# Experiences from Online Teaching and Learning during the Covid-19 Pandemic: Implications for Future Digital Education

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**Abstract**

*The Covid-19 pandemic has forced education systems worldwide to find alternatives to face-to-face teaching. Although digital education has provided the opportunity to continue teaching despite the pandemic, several challenges have been identified. This paper reviews the experiences from online teaching and learning during the Covid-19 pandemic. The results indicate that the experiences from online teaching and learning, have not been unanomously positive. Lack of internet connectivity and suitable digital equipment, lack of student-teacher and student-student interaction, challenges for students with special needs, students' lack of motivation and unprepared teachers, are among the challenges identified. Scaling up digital teaching and learning has been a political goal in many countries for years, and online teching is considered the solution for achieving life long learning. There are however, challenges that must be solved before online teaching alone can be considered as a replacement for traditional classroom teaching.*

***Keywords:*** Emergency online learning, brain-based learning, blended learning, Covid-19, student engagement, student motivation, student-teacher interaction, inequality.

## *1. Introduction*

To scale up digital learning has been a political goal in many countries for years, and the use of technology is considered the solution for achieving life long learning. The phrase 'online learning' refers to education that uses Internet technology (Basilaia, 2020). Online learning has indeed changed education within the last few years. Technology can provide flexible learning environments not limited by distance, space, or time, and facilitate more personalised and student-centred learning, at all phases and stages of education and training.

As noted by Lin et al. (2019), a student in today's digital world does not require the support of a physical classroom to learn. Through technology, students have access to an abundance of information, and can explore unlimited environments virtually. These authors noted also, that the definition of learning becomes more elusive with the use of networked computing and communications technologies. In addition to traditional classrooms and methods, learning can take place through simulations, visualization technologies, remote laboratories, games, virtual communities, to mention some. Trilling & Fadel (2009) noted that technology can also increase learning equity for individuals with special needs, by for instance providing tools to boost the reading skills and understanding for students with specific reading disabilities. Basically, virtual and augmented realities give new educational possibilities (Parsons et al., 2017; Parsons et al., 2017b).

However, as this paper will demonstrate, the skills needed to be an efficient learner are also changing with the use of technology. As noted by Lin et al. (2019), 'the abundance of information that is available at the touch of a button has replaced our need to remember information with a need to sift through and prioritize information quickly'. These authors also noted that the extreme availability of knowledge from multiple technologies may in effect complicate the learning process. Thus, digital teaching and learning will require a different approach to traditional classroom teaching and learning.

All though online teaching and learning may provide enormous possibilities, results from the digital transformation in education during the Covid-19 pandemic are not unanomously positive. Due to the Covid-19 pandemic, teachers were forced to change from classroom teaching to online teaching over night. Many teachers have modified their teaching techniques to fulfill the learning requirements of the students, and have tried to engage the students during the online classes as described by Amir et al. (2020). However, too many report that they were not prepared enough to shift to online teaching (Shermila et al., 2021; Korkmaz & Toraman, 2020). This forces us to ask whether or not we fully understand the impact of technology on teaching and learning.

This paper will review the experiences from online and remote teaching and learning during the covid-19 pandemic, and discuss these experiences in light of learning theories. Learning is a complex process which has been the centre of much research, and the complete process of learning is not yet known, nor are all the factors that influence learning. However, this paper will shed light on some of the main factors affecting learning, with particular emphasis on what must be considered when changing the learning context from a physical classroom environment to virtual communication. The review is organized as follows: In the next section the method applied for this paper is presented. Then, a review on the basic factors influencing our ability to learn is presented in section 3, before reviewing the learning experiences during the corona pandemic in section 4. The previous experiences from using Massive Open Online Courses (MOOCs) are also perceived as relevant when discussing the learning outcome of this sudden change to online teaching, and will be included in the paper.

## 2. Method

The basis of the literature review is obtained through searching the literature using certain key word. Furthermore, the search focus on the experiences with online teaching and learning during the covid-19 pandemic, with particular emphasis on the students' learning outcome in the period January 2020 – April 2021, when online teaching replaced classsroom teaching. The search is based on a Science Direct search with the terms «online teaching covid» and the key words «online learning» and «education», on April 28. 2021. This search came back with 170 results, of which 69 was found to be relevant for this paper. The studies included in this review cover mainly higher education.

## 3. What influences the learning process?

When discussing teaching methods and policies to make more pupils and students master education, we seem to ignore the fact that humans are biological creatures. Instead, we try to develop methods and guidelines that are supposed to fit all. Rodgers (2015) argued that many educational activities are not built for the enhancement of learning. Rather, Rogers noted that educational activities mainly run contrary to how people are naturally programmed to learn, and that many common teaching practices do not account for providing information in a manner most suitable for effective learning.

Learning must be considered from an individual perspective, because the actors in an educational system do not have the same basis and background, nor do they necessarily resemble each other (Snyder, 2013). What works for one child, teacher, district or system is not guaranteed to work for another. Thus, in order to contribute to the education of the student when having several individual learners in the classrooms, teachers should deepen their understanding of how the brain works and apply it in their teaching methods (Snyder, 2013). Learning must be regarded as a multidimensional activity comprised of numerous sub-processes, including attention, memory, prediction, pattern recognition, reasoning, decision-making, spatial cognition, and social cognition (Bruner et al., 1986), and that must be reflected in the way the teaching is performed.

Brain-based learning (BBL) is the use of research on how the brain works, to gain an understanding of how students learn and develop in a classroom. Although countless studies indicate that students retain the most by teaching others, practicing by doing and discussing in groups, lecturing continues to be the most widely used

method in the classroom (Madrazo & Motz, 2005). The goal of brain-based education is to create a learning environment that enhances the brain's natural ability to learn, and help students to access and utilize memory storage and retrieval more effective, as it will literally change their brains (as reviewed by Willis, 2007). Information can be presented to a student in great quantity, but only when the information passes into permanent memory, learning occurs. Thus, understanding how memory and retention of information works is vital when teaching students (Madrazo & Motz, 2005).

Bransford et al. (1999) noted that human learning is building the structure of the mind by modifying the structures of the brain, and modern neuroscience has established that dendrites, the communication arms between neurons in the brain, increase in both size and quantity in response to learning (as reviewed by Willis, 2007). The neurons where memory storage takes place are not replenished, but dendrites can however, be formed throughout life and form new circuits with other dendrites, and thus enable learning. Toga et al. (2006) argue that practice increases learning, and that there is a corresponding relationship between the amount of experience in a complex environment and the amount of structural change in the brain. Thus, learning changes the physical structure of the brain, and these structural changes alter the functional organization of the brain, i.e. learning organizes and reorganizes the brain (Toga, 2006).

Neuroscience and psychology can give us important knowledge about how to enable students to learn (Tommerdahl, 2010). Practical pedagogy should implement the findings of both educational neuroscience and educational psychology to optimize the educational processes (Vaninsky, 2017). Much of our thinking, or information processing, takes place in the working memory, where we try to make sense of the information presented to us, or to solve a problem (as reviewed by Banikowski and Mehring, 1999). The information must be moved into the long-term memory within about 20 minutes, or it can be lost (Willis, 2007). The long-term memory has a virtually unlimited capacity for storage of information and recall, and a complex network of interconnections among the vast amount of stored knowledge (Banikowski and Mehring, 1999). Thus, the learning process can be defined as acquisition and processing of new information, before saving it for later retrieval by pushing it deeper into the long-term memory (Vaninsky, 2010).

The challenge students' face when trying to aquire new knowledge is therefore to be able to move information from the working memory into the long-term memory. The teachers challenge is to enable students to do this. As noted by Banikowski and Mehring (1999), 'memory is a wonderful trait of human beings, and for educators, memory is the only evidence that something or anything has been learned'.

All the rules that govern learning is not known. Previous research indicate that humans seem to learn more effectively when they are actively engaged and intrigued, when the curiosity of the learners are stimulated; when they are challenged and status quo is perturbed; when they are not anxious, fearful, or distracted by other pressing concerns; when the learning is connected to their prior knowledge and experience; and when they are interested in what they are learning (see Rodgers, 2015; Mennin, 2013; Caine & Caine, 1994; Clapper, 2010; Hart, 1983). The factors that influence the learning process are multiple.

### 3.1 Engagement

The term «student engagement» in education often refers to the degree of attention, curiosity, interest, inspiration, enthusiasm, alertness, and passion that students show when they are learning or being taught. Bower and Karlin (1974) have demonstrated that the more attention you give to the details of a stimulus, the more mental processing you must use, and the more likely you are to remember it. Involving students actively in lessons have been shown to contribute to their long-term retention (MacKenzie & White, 1982). Thus, keeping students interested in what they are learning, helps to move information from temporary working memory into memory storage (Willis, 2007). Caine & Caine (1994) noted that the goal of teaching is to stimulate the learner to know or do something new or different, by creating new neural connections or strengthening existing ones. However, the learner must not be overly stimulated or, conversely, lulled into a state of boredom (Hart, 1983).

### 3.2 Perturbment

As reviewed by Mennin (2013), teaching and learning are disturbing activities, and a teacher's role is to disturb the status quo among learners and to create conditions that promote and trigger learning. When asking questions or otherwise engaging the learner, one calls attention to what the teacher want students to notice. By challenging

the learner, status quo is perturbed and this perturbment might enhance the learning process (Mennin, 2013). It might be tempting for a teacher to simplify the information to make it more accessible to learners. However, easy accessible knowledge that does not challenge the learner, may not enhance learning (Mennin, 2013; Snowden, 2002). As stated by Stacy (2001) – 'Knowledge creation is understood as an active process of communication between humans. Knowledge is not stored, but perpetually constructed. Knowledge is not transmitted from one mind to another, but is the process of relating'.

### 3.3 Emotions and stress

Several studies have suggested that the type and level of emotions and stress experienced, impacts how we learn (as reviewed by Banikowski and Mehring, 1999). The use of emotional components at the conclusion of a learning activity, such as a surprise activity or novel demonstration, increases both knowledge retention and recall accuracy. Such usage of emotional components can promote student enthusiasm and intensify episodic memory, with the result that seldom used pathways to long-term memory storage are illuminated (McGaugh et al., 1996; Willis, 2007).

Positive emotional experiences can lead students to generate new thoughts and motivation to learn (Madrazo & Motz, 2005). According to Willis (2007), the increased interest linked with an emotional response helps to keep the new information active in working memory. Willis argued that if newly learned material is to be retained, it must be kept activated, to increase the chance for new knowledge to be stored in the long-term memory. However, the complexity needed to create new opportunities for learning, can be challenging, and this may potentially generate fear of failure (Mannin, 2013; Rodgers, 2015). When the emotional component is too strong, and learners experience fear of failure in the learning process, learning is impeded, and might decreasing retention and recall (e.g. Hart, 1983; Caine & Caine, 1994; Clapper, 2010). As noted by Connell (2009) – 'learning is enhanced by challenge and inhibited by threat'.

When stimulating the "fight or flight" response through the sympathetic nervous system, the brain is prioritizing functions, and its ability to create long-term memory is then being pushed aside (Caine & Caine, 1994). Hart (1983) use the term 'downshifting' to describe these changes in the brain's encoding processes. Fransson (1977) found that intrinsic motivation, absence of threat, and absence of anxiety were associated with deep approach to learning, while threat, anxiety, and absence of intrinsic motivation were associated with the surface approach to learning.

### 3.4 Motivation

Motivation can be defined as the characteristic or drive that makes a person want to achieve something, like gaining knowledge and new skills, or acting or behaving in a particular way. The fact that learning is hard work, pushing the brain to its limits, the learners' motivation is probably the single most important element of learning (as reviewed by Filgona et al., 2020). The students' mere presence in the class is no guarantee that students will learn something, they must be motivated for it. Filgona et al. (2020) distinguishes between intrinsic motivation and extrinsic motivation. Intrinsic motivation may be characterized by curiosity and a desire to meet challenges, and is often driven by an interest or enjoyment which a person feels in a task. The driver of extrinsic motivation may on the other hand include some kind of reward, social approval, or appreciation.

Thus, the factors that influence learning are multiple. Learning improves when students are challenged (when status quo is perturbed), engaged, motivated, and positively stimulated, while learning tends to suffer when students are bored or otherwise disengaged (e.g. Mennin, 2013; Willis, 2007; Caine and Caine, 1994; Hart, 1983). Hart (1983) conclude that the teacher must maintain a balance to ensure an engaged and alert learner who is functioning in a safe learning environment, free from fear of failure, in order to enhance long term memory retention.

There is no doubt that repetition and rehearsal is important for the retention and recall of information. According to Banikowski and Mehring (1999), unless students are given time to mentally rehearse each new piece of information; later information is likely to drive it out of their working memories. Schön (1983) commented that experience by itself may not suffice to create new knowledge; a reflective process on action or experience is what builds new knowledge. Thus, teachers need to allocate time for rehearsals, by stopping the lesson and allowing time for questions. If students are bombarded with too much information at once, they may be overwhelmed,

particularly if the teaching is complex and designed to challenge (Dauer, 2016; Reber and Kotovsky 1997). After several repetitions, working memories are set down as permanent neuronal circuits of axons and dendrites, ready to be activated when the information is needed (as reviewed by Willis, 2007).

Moving information from working memory to long-term memory also involves connecting new information with prior knowledge (as reviewed by Banikowsky and Mehring, 1999). By activating previously learned knowledge, teachers may help the students to make associations, discover patterns, and sort and store the new data as relational memory and then long-term memory (as reviewed by Willis, 2007). Obviously, this is a difficult task, since all students have different knowledge and experiences. However, by involving students actively in the process, one can help the student find and activate previous knowledge, like branches to hang the new information on, and thus create meaning and enhance long-term memory. The extent to which students learned the material in the first place, is also suggested to be important for its long-term retention (Bahrick & Hall, 1991). In figure 1, the most important factors influencing the ability to learn are summarised, including the importance of reflection/repetition and activating prior knowledge in order to move information from working memory to long-term memory.

## *4. Online learning experiences*

### 4.1 The online teaching and learning experience during the Covid-19 pandemic

Several countries responded to the outbreak of the corona pandemic by closing schools and universities. Based on statistics from UNESCO (2020), in March 2020, about 1.7 billion students around the world were uanable to go to school or university. One year later, close to half the world's students were still affected by partial or full school closures. However, one expected that schools and universities would be able to provide lessons online, and that students would engage in home learning (Grätz and Lipps, 2020). And indeed, many studies indicate that the digital transformation experienced during the covid-19 pandemic has been mainly positive, and has inspired to increased use of online teaching. Studies show that online teaching has both enabled the continuation of education during these unprecedented times, and made positive contributions like increasing accessibility and flexibility (e.g. Bdair, 2021; Iglesias-Pradas et al., 2021; Mukhtar, 2020). Online teaching has been particularly important for hospital-based educations like medical educations, considering that clinical mentors and students are potential carriers (e.g. Tabatabai, 2020; Dost et al., 2020; Anwar et al., 2021). Using online teaching platforms has been effective in terms of achieving learning outcomes, both allowing students to digest information in their own time before discussing it with peers, and allowing for multiple repetitions when lessons are asynchronous (Dost et al., 2020; Amir et al., 2020; Bdair, 2020). Developing independent learning skills, communication skills, and IT skills are among the positive experiences reported by students (e.g. Slimi, 2020). However, a majority of the studies reviewed here, identify challenges that prevent efficient online teaching and learning.

### 4.1.1 Challenges with technological intrastructure and limited access to internet

A previous report from the EU has suggested that limited access to digital infrastructure and internet can be an obstacle for online teaching. OECD's PISA exercise in 2018[1], showed that many low-income homes had no access to computers, while Eurostat figures from 2019[2] indicated that access to broadband internet varies significantly across the EU. This is also supported by the OECD 2020 report[3].

Adnan & Anwar (2020) concluded that in underdeveloped countries like Pakistan, where a vast majority of students are unable to access the internet due to technical as well as monetary issues, online teaching and learning cannot produce desired results. This is also supported by others (e.g. Mukhtar et al., 2020; Anwar et al, 2021). Accordingly, Mishra et al. (2020) stated that the third world countries are facing policy paralysis in handling the sudden shifting scenario of educational planning, management and organization during this pandemic, having fractured technical infrastructure, academic incompetence and lack of resources.

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[1] https://www.oecd-ilibrary.org/education/pisa-2018-assessment-and-analytical-framework_b25efab8-en
[2] https://ec.europa.eu/eurostat/statistics-explained/index.php/Digital_economy_and_society_statistics_-_households_and_individuals
[3] OECD 2020, https://www.oecd.org/coronavirus/policy-responses/strengthening-online-learning-when-schools-are-closed-the-role-of-families-and-teachers-in-supporting-students-during-the-covid-19-crisis-c4ecba6c/

Thus, challenges with technological infrastructure, unstable internet connection, and extra financial burden for the internet quota, are identified as obstacles to online learning, and might be the major factors reducing students' learning outcome during the covid-19 pandemic. This is true also for many of the studies that describe online learning as a flexible and positive experience (e.g. Amir et al., 2020; Slimi, 2020; Adnan and Anwar, 2020; Muthuprasad et al., 2021). In the papers included in this study, limited access to internet needed to participate in online teaching and learning is reported in studies from Australia, China, Germany, Iraq, India, Indonesia, Jordan, Morocco, Nepal, The Netherlands, Pakistan, The Phillipines, Romania, Saudi-Arabia, Turkey, UK and USA (Table 1).

Another challenge affecting online learning effectiveness is whether the learner is able to use the technology or not (Hofmann, 2014). Students that experience difficulties in using technology may be excluded from the learning. As noted by Williamson et al. (2020), not all young people are the well connected, digital experts that one might think. Instead, there is a significant variety in the ways that young people can access, navigate and use the internet and other new technologies, which might exclude some entirely.

A survey among Swedish principals concluded that students with special needs or a stressful home environment, has been shown to be particularly vulnerable to distant learning[4]. This is supported by Morgan (2020), who noted that for many students with special needs, remote education is not as effective as the kind they receive at school. And particulary for disadvantaged students, lack of availability of digital infrastructure with proper internet availability can influence their study progress (Chaturvedi et al., 2021). Thus, accessibility of technological tools may impact directly on whether individuals are included or excluded from learning (Williamson et al., 2020). There are however, other factors contributing to the lack of learning outcome, as will hereby be adressed.

### 4.1.2 Student-teacher interaction

As noted by Lapitan et al. (2021), the most significant difference between online teaching and traditional classroom teaching is that students and instructors cannot see and communicate with each other face-to-face. These authors reported that most students were unwilling to use their webcams, even though the instructors requested the students to turn on their video cameras during synchronous sessions to promote visual communication. Not being able to see each other made it difficult to conclude on whether students are paying enough attention. This might prevent effective communication and decrease the effectiveness of student-teacher engagement.

In a national student survey in Norway 2020, students reported that they had learned less during the covid-19 pandemic, and 72 percent of the students agreed upon the statement "I would have learned more if I could have been physically present at the institution". These results were also confirmed in the Norwegian SHoT-survey on students' health 2021, where 70 percent of the students considered digital teaching to be worse, or much worse, compared to traditional teaching.

This finding has been supported by several studies, where students report lack of student-teacher interaction as a challenge (e.g. Korkmaz and Toraman, 2020; Adnan and Anwar, 2020; Chen et al., 2020; Bdair et al., 2021), and that they prefer face-to-face teaching (e.g. Aguilera-Hermida, 2020; El Firdoussi et al., 2020; Adnan and Anwar, 2020). Table 1 indicates that the students are not satified with the student-teacher interaction during the covid-19 pandemic.

**Table 1: Challenges identified as obstacles to online learning during the covid-19 pandemic**

| Country | Sufficient access to digital infrastructure and stable | Enough time for student-teacher interaction | Teachers prepared for online teaching / familiar with internet-based teaching tools | Comments | References |
|---|---|---|---|---|---|

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[4]https://skolinspektionen.se/globalassets/02-beslut-rapporter-stat/granskningsrapporter/ovriga-publikationer/2020/covid-19/uppfoljning-av-gymnasieskolors-distansundervisning---slutrapport.pdf (Swedish)

| | internet connection | | | | |
|---|---|---|---|---|---|
| Australia | NO | NO | - | Particular challenges for indigenous students – cultural and digital isolation | Bennett et al., 2020 |
| China | NO | NO | - | No or slow internet connection | Tang et al., 2021; Chen et al., 2020 |
| Germany | NO | NO | YES/NO | Challenges with digital infrastructure; lack of internet connectivity | Offergeld et al., 2020; Eberle & Hobrecht, 2021 |
| Iraq | NO | - | - | Unreliable internet connectivity | Tuma et al., 2021 |
| India | NO | NO | NO | Limited access to internet and infrastructure, limited class interaction, lack of digital skills | Mishra et al., 2020; Singh et al., 2021; Chaturvedi et al., 2021; Gupta et al., 2021; Muthuprasad et al., 2021; Shermila et al., 2021 |
| Indonesia | NO | NO | - | Technological barriers and limited internet connectivity | Rahiem, 2021 |
| Jordan | NO | NO | NO | Bad internet connection, poor technical setup, not enough interaction | Sindiani et al., 2020 |
| Morocco | NO | NO | NO | Below average or no internet connection, lack of digital skills | Elfirdoussi et al., 2020 |
| Nepal | NO | - | - | Limited access to internet | Paudel, 2021 |
| Netherlands | - | NO | - | Offline meetings provides more interaction and higher level of relatedness | Meulenbrocks, 2021 |
| Pakistan | NO | - | - | Limited access to internet and computers | Mukhtar et al., 2020; Anwar et al, 2021 |
| Philippines | NO | NO | NO | Unstable internet connection, unprepared teachers and too little time for interaction | Lapitan et al., 2021 |
| Romania | NO | NO | - | Unsatisfactory internet Access; academic support important | Roman & Plopeanu, 2021 |
| Saudi Arabia | NO | NO | - | Limited access to internet | Bdair, 2021 |
| Turkey | NO | NO | NO | internet connection problems, lack of educator-student interaction, reshape the competencies of the educators | Korkmaz & Toraman, 2020 |
| UK | NO | NO | NO | Poor internet connection commonly perceived barrier | Dost et al., 2020 |
| USA | NO | NO | NO | Unequal access to technology – children from low-income families less likely to have computers and internet connection | Morgan, 2020; Moser et al., 2021 |

Meulenbroeks (2020) found that when offered a choice, students preferred offline meetings to online meetings, based on the higher level of interactions in the former, and higher levels of relatedness. The students enjoyed the low threshold for asking questions, and reported more focus during the offline meetings. However, students also enjoyed the possibility to perform small group work in an online environment (Meulenbroeks, 2020).

### 4.1.3 Students' motivation for online learning

The Covid-19 outbreak has made a significant impact on the mental health and daily routine of students (Chaturvedi et al., 2021). Several studies have revealed that students have expressed stress related to online learning and difficulties when completing schoolwork during the Covid-19 pandemic (Aguilera-Hermida, 2020; Jamalpur et al., 2021; Roman and Plopeanu, 2021). Eberle & Hobrecht (2021) noted that even though teachers' implementation of digital learning opportunities was perceived as adequate, students were overwhelmed by the increase in autonomy and the decrease in social relatednesss during emergency online teaching. Accordingly, Aguilera-Hermida (2020) found that attitude, motivation, and self-efficacy played a significant role when adapting to online learning.

Thus, students' self-motivation and self-organization skills play a crucial role when adapting to online learning. Students also reported difficulty to focus while learning online for a longer period of time (Amir et al., 2020), and perceived fatigue when listening to online lectures (Tuma et al., 2021; Rahiem, 2021). The challenges during the emergency online teaching and learning periode have been multiple, and an important question is whether the teachers were prepared for online teaching or not.

### 4.1.4 Teachers' preparedness for online teaching

Even though online teaching and learning has been present in higher education for nearly two decades, several studies indicate that the teachers were not prepared for the unique demands that online teaching and learning pose or familiar with internet-based teaching tools (e.g. Shermila et al., 2021; Korkmaz and Toraman, 2020), as reported by themselves or their students (Table 1). Scherer et al. (2021) noted that teachers in higher education is a heterogeneous group with respect to their reported readiness for online teaching and learning, and that their readiness goes beyond their self-efficacy and teaching presence and depends on the institutional, cultural, and innovation context.

### 4.2 What can we learn from the MOOCs?

The experiences from the digital transformation during the corona pandemic have revealed many challenges, like lack of internet connectivity and suitable digital equipment, lack of communication and teacher-student and student-student interaction, challenges for students with special needs, and unprepared teachers, among others.
These challenges should not come as a surprise, as several of them were noted as MOOCs were introduced. The introduction of MOOCs was the educational revolution that should make education accessible to everyone and everywhere. As noted by Ohna et al. (2014), the problems observed with the use of MOOCs became even more acute when MOOCs were proposed as a replacement for traditional teaching, rather than just free, spare time activities. This could be compared to what happened as we entered the Covid-19 pandemic – where online teaching replaced classroom teaching almost over night.

MOOCs arose in popularity a few years ago, for being open, free and accessible to many more learners than would be possible through conventional teaching. Despite of the great enthusiasm and rapid growth of MOOC courses and platforms, there has also been rising concern over a number of MOOC aspects (as reviewed by Onah et al., 2014).

One key criticism of MOOCs has been the high drop-out rates (Rabin et al., 2019; Gardner & Brooks, 2018; Reich & Ruipérez-Valiente, 2019). These rates are on average as high as 93% (e.g. Rabin et al., 2019; Chuang & Ho, 2016; Jordan, 2014; Margaryan et al., 2015). According to Onah et al., (2014), of the millions of learners who have already participated in MOOCs, the vast majority do not get to the stage of obtaining a certificate of completion.

Actually, most MOOC participants who earn certificates for completing the course are experienced learners with a strong academic background (Rabin et al., 2019; Christensen et al., 2013; Daily, 2014; Guo & Reinecke, 2014; Hansen & Reich, 2015; Koller et al., 2013; Reich & Ruipérez-Valiente, 2019).

Only a few of the MOOCs have reached high completion rates, and most courses have a passing rate less than 13% (Amnueypornsakul, 2014; Jordan, 2015). Jordan also found that completion rates varied significantly according to course length, with longer courses having lower completion rates. However, it has been argued that completion rate statistics should not be viewed in this way (Rabin et al., 2019; Onah et al., 2014). Technological

developments such as online teaching and learning in general, and MOOCs in particular, have enabled lifelong learning. If even a small percentage of a very large group completes, the actual number of successful students will still be far greater than would otherwise have been possible (as reviewed by Rabin et al. (2019); Onah et al., 2014). This is not the case when online teaching fully replaces classroom teaching.

As reviewed by Ohna et al. (2014), there are several reasons for why students drop out of MOOCs, and lack of motivation to complete, level of difficulty, timing and lack of digital and learning skills are some of the reasons (Milligan & Littlejohn, 2017; Lan & Hew, 2020). These authors also point out that the "one size fits all" MOOC format is not adapted to individual needs.

Lan and Hew (2020) found that the current MOOC design seem to inadequately meet the MOOC participants'sense of relatedness, with instructor availability and active learning being the main factors affecting the sense of relatedness with tutors and with peers respectively. Lacking face-to-face interaction has been identified as one of the major problems with MOOCs (reviewed by Bralic and Divjak, 2018).

## *Conclusion*

This paper identifies several challenges with online teaching and learning during the Covid-19 pandemic. All though it may be argued that much of it can be regarded as emergency online teaching and learning, these challenges must be dealt with when planning for future digital education.

As summarized in section 4.1, some of the challenges that influenced the learning process during the pandemic, was lack of internet connectivity and suitable digital equipment, lack of student-teacher and student-student interaction, challenges for students with special needs, students' lack of motivation, unprepared teachers, among others.

Issues as technical skills, lack of connectivity and infrastructure can be solved. Preparing teachers better for online teaching and make them familiar with internet based teaching tools can also be done. However, online teaching demands different pedagogical approaches. When using e-learning systems in order to promote student learning, teachers must be able to innovate in their pedagogical approaches and the material in their teaching (Basilaia, 2020). Teachers must be confident and skilled in using digital technology to support their teaching and adapted pedagogy, but also learners need to develop the skills for online learning. To understand why changing from classroom teaching to online teaching without changing the pedagogy might not work, one has to consider what is essential for learning. Learning is a complex process, and must be treated as such.

In studies from countries all over the world, students reported lack of student-teacher interaction (Table 1). Maintaining a two-ways communication through a computer screen when the students turn their cameras off, is demanding. As noted by Meulenbroeks (2020), students preferred offline over online lectures because the former provided better communication - direct eye contact between students and teachers and use of body language. Online teaching and learning is missing what comes natural with face-to-face teaching and learning, and which is crucial for the process of learning – the relatedness and interaction with the teacher and other students (e.g. Adnan and Anwar, 2020; Meulenbroeks, 2020). This affects engagement, motivation, communication relatedness and well-being of the students. Several studies have concluded that engaged and motivated, self-directed, self-organized online learners with self-efficacy are crucial for effective online learning (i.e. Aguilera-Hermida, 2020; Su, 2016; Daumiller, 2021; Eberle & Hobrecht, 2021).

Some of the challenges reported in the studies during the Covid-19-induced online teaching and learning were lack of student motivation (e.g. Korkmaz and Toraman, 2020), difficulties to maintain student interest and engagement during online classes (e.g. Lapitan et al., 2021), perceived fatigue when listening to online lectures (e.g. Tuma et al., 2021), and experiencing stress, anxiety and imprisonment (Jamalpur et al., 2021). Singh et al. (2021) noted that the attention span of the students depended on the motivation of the students, time of the day, and their learning experience. In light of this, it may come as no surprise that the efficiency of the online teaching and learning was reported to be less than optimal.

It might be argued that these challenges were the sole result of the Covid-19 pandemic, as stated by Offergeld et al. (2021): 'The current conversion to digital teaching is not primarily driven by didactic rationale or institutional strategy but by external circumstances'.

However, it must be noted that similar problems have been reported also for MOOCs. One of the major problems with MOOCs has been that they do not meet the participants' sense of relatedness with tutors and peers (as reviewed by Bralic and Divjak, 2018). In a traditional classroom, there are various teaching interaction modes, such as reversed classroom, random questions, and group reports. During online teaching, teachers' input teaching is however the main teaching mode (Chen et al., 2020).

In an online lesson, it might not be natural to stop the lesson and give time to rehearsal or reflection, particularly if students are hiding behind black screens (Lapitan et al. (2021). Repeating the same information several times, and stopping to provide time for the students to reflect upon the information presented, is important to promote the processing of information in working memory. Working memory processes the new information during the lecture and integrates it with prior knowledge to form long term memory (Schweppe and Rummer, 2014). If teachers are presenting new information while previous information is still being processed, this may empede the learning. Asyncronous online lessons that are available for students to repeat whenever they want to, may however, enhance the learning process (Bdair et al., 2021).

Students with cognitive disabilities, have limited space in their working memory, and it is important not to present too much information to them too quickly (Banikowski & Mehring, 1999). This might explain why remote education is not as effective as the kind they receive at school for students with special needs (Morgan, 2020), and is in accordance with what we have learned from the MOOCs - experienced learners with strong academic background are the ones most likely to complete the courses (Ohna et al., 2014).

Acknowledging the problems of MOOCs, has led to developing MOOCs as a part of blended learning (Bralic and Divjak, 2018), where MOOCs can enrich traditionally taught courses and act as a complementary resource in achieving teachers' and students' goals. Blended learning can be defined as the "use of technology with face-to-face teaching" (Torrisi-Steele & Drew, 2013).

Students following blended courses has been shown to have higher perceptions of learning, satisfaction, cognitive presence, teaching presence and social presence, than students in online courses (Akyol & Garrison, 2011). Blended learning has been shown to create an effective learning environment that motivates students to participate, and collaboratively and individually construct knowledge and develop critical thinking skills, resulting in better learning outcomes (e.g. Wang and Zhu, 2019; Kong, 2014; Giraldo-García et al., 2015). This is however, in contrast to the findings of Lim et al (2007), who did not find a difference on perceived learning between blended and online learning environments.

Van Alten et al. (2019) concluded that students in flipped classrooms even achieved significantly higher assessed learning outcomes than students in traditional classrooms, and were equally satisfied with the learning environment. These authors emphasized however, that sustaining face-to-face time and adding quizzes are critical features for a successful implementation of a flipped classroom. With blended learning, both teacher and learner are given time to share the content, ideas and construct knowledge through online interaction, while support and help with problem solving are provided by during the face-to-face teaching (Giraldo-García et al., 2015).

Thus, blended learning, with a combination of online and face-to-face learning is suggested to give the best learning outcome (e.g. Wang and Zhu, 2019; Kong, 2014; Giraldo-García et al., 2015). "This has also been suggested in several of the studies..." regarding the covid-19 online teaching and learning experiences (e.g. Abbasi et al., 2020; Amir et al., 2020; Dost et al., 2020; Korkmaz & Toraman, 2020; Paudel, 2021).

Future pandemics or new waves of the present pandemic may impose lockdowns again, and the current COVID-19 pandemic has despite of the challenges, changed the utilization of technology in education. As noted by Zawacki-Richter (2020), this crisis might have a positive effect on digital innovations in universities around the world, and the expectations of more digital education have raised. Accordingly, the European Commission has recently launched the Digital Education Action Plan (2021-2027)[5], which outlines the vision for high-quality, inclusive and accessible digital education in Europe. It is a call to action for stronger cooperation at European level to learn from the COVID-19 crisis, during which technology is being used at an unprecedented scale in education and training. The focus is to develop an EU-wide common understanding of how to make distance, online and blended learning effective, inclusive and engaging by the end of 2021.

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[5] https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan_en

However, if the sudden change from classroom teaching to online teaching should be used as opportunity to achieve more digital education, one should learn from the above mentioned experiences. The challenges must be dealt with, and the best experiences must be used to develop new teaching strategies to maximise the effectiveness of online learning. Su (2016) concluded that an ideal online learning environment should include high levels of social presence, cognitive presence, and teaching presence, well-established online learning communities, and self-directed online learners. Findings also reveal that student accessibility and motivation play important function in online learning, and increasing the student-teacher interaction can improve students' learning enthusiasm and concentration (e.g. Ali, 2020; Daniel, 2020; Hodges et al, 2020; Murphy, 2020).

To ensure that the most important factors influencing the process of learning (as presented in figure 1), is taken care of during an online session may seem like an impossible task, and not only during a pandemic. The students should be kept safe and related, engaged and motivated, while simultanously challenging them to perturb their status quo and make them learn.
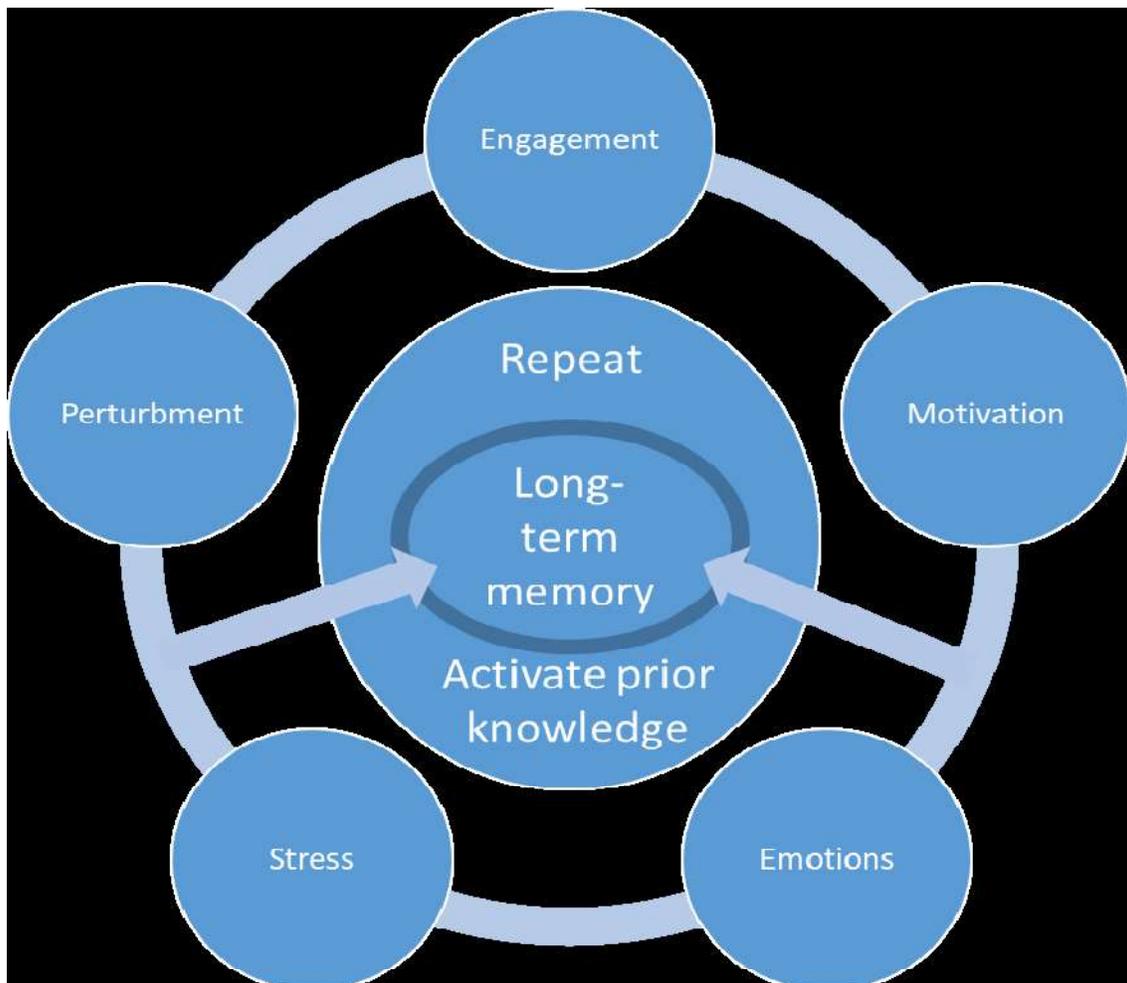


Figure 1: The most important factors influencing the process of learning and storing knowledge in the long-term memory.

This must be considered for future online teaching and learning, whether it occurs in a "normal" situation or during a pandemic. Blended learning, combining online learning with face-to-face learning is considered to give the best learning outcome. When this is not possible, ways of compensating for the lack of student-teacher interaction should be considered, like interactions in smaller online discussion groups (with cameras on!). The lessons must be shorter than a traditional classroom session, to avoid information overload that may empede the learning, and the student should be engaged and motivated through the use of questions, quizzes etc. Shorter, diverse lessons with different means of instruction may be more effective than an ongoing lecture environment (Madrazo & Motz, 2005).

Thus, several factors must be considered to increase the effectiveness of online teaching and learning, in order to enhance, instead of empede learning. As summarised by Rodgers (2015), the possibilities to make the wrong turns during teaching are multiple; 'The list of assaults on the brain's ability to learn are many: the drone of a seemingly endless lecture, unengaging online activities that only supply page turn interactions, simplistic exercises that hold little relevance to the learner's world, rapid fire content that overwhelms the ability to assimilate new information, and intimidating classroom environments that create fear of failure.'

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