mode. • I was satisfied with my learning experiences in my unit/s in the online mode. • Moving to the online mode was easier than I had anticipated. • I found it difficult to engage with the science/technology/mathematics activities when we moved to fully online. • I learned best in a F2F social environment. • I felt isolated from my peers when we moved to the online mode. • I felt isolated from my tutor/s when we moved to the online mode. • I was able to better organise my time in the online mode. • I was distressed at having to continue my studies in a fully online mode. • I was more motivated to complete my unit/s in the online mode.	1. How would you describe your learning experience during F2F classes, and how did it change when it moved to the online mode? 2. Can you please describe the main challenges you had in moving to the online mode? 3. What do you think were the positives or negatives to the move to the online mode? 4. Do you think that the move to the online mode impacted your academic achievement? If so, in what ways?
2	• The social interactions in my unit/s were better in the online mode. • I enjoyed the collaborate sessions in the online mode. • I connect and network with my peers better in the F2F mode. • I was able to have my questions answered better in the F2F mode. • Now that I have experience fully online learning, I find that I prefer it to F2F. • I was able to participate easily in the online activities. • F2F interactions are essential to my learning.	5. How would you describe your social interaction with your tutor/s and peers during F2F classes, and how did this change you moved to the online mode? [If this aspect was mentioned by the interviewee in Q1, skip it] 6. Were there any activities that you preferred or not preferred in the online mode compared to face-to-face? If so could you please describe these? 7. Were there any social interactions that you preferred or not preferred

		in the online mode compared to face-to-face? If so could you please describe these?
3	• Going forward, I would like all of my units to have a blend of F2F and online modes. • I would prefer to be able to move between delivery modes as it suits me and my circumstances.	8 How would you like the School of Education to design units in the future? 9, Is there anything else you would like to comment on given that you chose to be a face-to-face student and had to move to the online mode? 10. What kind of blended approach, combining features of F2F and online learning, would you like to see in the future? 11. Are there any other comments that you would like to make?

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