Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Going digital as a result of COVID-19: Insights from students’ and teachers’ impressions in a Swedish university

Fisnik Dalipi*, Päivi Jokela, Zenun Kastrati, Arianit Kurti, Patrik Elm

Department of Informatics, Linnaeus University, P G Véides väg, 351 95, Växjö, Sweden

ARTICLE INFO

Keywords:
- Emergency remote education
- Students’ and teachers’ impressions
- Technology-mediated learning
- COVID-19
- Higher education
- Mixed method

ABSTRACT

During the past two years, the entire world has been coping with the consequences of the COVID-19 pandemics. The need for physical distancing, forced an accelerated digital transformation of the education sector. The emergency remote education (ERE) has been manifested differently across diverse countries in the world. In this paper, we bring a case study about students’ and teachers’ impressions and experiences regarding the changes that have happened due to pandemic conditions in university courses in informatics at a Swedish university. This research is conducted through a mix of quantitative and qualitative empirical data. These data have been collected through the students surveys, course logs, as well as teachers and ICT pedagogy interviews. The collected data have been analyzed through the technology-mediated learning (TML) theoretical framework. Based on the thematic analysis on the collected data, we have identified three main themes: a) Preparedness, b) Challenges with ERE and c) Opportunities with ERE. As a result, through analyzing data in the light of the ERE experiences that encompasses the educational process, affordance, and beliefs, knowledge, and practices, we provide a set of lessons-learned experiences and indicate probable lines of actions when it comes to the learning design in the constrained pandemic situations.

1. Introduction

In the past two years, the world is facing the challenges posed by the COVID-19 pandemics. These challenges have affected almost the entire world population in terms of day-to-day activities and operations. Consequently, people are working, studying, shopping, and socializing from a distance. Among other aspects, these challenges brought the need for an urgent digital transformation across different fields and human activities (Jivari et al., 2020). Education sector in all the levels from primary school up to university level has been under this transformation journey in the past two years (Bogdandy et al., 2020). Because of the need for physical distancing during the pandemic times, many universities were forced to move their operations completely on a distance mode (Schneider and Council, 2021). In this situation, many universities needed to adjust and adapt their way of working to maintain the good quality teaching and learning during the pandemic times. The advances of information and communication technology (ICT) in the form of videoconferencing, recorded lecture streaming and diverse learning management tools created a good foundations for the transition of the university learning and teaching. However, the learning activities in the universities do not consist of only content delivery, but they are intertwined in diverse interactive activities such as tutoring and supervision, assignments, examination, laboratory work, etc. All these activities needed to go through a change and adoption process to the new situation during pandemics. This required to scaffold the adequate practices and have a more detailed learning design to maintain the good quality education (Pappas and Giannakos, 2021). These changes implied adoptions both from the student and from the teacher side.

This research aims to provide insights about students’ and teachers’ impressions and experiences regarding the changes that have happened forced by pandemic conditions. This study focuses on university courses in informatics subject during 2021 at a Swedish university. Through a mix of quantitative and qualitative empirical data, in this paper, we provide important insights through a set of lessons-learned experiences regarding the learning design approaches to accommodate the needs during pandemics.

In the following section, we reflect on the related work done in the field and that is followed with a set of theoretical and methodological considerations that guided this research. After that we report the data collected in the process from students and teachers, as well as provide an analysis of them. We conclude this paper with the discussions in a form of lessons-learned experiences and indicate the possible lines of actions when it comes to the learning design in the constrained pandemic situations.

* Corresponding author.
E-mail address: fisnik.dalipi@lnu.se (F. Dalipi).

https://doi.org/10.1016/j.ijedro.2022.100136
Received 3 December 2021; Received in revised form 9 February 2022; Accepted 10 February 2022
2666-3740/© 2022 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).
2. Related work

The current pandemics has affected the educational systems worldwide. The effects of the pandemics have affected the students, teachers, technology support as well as administration. The recent research conducted across different countries in the world provide a substantial body of knowledge regarding the effects of pandemics in the education sector. For instance, Niemi and Kosua (2020) reported their findings regarding the students and teacher perspectives in the Finish high school. They report that the main challenge for the teachers was the “non-authentic interactions” and “lack of spontaneous interaction”. From the student part they highlighted as main challenges “heavy workloads and fatigue” as well as “loss of motivation”. In a similar line, Jacques et al. (2020, 2021) report that even though distance learning did not affect the overall students’ performance, there were some teaching activities such as practical work and projects delivered online for which students felt less enthusiastic as they require more interaction among the peers as well as with the lecturer. Similarly in the work conducted by Iglesias-Pradas et al. (2021) they report their findings of students experiences in Spain. Interestingly, in their findings they report an “increase of the students’ academic performance” and they attribute that to organizational factors of online teaching.

Another study conducted with respondents in Bangladesh, India, Nigeria, and Saudi Arabia reports that “COVID-19 has adverse effects on education including, learning disruptions, and decreased access to education and research facilities” (Onyema et al., 2020). Furthermore, they also report that online education was hindered by “poor infrastructures including, network, power, inaccessibility and unavailability issues and poor digital skills”. Part of these findings can also be attributed to the demographics of the respondents in the survey conducted. The emerging economies in the above-mentioned states might not have had the developed IT infrastructure to cope with the demands posed by online teaching. The “unstable internet connection” was also brought up as one of the major challenges of online learning, reported in recent research conducted with Hong Kong University students during pandemics (Xiong et al., 2020). Similar challenges have also been reported in the study by Alvarez (2020) regarding the shift to online teaching during pandemics in Philippines. He identified four themes impacting the online learning experience: poor to no internet access, financial constraints, lack of technological devices, and affective or emotional support. An interesting finding was reported in study conducted in India, where students found the flexibility as the most liked element of the online teaching experience during pandemics (Hasan and Khan, 2020).

In the study focusing on teachers’ expectations and experiences during pandemic period in the Netherlands (van der Spoel et al., 2020) they highlight the professionalization of teachers and their intentions to implement ICT as main characteristics for successful implementation of the online teaching. Furthermore, in the similar study done in higher education in Germany it is reported that the current situation will have a positive effect on digital innovations in university teaching (Zawacki-Richter, 2021). In a recent work conducted in Canada (Boutler et al., 2021) regarding the students perspectives on the effectiveness of the emergency remote education (ERE) due to the COVID-19 crisis, the authors provide the five big factors for the successful ERE implementation. These factors are summarized as: support with all the necessary resources, showing empathy and care from the teacher side, involvement of the students in the design of the final exam, relaxed teaching schedule and simplified logistics. In the research conducted in Australia with tertiary students (Lorenza and Carter, 2021) regarding ERE during COVID-19, they expand these factors with also the need for collaboration between students in online settings as well as the need for adjusting the pedagogical approaches for online settings. Two studies from USA elucidate the needs and requests of students with disabilities during the pandemic (Meleo-Erwin et al., 2021; Smith, 2020). One of the studies illustrates both challenges and opportunities (Smith, 2020) that are related to design of sustainable an accessible distance learning environments. The other study points out the importance of making information easily available to students with disabilities, so that they can effectively use the provided services and resources (Meleo-Erwin et al., 2021).

With this body of knowledge from the recent work worldwide, we have a rather good foundation to built up a theoretical framework for analysing the students and teachers experiences during the emergency remote teaching shift in the university case in Sweden.

3. Theoretical framework

The technology-mediated learning theory, hereafter TML (Bower, 2019), is used as a pedagogical approach and serves as the theoretical framework in this paper. The fundamental assumption of this theory is that in a technology-enhanced learning environment, agentic intentions reside with humans, rather than with technology. TML theory represents a well-integrated and holistic theoretical framework that can easily be leveraged for developing and analyzing situations where technological solutions mediate learning. Based on adaptive structuration theory (De and Poole, 1994), this model involves several essential aspects of online education, including students’ conceptual, social, and emotional needs, and can also frame the understanding of the emergency remote education experience (Oliveira et al., 2021).

As can be seen from the Fig. 1, the technologies play the role of mediators between participants, which in this case are teachers and students. In order to frame how technology mediates learning, the TML involves seven premises (P1-P7):

P1: digital technologies can mediate for participants to achieve their learning and teaching objectives.

P2: participants’ beliefs, knowledge, practices, and the environment all mutually influence one another within the broader environment, which represents the ongoing pandemic in higher education.

P3: the role of the teacher in the process to optimize, design and deliver effective learning tasks, resources, and environment, “the learning design” (Oliver and Herrington, 2003). This also encompasses the assessment of needs that help students to achieve the learning outcomes.

P4: identification and utilization of the affordance that provides functional options to users (ICT usage) can affect learning interactions between learners and teachers.

P5: the way in which modalities are used and combined influences the way in which students can process, interpret, create, and interrelate information.

P6: the way in which technology is creating interaction patterns and possibilities between networks of participants impacts upon learning processes.

P7: the development of ‘communities of practice’, where participants aiming to achieve the same goal mutually engage, and share their insights within and beyond a course. This results in a strong sense of presence, belonging, community, engagement, and social connection.

Considering the ERE circumstances that universities have faced, where the education process started to be entirely mediated by digital technologies, TML represents a suitable theoretical framework to structure and guide this research, as is described in the upcoming sections.

4. Methodology

To understand how the learning experience was affected by ICT tools and how students and teachers perceived the extraordinary learning context imposed by COVID-19 pandemics, an explanatory sequential mixed method approach was employed. As described by Creswell and Creswell (2017), this research approach implies collecting and analyzing first quantitative and then qualitative data in two consecutive phases within one study. The main logic behind this approach is that the quantitative data and their subsequent analysis contribute to a general understanding of the research problem. On the other hand, the qualitative
data and their analysis distill and explain those statistical results by investigating participants’ views in more depth (Creswell and Creswell, 2017; Rossman and Wilson, 1985; Tashakkori and Teddlie, 2010). The visual representation of our methodological approach is presented in Fig. 2.

4.1. Data collection

The quantitative data consists of anonymous online questionnaire and Moodle-generated students clickstream data from four different courses. A total of 21 students answered the online questionnaire, while the clickstream were collected from 200 students. It should be noted that our university went back to campus teaching in September 2021. The students that have answered the survey have been identified as ones that have passed through the ERE transition due to COVID-19 pandemics. Students were from bachelor’s study program in Informatics and most of them considered themselves novices, i.e. having little or no previous experience of online learning. Due to the anonymous responses and as we did not include disability as background variable, we were not able to distinguish whether any of the participants were students with disabilities.

When it comes to the qualitative data, a total of five teachers and one ICT pedagogue were interviewed, following a convenience sampling process. Students, teachers, and the ICT pedagogue were actively using ICT platforms for communication purposes, including learning management system, and learning content edition and streaming, among others. The five teachers that were interviewed considered their online teaching experience prior pandemic as follows: two teachers were experienced, two had intermediate experience and one was novice in online teaching when the pandemic started. Both the experienced teachers and those with intermediate experience had been teaching in pure online mode, as well as in blended mode.

The department that was the unit of analysis in this case study, had quite a lot of organizational experience of distance education, including technology that is required to support distance teaching.

The interviewed ICT pedagogue observed the situation from a wider perspective, comprising the entire faculty. The ICT pedagogue confirmed that in the beginning of the pandemic there was a wide variation of knowledge and skills among the teachers concerning distance teaching.

4.1.1. Survey data

Quantitative data was collected through an online questionnaire between 01.06.2021 – 20.06.2021, and the second period between 06.09.2021 – 27.09.2021. The questionnaire used to collect students’ perceptions is structured around six different pedagogical activities including Interaction and cooperation, content delivery, course structure, examination, technology, and challenges and benefits around learning in emergent remote education. In addition, some background information of participants was collected.

4.1.2. Course logs (clickstreams)

These data comprises the use of recorded material, i.e. how often did the course participants access the material (number of views per day), and when did this happen during the course period. This statistic is collected from the university’s service/media portal LnuPlay logs and course’s Moodle room for four different courses that were offered during spring term 2021. The courses were provided to students of informatics and include: 2IK015 Evaluation of Information Systems and Business Development, 2IK400 Project work and Philosophy of Science, 1IK424 Web Management, 1IK173 Quality Assurance in Information Systems.

Due to pandemic, all the courses were given entirely on-line, and all lectures were streamed live and at the same time recorded. The recordings were available for students from the day they were streamed to the
end of the course, except the 1IK173 course, in which the lectures were made available on the day when the course started. Additionally, in all the courses, the lectures were scheduled in the beginning of the course, so that the course participants could focus on their assignments/project report after that.

4.2. Interview data

Interviews were conducted on campus (2) and remotely (4) during the period 04.10.2021 – 08.10.2021, covering the adaptation period to the new and emergent teaching and learning format. Each interview took on average 60 min, and the participants freely chose to participate in the research. Thus, no interview commenced before a clear verbal consent to participate and record the interviews for further analysis. The interview transcripts were coded, and three main themes were generated. The technology-mediated learning theory, TML, Bower (2019), was used as a holistic framework to organize the themes and their subthemes. Based on the thematic analysis, the three identified main themes are: (a) Preparedness, (b) challenges related to ERE, (c) Opportunities related to ERE. The themes, their subthemes, and their relation to TML theory are shown in Fig. 3. These findings are also integrated and represented in Table 1.

5. Results and analysis

In this section, we present findings from the survey administered to students and the interviews conducted with teachers and the ICT pedagogy. We also provide results related to log analysis with student data collected from the learning management system. The collected data is analysed in the light of the ERE experiences that encompasses the educational process, affordance, and beliefs, knowledge and practices, as depicted in Table 1.
Table 1
Emergency remote education experiences and dimensions.

| ERE experiences | ERE dimensions | TML premise | Definition |
|-----------------|----------------|-------------|------------|
|                 | Interaction and Cooperation | Teacher-student and student-student Interaction (P6) | Challenges in the interaction between teachers and students and between students themselves in ERE setting |
|                 | Course content (P3) | Need to adapt the course material due to ERE adoption |
|                 | Course content availability (P3) | Challenges regarding course content availability |
|                 | Improving the structure (P2) | Perception and beliefs of students towards improving digital course structure |
| Educational process | Examination | Assessment (P3) | Challenges concerning the students’ assessment in the ERE setting |
| Affordances (ICT usage) | Technology | Quality (P4) | Issues related to quality of ICT tools |
| | Platform features (P5) | Richness and usefulness of features available on ICT platforms |
| | User engagement (P4) | Interaction of students with ICT platform in relation to teaching material and examination periods |
| | Reliability (P4) | Challenges regarding the consistent performance of ICT platforms |
| Beliefs, Knowledge, Practices | Teacher capability (P3) | Teachers’ capability towards adoption and offering online learning |
| | Students skills (P5) | Challenges regarding the students’ needed skills |
| | Motivation (P2) | Perception of students motivation felt in pandemic times |
| | Interactive patterns (P6) | Impact of interactions between networks of participants (students and teachers) |
| | Technical and practical skills (P5) | Challenges while conducting technical and programming tasks during pandemic |
| | Flexible education (P5) | Perception that online education has supported flexible learning process |

![Fig. 4](image-url) Teacher - student and student - student Interaction.

5.1. Educational process

Educational process relates on how the learning and teaching process was affected and adjusted to the emergency remote education circumstances. Regarding the educational process, it involves three dimensions, namely interaction and cooperation, content delivery and structure, and examination.

Regarding the interaction and cooperation, our survey findings shown in Fig. 4 reveal that under emergent remote education circumstances the interaction was highly impacted, especially between students. Surprisingly, a considerable number of students were not having a clear attitude on this regard. One reason that could explain this situation is the fact of being first year students and that they have not previously been exposed to any distance education before.

On the other side, the interviewed teachers perceived detachment from their students in different ways during the pandemic. One of them expressed:

“As the name indicates, distance education creates distance between the teacher and course participants.”

Obviously, the difference was most significant in courses that usually are given on campus or in blended mode, especially if the blended learning includes live streaming of campus lectures. Some of the teachers prefer campus lectures, as they find that face-to-face meetings make it easier to get to know the students. One of the teachers with long experience of blended teaching mentioned that students in classroom “create energy” and being in pure online mode provoked loss of interaction. Another experienced teacher mentioned that giving online lectures forced the teacher to be stationary in front of the camera, whereas live streaming of campus lectures gave opportunity to move around in the room. In addition, all the teachers find that pre-recording of the lectures asynchronously enhances the feeling of detachment from the students, and lack of immediate feedback from the audience can be tedious and frustrating.

Another feature that was mentioned by teachers was that the students that were not used to distance education may lack netiquette.
Students could also randomly move in and out the Zoom room and be engaged in other things when their camera was off during the lecture. One of the teachers put forward that this kind of undesirable behavior may be due to involuntary detachment from the teaching environment, as well as from the teacher and other course participants.

The interviewed teachers did not find it more difficult to collaborate with other teachers during the pandemic; formal, work-related meetings could successfully be conducted online. However, it was mentioned that informal meetings and social interaction were not as frequent and lively when teachers could not meet on campus. One of the teachers said:

“Distance teaching is OK but I’m inclined to come to office every day – we need interaction with other people.”

As far as content delivery and structure is concerned, the survey results show that there is a need to adapt the course material due to the ERE setting since most of the students have perceived lectures and seminars delivery was worse, when compared to pre-pandemic times, as shown in Fig. 5.

Moreover, asked about the course structure – making most of the teaching materials (pre-recorded lectures, ebooks, code examples) available to be explored prior to the classroom activities, has been preferred mostly by the students. Also, it is worth mentioning that on the question “What other suggestions for improving the digital course structure do you have?”, students’ feedback involves suggestion towards offering workshop sessions, organize activities with smaller groups, all-in one platform (MS Teams) for all teaching activities and learning materials.

On the part of teachers, their opinions varied concerning the recording of lectures. The teachers with long experience of blended courses that are live streamed and recorded finds this practice helpful for students that miss a live lecture, and if students with functional variations may need more time to absorb the lecture content. On the other hand, teachers do not think that it is necessary or desirable to record pure campus lectures. One of them expressed:

“If everyone is there, there is no point in recording. The students are listening and talking, and they’ll have the handouts.”

It was also interesting to note that the more experienced teachers were quite happy with live recordings from blended lectures, and they did not usually edit the recordings. However, the less experienced teachers considered pre-recordings as more appropriate alternative. Pre-recorded material can be made more professional, especially if it is recorded using adequate equipment and properly edited. This kind of material requires more effort to produce, but it can also be re-used afterwards. Live recordings are more bound to their context in time and place, and they are not necessarily suitable for re-use. There might also be privacy issues related to live streaming and recording.

When it comes to assessment, in general, there exists a common agreement among students on the fact that examination process has not been largely affected by emergent remote education. Moreover, as indicated in Fig. 6, most of the students agreed that home exam and quizzes were the most appropriate and fair ways to assess their knowledge.

The teachers also confirmed that the examination process was only affected when on campus written exams had to be replaced with other examination models. In those cases where take home exams were used instead, there were misgivings about increased cheating, but no such trend could be observed. In blended learning, the examination is mostly conducted through written assignments, seminars (both online and campus), oral exams and sometimes online quizzes. One teacher pointed out that distance examination implies a lot of checking and monitoring, which puts an extra strain on teachers, and may also affect the trust between teachers and students. Examples of monitoring activities are checking student’s identity before oral exams and keeping track on online seminar attendance.

The ICT pedagogue confirmed that many teachers tested different examination methods during the pandemic. However, both the pedagogue and the interviewed teachers deem that there is not yet any perfect model or method for distance examination, and to guarantee academic integrity. One of the teachers commented:

“You just have to trust the students.”

5.2. Affordances

Affordances encompass the ICT dimension, and the experiences associated with the technological tools and platforms used in the ERE setting. Overall, students did not experience any difficulty related to quality, reliability and performance of the ICT platforms used for teaching and learning purposes. In particular, the survey findings presented in Fig. 7 indicate that there was no issue perceived by students related
to the quality of the ICT tools including audio and video quality, and chat.

The teachers confirmed that they were satisfied with the distance teaching equipment and tools that were available during the pandemic. Most of the time, teachers were using equipment at home, but it was also pointed out that after the pandemic it would be beneficial to utilize available studio equipment more effectively, for instance to produce more professional recordings. It is also interesting to note that the teacher with least prior experience was the most enthusiastic and innovative when equipping the home teaching environment and testing new techniques and tools.

In addition to the findings obtained from survey and the interview, an analysis of students’ clickstreams from learning management system was conducted to understand interaction of students with ICT platforms in relation to teaching material and examination period.

The views of different lectures are pooled together, showing only the sum of the views for each day. Moreover, the views are anonymous and no individuals can be traced. The distribution of ratio of views for all the courses is shown in bar charts, Fig. 8(a–d). The charts also include a cumulative distribution of views. They also indicate when all the lectures were available for the student, as illustrated by the red, vertical dotted line, and when the different examinations were conducted.

As can be seen from Fig. 8(a) and (b), the number of views is correlated to the examination activities, that is, before every assignment/project the number of students who watched the recorded lectures was significantly increased. Also, one can observe the cumulative distribution of views in both courses is constantly growing throughout the entire course. It is interesting to mention that the content of these courses is applicable and also the examination is project-based. Conversely, different trends are observed in charts shown in Fig. 8(c) and 8(d), where lectures are mainly accessed and viewed in the beginning of the course, and no correlation between number of views and examination is evident. Also the cumulative distribution curve remains unchanged during the second part in both courses. One possible explanation for these trends could be related to the theoretically-driven nature of these courses.

5.3. Beliefs, knowledge and practices

The unexpected changes triggered by COVID-19 implicate a process of personal beliefs and adaptation by the teachers and students that has greatly impacted the learning and teaching experience. Most of the surveyed students felt that the skills of teachers were adequate towards adoption and offering online learning. Also, they perceived having the adequate skills to participate in an online learning environment, as depicted in Fig. 9.

The interviewed teachers estimated that their skills were adequate concerning the online teaching technology, or even if they had not used this technology prior the pandemic, they could learn to utilize the equipment when it was needed. On the other hand, the teachers pointed out that they would like to enhance their knowledge and skills of the distance pedagogy, as well as to be able to allocate more time for testing and assessing new distance teaching techniques and tools. It was also mentioned that it is important that teachers continuously share their experience with colleagues, this would provide mutual benefits for both novices and more experienced teachers.
Table 2
A summary of experiences in ERE settings.

| ERE experience          | Students                          | Teachers and ICT pedagogue                      |
|-------------------------|-----------------------------------|--------------------------------------------------|
|                         | Mostly negative | Mostly positive | Mostly negative | Mostly positive |
| Teacher-student and student-student interaction (P6) | Course content availability (P3) | Teacher-student and student-student interaction (P6) | Course content availability (P3) |
| Course content (P3)    | Assessment (P3) | Assessment (P3) |
| Improving the course structure (P2) | Quality (P4) | Quality (P4) |
|                        | Platform features (P5) | Platform features (P5) |
|                        | Reliability (P4) | Reliability (P4) |
|                        | User engagement (P4) | Teachers’ capability (P3) |
| Beliefs, knowledge, practices | Students skills (P5) | Technical and practical skills (P5) |
| Motivation (P2)        | technical and practical skills (P5) | Motivation (P2) |
| Technical and practical skills (P5) | interactive patterns (P6) |
| Flexible education (P5) |                          |                                                  |

The interviewed teachers had observed that students had adequate technical skills to manage distance learning, but their equipment was not always sufficient, typically there were problems with microphones and cameras. This kind of technical problems could become frustrating during seminars and oral exams and other activities where active participation was required. Another issue that was mentioned earlier, was students’ deficient netiquette.

Regarding students motivation to participate in online learning activities, findings shown in Fig. 10 indicate scattered opinions where almost half of the students rarely felt motivated to actively participate in learning activities. In addition, half of the students felt that practical training, such as programming skills, have been more difficult to conduct during the pandemic. Moreover, they do not agree that online courses have enabled and supported a more flexible learning process.

Other aspects concerning the learning process highlighted by students were related to the diverse pedagogical approach used by different teachers in different courses. Although this non-uniform approach has been well accepted by some students, still there were some other students who felt this unsuitable.

Regarding the teachers’ motivation perspective, they felt occasionally unmotivated to teach during the pandemic, this feeling was mostly related with the perception of detachment, as was mentioned before. Teachers could also observe that students, especially those who had not voluntary chosen distance studies, were unmotivated and bored during the online learning activities. One teacher expressed the feelings:

“The teaching was more limited, but I’m still grateful to technology that I could continue teaching, even it sometimes was boring.”

When it comes to the impact of interactions between networks of participants (students and teachers), one of the teachers was concerned that in distance mode it was more difficult to detect if some of the students would need more support, and that students may not be as inclined to ask for help on-line. This was also related to the general perception of detachment between teachers and students. This aspect of different pedagogical approaches and its consequences were also pointed out by some teachers during the interviews.

A summary of students’ and teachers’ experiences with ERE is presented in Table 2. As can be seen from Table 2, no negative experiences are related to aspects of affordances, meaning that the ICT platforms enabled a good experience for both students and teachers. On the other hand, interaction, technical and practical skills, and motivation have contributed to negative experience.

6. Discussion

Emergency remote education (ERE) and educational disruptions have the tendency of demotivating learners and may trigger unprecedented consequences for their learning. The results of our study indicated that ERE is characterized with both positive and negative experiences. Since the learning process was intermediated by technology in pandemic settings, the study was grounded on the Bower’s TML theory (Bower, 2019) to support data collection, analysis, and the discussion of the results. In a nutshell, the study results can be encompassed by
the first premise (P1), that emphasizes that “ICT can perform a mediating role for participants in their mission and attempts to achieve the learning goals”.

When it comes to the TML’s second premise (P2), which relates to participants’ beliefs, knowledge, practices, and the learning environment, we can notice that these were related to learners’ content delivery and structure (improving course structure) and personal beliefs and adaptation (motivation). We can observe from the findings that these are associated with a negative ERE experiences, i.e., neither students nor the teachers felt motivated for online learning. Such results are aligned with previous research corresponding to the negative impact of pandemic on motivation (Niemi and Kousa, 2020). Furthermore, the findings also indicate a negative sentiment of students towards teachers’ effort on improving or adapting the digital course structure. The teachers’ adaptation emphasizes the difficulties and the burden they experienced to fully leverage and adopt technology for teaching, which can also be triggered by teachers’ technology anxiety and competency (Uerz et al., 2018). In addition, teachers were not prepared to adjust to work in a home office setting, which makes difficult to manage the work-life boundary (Watermeyer et al., 2021).

Next, the third premise (P3) covers the outcomes of TML including the role of teachers in learning design and assessment, which is more directly connected with accomplishing the learning objectives (Pappas and Giannakos, 2021). In our study, this premise is presented in the content delivery and structure, and examination dimensions. Overall, there exist a positive experience among students and teachers in relation to course content and structure. The only concern expressed by students is connected to the need of adjusting the course material contents due to ERE adoption. Moreover, the teachers convey that they need to improve their knowledge and skills of the distance pedagogy, and they also wish to be able to follow the development of distance teaching techniques and tools, jointly with their colleagues. Similar results appear in Lorenza and Carter (2021), reporting on the need for the pedagogy and course materials to be adjusted for online teaching and learning. Surprisingly, the examination dimension is positively experienced by both students and teachers. However, since most of the examinations were carried out from home, it was challenging for teachers to find the right model of examination that will guarantee maximum integrity, credibility and authenticity to online exams (Pokhrel and Chhibri, 2021).

In order to ensure a sustainable progress of distance learning it is also crucial to consider the needs of disabled students, and to be prepared to adapt the learning design to meet these requirements (Meleo-Erwin et al., 2021; Smith, 2020). In general, the university offers various forms of support for accessibility, and the support measures are adjusted to the student’s personal needs and requests.

As far as the impact that technology and affordances have on learning (P4), this premise is related to ICT usage dimension, more specifically to quality and reliability of ICT tools (or platforms), and user (students) engagement with ICT platforms. The findings of this study point out the positive experience on the required affordances for ERE among both students and teachers. The positive attitude or experience towards technology, however, does not implicate an effective use of it for educational purposes under ERE circumstances. This correlates with the findings related to next premise (P5), where technical skills were absent for some students and teachers (Zalat et al., 2021).

Considering the premise 5 (P5) that entails a combination of modalities on how P4 influence the students processing, interpretation, and creation of information, our findings unveil the presence (or distribution) of P5 in platform features, students’ skills, technical and practical skills and flexible education. Our findings showcase a combination of positive and negative experiences on this premise for both students and teachers. The negative experience relates to conducting tasks that require technical and programming skills and to the perception that online education can support a flexible learning process. On the other hand, the positive experience is related to the platform features for both groups, indicating that the richness and usefulness of features of ICT platforms can support the continuity of teaching and learning and bring the ERE experience closer to classroom teaching (Dhawan, 2020).

When it comes to premise 6 (P6), that is associated with the role of technology to create and mediate interaction between the involved participants or between the networks of participants in the remote education environment, our findings are related to interaction and cooperation, and personal beliefs and adaptation dimensions. The former is associated with teacher-student and student-student interaction whereas the latter deals with interactive patterns. Both students and teachers share a negative experience on interaction by highlighting various challenges in the interaction between teachers and students and between students themselves. Also, the negative experience from teachers’ side is reflected in the interactive patterns, where the interactions between the networks of participants have been vastly deteriorated (Crawford et al., 2020).

Finally, premise 7 (P7) represents the development of “Communities of Practice”, where a strong sense of belonging, engagement, and social connection is expected. Obviously, such a premise in our study is missing, which indicates for disadvantages and shortcomings of ERE. However, this reality carries various implications and lessons learned that are discussed in the upcoming section.

7. Conclusion and future work

This research aimed to identify, analyse and describe the educational process, the digital technologies used and the individual adaptation of students and teachers during pandemic times. The results indicate that even though ERE posed many challenges for the students and teachers, the distance mode also made it possible to continue the educational activities without any drastic disruption. Therefore, one of the core lessons learned is the need to promote preparedness for distance teaching and learning, i.e., continue the agile development of teachers’ pedagogical and technical competence.

Also, in relation to teachers’ negative experience on motivation, we believe that it is necessary to consider training teachers with new skills related to teaching in extraordinary and stressful circumstances. Such support and training would enhance teachers’ self-reliance and effectiveness and will help them to manage workload and well-being while transforming the educational process. In addition, on the student side, the importance of providing support to ERE becomes apparent in connection with fostering the interaction, participation and motivation in learning activities. In this perspective, to improve students’ skills, well-being and resilience, a model for more comprehensive support is needed. Such model could entail efforts to understand the student’s social and emotional changes triggered by the pandemics, including beliefs, motivations, practices, and culture.

Another indicative conclusion highlights the students’ negative experiences with ERE in conjunction with performing educational tasks that require technical and programming skills, despite the rich functionalities of the ICT platforms. Therefore, new approaches need to be explored to ensure resilience towards adopting and leveraging digital technologies for strengthening and supporting more flexible learning processes.

Notwithstanding that most premises (1–6) of TML are represented and linked with ERE dimensions, there is an inconsistency between premise 7 and ERE experiences, which can be explained by the abrupt transition of courses to remote learning. Correspondingly, in order to reduce the loss of sense of community for both students and teachers and to foster collaborative action, essential implications can be considered regarding developing and promoting communities of practice in the context of remote education environments. Aiming to strengthen the collaborative action in conjunction with ERE (premise 7), several actions including the application of emerging technologies could be considered to facilitate the learning and collaborations. Artificial Intelligence technologies, such as dynamic expert systems, intelligent tutors and educational chatbots, would assist with pedagogical planning and fully leverage the potential of learning management system. In addition, the application of visualizations, virtual and 3D learning environments could
accelerate and expedite learning and collaborations and improve students’ engagement. Actively maintaining and promoting such communities may be important as universities continue to adapt to the changing educational landscape caused by COVID-19. This approach may also require adjusting organizational regulations with respect to the needs of the university community during adverse social and health situations. It is worth noting that this study covers the experiences of students and teachers in an extraordinary teaching period, providing an understanding focused only to one academic field (informatics). A future study may explore how different academic fields have adapted to the ERE context, especially those fields that are primarily oriented towards laboratory or clinical learning. Moreover, to ensure constructive progress of technology-enhanced learning, it is important to elucidate the design requirements for accessible distance learning environments, and to recognise the support needs for disabled students when learning innovations are implemented. Also, since the study covers only the Swedish context, a further study is needed, which would include more countries and compare cultural differences in relation to ERE experiences. However, we believe that the findings of this study may provide insights and implications for other countries and cultures as well.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Alvarez, A. V., Jr. (2020). The phenomenon of learning at a distance through emergency remote teaching amidst the pandemic crisis. Asian Journal of Distance Education, 15(1), 144-153.

Bogplandy, B., Tamas, J., & Toth, Z. (2020). Digital transformation in education during COVID-19: A case study. In 2020 11th IEEE international conference on cognitive informatics (CoginfoCom) (pp. 000173-000178). IEEE.

Bower, M. (2019). Technology-mediated learning theory. British Journal of Educational Technology, 50(3), 1035-1048.

Butter, T., George, D., & Bruggemann, K. (2021). Student input on the effectiveness of the shift to emergency remote teaching due to the covid crisis: Structural equation modeling creates a more complete picture. International Journal of Educational Research Open, 2, 100056.

Crawford, J., Butler-Henderson, K., Rudolph, J., Malkawi, B., Glowatz, M., Burton, R., Magni, P., & Lam, S. (2020). COVID-19: 20 countries’ higher education intra-period digital pedagogy responses. Journal of Applied Learning & Teaching, 3(1), 1-20.

Creswell, J. W., & Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.

DeSanctis, G., & Poole, M. S. (1994). Capturing the complexity in advanced technology use: Adaptive structuarization theory. Organization science, 5(2), 121-147.

Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. Journal of Educational Technology Systems, 49(1), 5-22.

Hanan, N., & Khan, N. H. (2020). Online teaching-learning during COVID-19 pandemic: Students’ perspective. The Online Journal of Distance Education and e-Learning, 8(4), 202-213.

Iglesias-Pradas, S., Hernández-García, A., Chaparro-Peláez, J., & Prieto, J. L. (2021). Emergency remote teaching and students’ academic performance in higher education during the COVID-19 pandemic: A case study. Computers in Human Behavior, 119, 106715.