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The switch to online teaching during the first COVID-19 lockdown: A comparative study at four European universities

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Abstract

In 2020, for the first time in history, COVID-19 measures necessitated emergency online teaching to ensure continuity of education. Although institutional support was offered to lecturers, the situation posed an extraordinary challenge for university teaching. Using a comparative approach, this study surveys lecturers from different countries and their use of educational technology for emergency online teaching. Its focus lies on the relationships between use of educational technology, online teaching self-efficacy and attitudes towards educational technology. Overall and according to reports, the use of educational technology increased significantly compared to pre-pandemic conditions. The universities studied had different levels of digitalization, which influenced lecturers' use of educational technology. Furthermore, lecturers differed in terms of self-efficacy, attitude, and perception. Regarding factors affecting educational technology use, results showed that especially pre-pandemic experiences with educational technology, as well as self-efficacy and perceptual variables influenced the use of educational technology during the pandemic. Based on these results, it is advisable for universities to embrace this ad hoc switch to online teaching as an opportunity for purposeful digitalization of university teaching.

Practitioner Notes

1. Universities have varying degrees of digital maturity and this needs to inform institutional strategy.
2. COVID-19 brought to the fore university strengths and weaknesses relating to digital competency.
3. Synchronous web-conferencing has grown in popularity during the pandemic compared to other educational technologies.
4. There are significant differences in EdTech usage across UK, Germany, France, and Switzerland.
5. The UK had the greatest propensity to adopt/adapt EdTech resources.

Keywords

Educational technology, COVID-19, higher education, emergency online teaching, self-efficacy, university lecturers

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Introduction

The strengths and weaknesses in the digital maturity of universities have been exposed by the COVID-19 pandemic. Before the first COVID-19 lockdown, the digital transformation had followed its own dynamic and pace. On the macro-level, it progressed alongside policy, and on the meso-level, its progress depending on institutional strategies of adapting to industrial and social technological advances (European Commission, 2020). After the enforced closure of educational institutions in March and April 2020 in Europe, the existing pattern of digital transformation changed from one day to the next. Consequently, the lockdown of universities demanded an emergency migration to online teaching. Educational institutions across the globe had to ensure that education continued, and took diverse measures to do so. The most common route was to intensify the use of educational technology for synchronous and asynchronous online teaching (Hunter & Sparnon, 2020; Marek, Chew, & Wu, 2021).

Universities offered lecturers various levels of support to build an online learning environment, such as newly introduced software, best practice lists, and task forces for online teaching. Nevertheless, the burden of ad hoc adapting and adjusting to the situation and ensuring high quality teaching remained with the lecturers. What had already been established in everyday life for online and distance lecturers became the new reality for lecturers who had been accustomed to conventional face-to-face classroom teaching methods as well.

As a result, these lecturers had to engage more deeply in using educational technology. For some of them this was not a big hurdle, while for others it posed a new and overwhelming challenge. For a third group it turned into a window of opportunity for pedagogical innovation and development of personal skills (Göbel et al., 2021). Although the last two decades have seen advances in online teaching at universities, conservative stances persist in the sense that traditional lecturer-centered teaching is often viewed as “the gold standard for higher education” (Kehrwald & Parker, 2019).

As Carrillo and Flores (2020) note, it is essential for administration and lecturers of universities to overcome rigid thought patterns. Thus, it is possible to draw constructive conclusions from these unprecedented times. As a result of pandemic-disrupted change, it will be possible to shape the post-pandemic university regarding online and blended teaching and learning (Hodges et al., 2020; Littlejohn, 2020; Rapanta et al., 2020). It is therefore of utmost importance to examine those processes which the pandemic prompted in university lecturers in order to identify factors that enable a successful switch to online teaching.

To do so, the current study differentiates three analytic dimensions and takes into consideration their interrelatedness (see The aim of this study is to analyse the transition lecturers made during the first COVID-19 university lockdown. Therefore, the focus lies on individual and institutional factors that facilitated or inhibited the switch from conventional teaching before the pandemic to online teaching during the lockdown.

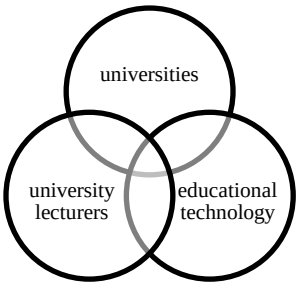
Figure 1):

1. *Educational technology* as the tool to ensure education in lockdown situations.
2. *Universities* as an institutional context for online teaching.
3. *Lecturers* as the key factor in the transmission of knowledge and skills at universities.

The aim of this study is to analyse the transition lecturers[1] made during the first COVID-19 university lockdown. Therefore, the focus lies on individual and institutional factors that facilitated or inhibited the switch from conventional teaching before the pandemic to online teaching during the lockdown.

Figure 1

Three dimensions for analyzing digitalization in higher education.



"Lecturer" includes persons who teach at a university, regardless of their position.

Earlier studies have shown that facilitating and inhibiting factors for online teaching are, on the one hand, individual factors such as teaching self-efficacy, experiences, attitudes, behavior, and lecturers' relatedness to colleagues and students (Bolliger & Wasilik, 2009; Marzilli et al., 2014; Guillén-Gámez & Mayorga-Fernández, 2020; Klassen et al., 2012; Chang, Lin, & Song, 2011; Horvitz et al., 2014). Moreover, institutional factors such as technological infrastructure, professional development, and support are decisive for online teaching (Buchanan, Sainter, & Saunders, 2013; Reid, 2012, Cook et al., 2009; Marek, 2009). On the other hand, potential barriers to online teaching are the lack of support and insufficient preparation of lecturers (e.g., through peer feedback, content-specific and teaching assistance). Likewise, ailing infrastructure, lack of instructional design support as well as continuing pedagogical and didactics education were found to hamper the switch to online teaching (Marek, 2009). So far, little research has compared and investigated lecturers from different countries as well as their use of educational technology for online teaching (Martin et al., 2020; Huang et al., 2019). However, there have been a few comparative studies on digital transformation in higher education during a pandemic (e.g., Tejedor et al., 2020; O'Brien et al., 2020; Göbel et al., 2021).

State of research

COVID-19 and Digitalisation at universities

With its disruptive force, the COVID-19 pandemic paved the way for a new era at universities. Simultaneously, it can be perceived as a window of opportunity in which individuals, groups, and institutions grasped chances for development. After the medieval university, the Humboldt university, and the entrepreneurial university, Strielkowski and Wang (2020) describe the 4th generation as the "online & digital university". Although COVID-19 propelled sudden migration to online teaching and learning, it posed a considerable challenge to lecturers and students. Consequently, universities from various parts of the world responded with an emergency digitalization of teaching, learning and research (Crawford et al., 2020; Bozkurt & Ramesh, 2020).

Digitalization in this context means the integration of educational technology to fulfil the teaching mandate of universities and the difficulties that come with it. The current literature on emergency online teaching highlights the lack of technical capacities for online teaching. Existing infrastructure was exceptionally strained by the increase in demand for implementing new synchronous and asynchronous online learning environments (Zhang, 2020). Furthermore, university administrations had to address additional problems related to the lockdown of universities and various members of universities needing support. For lecturers and students, not only technological burdens emerged but also family and housing situations came into play as decisive factors for effective teaching and learning (Huber & Helm, 2020; Göbel et al., 2021; Watermeyer et al., 2020). Beyond the availability and quality of teaching and environment, lecturers' competencies to use the means to switch to online teaching and to cope with the challenging situation were of crucial importance (Martin et al., 2020; Ritzhaupt et al., 2018; Kushner Benson & Ward, 2013). Despite the rapid rise of awareness of health risks among lecturers (Xiong et al., 2020; Sieber et al., 2020), the social isolation of the pandemic put at risk the mental and physical health of lecturers and students alike, ultimately affecting teaching and academic performance (El Ansari & Stock, 2010; Lipson & Eisenberg, 2018).

However, the ongoing digital transformation in society and institutions led to a certain familiarity with educational technology and smart devices among university students and lecturers. Lecturers were accustomed to established educational technology, such as web conferencing systems (WCS) and learning management systems (LMS). This circumstance facilitated the switch to online teaching (Mishra, Gupta, & Shree, 2020). Marek, Chew, & Wu, (2021) show that the success of online teaching during the pandemic depended on lecturers' previous experience with educational technology. Accordingly, lecturers who taught five or more online courses reported a more positive experience with fewer difficulties in teaching online during the pandemic than those who had had little to no experience.

The study by Mishra, Gupta, & Shree (2020) found that during the lockdown, university lecturers and students intensified their use of educational technology. The tools reached from in-house LMS to Google Classroom, various WCS, and YouTube for broadcasting and/or sharing educational videos. Additionally, the authors found that a very high percentage (87%) of lecturers used conventional telephone calls to connect with students, which is presumably due to the size and rural location of the university investigated. Nevertheless, these findings are in line with the results from a cross-sectional study that assessed the use of educational technology before and during the lockdown. According to this study, lecturers used asynchronous online platforms such as audio and video recordings, text forums and particularly WCS more often (Sieber et al., 2020). Conversely, Sarfaraz et al. (2020) found that 61% of participating lecturers taught asynchronously while 39% taught synchronously during the lockdown. In sum, these studies show that university lecturers could take up new educational technology and combine it with existing platforms that their universities provided.

Educational technology as the gateway to online teaching

Educational technology includes a variety of digital tools and applications. Ross, Morrison, and Lowther (2010, p. 19) describe it as "a broad variety of modalities, tools, and strategies for learning. Its effectiveness, therefore, depends on how well it helps lecturers and students achieve desired instructional goals". Research based on first and second-order meta-analysis has shown that educational technology can have a positive effect on learning outcomes. However, the reported effects were rather weak and depended on many other factors (Ben Abid-Zarrouk & Audran, 2008; Tamim et al., 2011, Schmid et al., 2014).

University learning and teaching can benefit profoundly from educational technology integration. Getto (2020, p. 368) has highlighted that educational technology should "improve the quality of teaching and learning" by

- increasing the intensity of learning, supporting active learning,
- supporting individualized/personalized learning, and
- supporting online social learning.

Previous research has established that educational technology integration is influenced by personal and external factors. This was examined with regard to the concept of technology acceptance (Wingo, Ivankova, & Moss, 2017; Granić & Marangunić; 2019), technological, pedagogical and financial support for the transition to online teaching (Baran & Correia, 2017; Alemu, 2015; Reid, 2012; Gannon Cook et al., 2009), motivation and teaching load related to online teaching (Polly, Martin, & Guilbaud, 2020; Bolliger & Wasilik, 2009; Kebritchi, Lipschuetz, & Santiague, 2017), ICT competencies (Martin et al., 2020; Ritzhaupt et al., 2018; Kushner Benson & Ward, 2013), and demographic variables and previous experience with educational technology integration (Semerci & Aydin, 2018; Scherer & Teo, 2019; Liesa-Orús et al., 2020; Marek, Chew, & Wu, 2021). The above research on educational technology integration at universities is complemented by two other important strands: one is (online) teaching self-efficacy and the other the influence of attitudes towards educational technology. Both strands are more broadly discussed in the following two subchapters.

Self-efficacy in teaching

Teaching self-efficacy is defined as the teacher's belief or confidence in their ability to foster student learning outcomes. A teacher or lecturer does so by offering the students a stimulating learning environment and facilitating engagement with the subject matter of learning (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998). In this context, a lecturer may feel confident and efficient at teaching in a familiar offline teaching setting. However, a lecturer without previous experience in online teaching may feel lost in the digital realm of university teaching and thus have low self-efficacy beliefs. According to Bandura (1977), self-efficacy is stimulated by four principal information sources, namely mastery experiences, physiological and emotional arousal, vicarious experience, and social persuasion. Although the information sources are crucial for the formation of self-efficacy, the effect of these depends on the cognitive process in which information is appraised, based on contextual factors. Accordingly, self-efficacy beliefs are more likely to be strengthened when attainment is attributed to one's own abilities rather than to external factors which may have led to success.

Especially in a stressful situation, like the current COVID-19 pandemic, lecturers with high self-efficacy beliefs about their teaching may be able to adjust to difficulties more effectively, so that they can adapt and alter their plans to maintain high teaching standards. Moreover, lecturers with high self-efficacy beliefs may be able to persist through difficult times (Bandura, 1986). Taken together, teaching self-efficacy beliefs enhance or diminish behavioral attainment. Their influence depends on previous experiences, social contexts, professional environments, and cognitive appraisals. "It is partly on the basis of efficacy beliefs that people choose what challenges to undertake, how much effort to expend in the endeavor, how long to persevere in the face of obstacles and failures" (Bandura, 2001, p. 10). Klassen and Tze (2014), for example, conclude in their meta-analysis that teaching self-efficacy strongly correlates with teaching performance and thus also with student academic achievement.

As for online teaching, the construct of self-efficacy has been broadly researched and transferred into the online teaching setting. The evidence of a link between general self-efficacy and online teaching self-efficacy has been empirically established (Paraskeva, Bouta, & Papagianni, 2008). In a literature review, Corry and Stella (2018) identified three principal research strands of online teaching self-efficacy: measurement of self-efficacy related to online teaching; measurement of self-efficacy independency with demographic variables; measurement of intervention impact. However, studies conducted on self-efficacy commonly assume that the demands on lecturers in online teaching profoundly differ from those in conventional offline teaching.

Horvitz et al. (2014) found that lecturers reported high confidence in online classroom management and online instructional strategies and lower self-efficacy beliefs in facilitating student engagement. Furthermore, perceptual variables such as students' view of learning and their satisfaction with online teaching positively influenced online teaching self-efficacy. Other research on online teaching self-efficacy has shown a positive correlation between self-efficacy beliefs and job satisfaction (e.g. Hampton et al., 2020), emotional intelligence (e.g. Ali, Ali & Jones, 2017), and previous experience with online teaching (e.g. Robinia & Anderson, 2010). Lastly, empirical evidence also exists for the positive impact of training for online teaching on online teaching self-efficacy (Northcote et al., 2015; Samuel, 2016).

Attitudes toward educational technology

Attitude "refers to the degree to which a person has a favorable or unfavorable evaluation of the behavior in question" (Ajzen & Madden, 1986). Consequently, positive or negative attitude ultimately influences that behavior. Applied to the integration of educational technology in university teaching, lecturers with a positive attitude toward educational technology would be more motivated and make more efforts to integrate educational technology in teaching. In contrast, lecturers with a negative attitude towards educational technology integration are likely to blench at the idea of doing so and show resistance to digitalization strategies for university teaching.

Previous research has found that a lecturer's attitude toward educational technology influences the rate of integration into the context of universities (Amhag, Hellström, & Stigmar, 2019; von der Spoel et al., 2020). Semerci and Aydin (2018) identified two dimensions of attitudes towards educational technology integration: willingness and anxiety. Their study found no significant relationship between gender, age, or general teaching experience and the two dimensions. However, lecturers who were experienced and competent in using educational technology and had undergone relevant training were less fearful of using educational technology in their teaching. In another study, Tabata and Johnsrud (2008) measured the likelihood that lecturers would teach online. They found that lecturers who valued software and e-resources, who had technological and instructional skills and who recognized educational technology as a tool for university teaching reported more willingness to teach online.

In contrast, expecting negative outcomes of educational technology use, such as little interaction in class, time pressure, lack of ICT competencies and digital tools, can lead to negative experiences during online teaching. In the context of COVID-19, van der Spoel et al. (2020) highlighted the finding that lecturers perceived a loss of control over their students' progress due to the lockdown. In short, having low expectations of the usefulness of educational technology for teaching can have a negative impact on actual use (Amhag, Hellström, & Stigmar, 2019).

Comparative research on educational technology use

Although empirical research is sparse, comparative studies on educational technology use and its relation to attitudes and teaching self-efficacy have shown differences between culturally distinct populations. Culture can be analyzed across nations, organizations, and sub-groups within a nation (Nistor, Göğüş, & Lerche, 2013; Martin et al., 2020; O'Brien et al., 2020; Tejedor et al., 2020; for an overview consult Leidner & Kayworth, 2006).

Nistor, Göğüş, and Lerche (2013) confirmed a correlation between technology acceptance and culture with a large-scale cross-sectional sample in three countries. They used the Unified Theory of Acceptance and Use of Technology (UTAT) model to identify factors that influence educational technology use among German, Romanian and Turkish lecturers. The authors conclude that culture influences educational technology acceptance among lecturers and students, attributing this to the level of technological development in the countries.

Following a research summary of IT-culture, Leidner and Kayworth (2006) assume an interaction between national and organizational values that influences the integration of technology in organizations and society. Consequently, the authors recommend that both the national and organizational level should be considered when researching the integration of educational technology.

Martin et al. (2020) compared US and German university lecturers and found substantial differences in online teaching self-efficacy and thus cultural differences in the use of educational technology. More specifically, lecturers from the two countries reported different levels of perceived importance and self-efficacy for educational technology integration, with US lecturers consistently reporting higher scores. The authors argue that German lecturers may have had less experience in the advanced use of educational technology and that "these results could be caused by the different perception of what constitutes online learning" (p. 64). For this reason, the authors acknowledge that differences may have arisen due to culturally divergent perceptions of the constructs used. Van de Vijver and Leung (1998) address this problem in more detail with the concepts of bias and equivalence, which originate from social psychology.

As explained in this introduction, countries and universities have taken different but overlapping approaches to tackling the first COVID-19 wave. It may seem self-evident that different countries had different preconditions for the transition to online teaching and therefore took different measures (Crawford et al., 2020; Bozkurt & Ramesh, 2020). From a research perspective, it is therefore interesting to examine hypothesized differences at the level of lecturers from different countries. Although culture at the national level plays an important role in the integration of educational technology, this study focuses on the organizational level of culture across countries. Besides values and attitudes at the national level, an organization represents a cohesive unit with unique characteristics of its members within a nation. From a comparative perspective, this research identifies facilitating and inhibiting factors for the switch to online teaching.

The current critical COVID-19-related teaching situation might reveal both weaknesses and strengths of contemporary online teaching at universities. Therefore, this study analyses lecturers' use of educational technology during the first COVID-19 lockdown. The following research questions are of interest:

Q1 How was educational technology used for teaching at European universities *before* and *during* the COVID-19 lockdown?

Q2 How can lecturers' individual characteristics influence the integration of educational technology for online teaching?

This exploratory study will examine the interplay of the analytical dimensions defined in The aim of this study is to analyse the transition lecturers made during the first COVID-19 university lockdown. Therefore, the focus lies on individual and institutional factors that facilitated or inhibited the switch from conventional teaching before the pandemic to online teaching during the lockdown.

Figure 1. The aim is to draw conclusions for the future of the digitalization of university teaching.

Method

Context of the study

SARS-CoV-2 and its associated disease, COVID-19, emerged in Wuhan, China in late 2019. The situation in Wuhan rapidly deteriorated and numbers of diseased persons soared. In January 2020, the World Health Organization (WHO) declared a global health emergency, raising awareness of the risk situation. Countries across Europe reacted quickly after the pandemic initially overran Italy. Borders were closed and campaigns aimed at making residents aware of health measures to keep the curve flat. Despite the efforts of governments and citizens, the pandemic required more drastic measures that ultimately affected the education system.

Consequently, educational institutions from kindergarten to university were closed, as happened in Europe for the first time in March 2020. The switch to online teaching and learning was thus inevitable. As a result, universities then retroactively upgraded their technological infrastructure to enable online teaching and learning. The universities included in this study have in common that lecturers and students alike were affected by the lockdown. Both sides had to take action to overcome the difficult circumstances and continue learning, teaching and assessment (Watermeyer et al., 2020).

Survey

The data was collected by means of a survey. The questionnaire comprised items on the situation before, during, and after the COVID-19-related teaching situation (CRTS). It was developed for this study by the international CRTS-study research team[2]. The questionnaire was first translated and back-translated from English to French and German. It was then piloted in each language on a subsample of the target population. Pilot participants provided feedback on content and technical aspects of the survey, which was then implemented by the research team. In addition, content and face validity were checked by three higher education experts. Accompanying the demographic and professional items, the questionnaire comprised three content sections related to emergency online teaching. These included online teaching self-efficacy, attitude towards educational technology and the use of educational technology.

The online teaching self-efficacy scale (OTSE) is a unidimensional 4-point Likert scale developed by the research team. It accurately and economically measures online teaching self-efficacy beliefs. The scale assessed online teaching self-efficacy with eight adapted and modified items from the

[2] The following researchers initiated the Study: Prof. Dr. G. Horenczyk and Dr. M. Dorfsman, Hebrew University (Israel), Prof. Dr. E. Makarova, University of Basel (Switzerland), Dr. C. Leon, Universidad de Buenos Aires (Argentina), Prof. Dr. K. Göbel, University of Duisburg-Essen (Germany) and Prof. Dr. D. Birman, University of Miami (USA). Further researchers from Universidad Tecnológica Nacional (Argentina), Universidad Autónoma (Chile), University of Strasbourg (France), University of Upper Alsace (France) and University of Westminster (UK) have joined the study.

Online Teaching Self-Efficacy Inventory (Gosselin, 2009) and the College Teaching Self-Efficacy Scale (Prieto, 2006).

For the attitudinal and perceptual variables, three one-item measurements on 4-point and 5-point Likert scales were used: (1) To what extent have digital tools enriched your conventional teaching (1 = not at all, 4 = to a large extent); (2) How do you consider your first synchronous online teaching lesson (1 = unsuccessful, 5 = very successful); (3) How will the new experience of using digital tools affect your pedagogical practice (1 = not at all, 4 = greatly). For the further analyses, the mean scores of the above scale and items were calculated for each university, as well as a total score.

Lastly, lecturers were asked to indicate the extent to which educational technology was used on a 4-point Likert scale from 1 – "not at all" to 4 – "to a large extent". Lecturers were asked about their usage of six tools, namely LMS for syllabus and bibliography, asynchronous discussion forums, presentations, selected educational videos, self-produced videos, and WCS for synchronous teaching before and during the pandemic. A sum score of educational technology usage was calculated for better comparability between universities. The sum score has a range from 0 to 18 (0 = not at all, 1 = to a small extent, 2 = to a moderate extent, 3 = to a large extent), with the highest score corresponding to a maximum use of educational technology and the lowest score to no use of educational technology at all. A maximum use of all six tools would correspond to a sum score of 18. If, however, a participant did not use any of the tools at all, the sum score would have been 0. The response option of the original scale 1 - "not at all" was changed to a 0 for the calculation of the sum score. In this way, the score more directly reflected educational technology usage.

Sample

After the ethics committees and the rectorates of the participating universities had approved the distribution of the questionnaire, the respective administrative units sent the study invitation to the lecturers by e-mail. The lecturers confirmed their knowledge of the data processing of the study by signing an informed consent. Participation in the survey was voluntary. In addition, participants could skip items, and participants could end the survey at any time.

All participating universities were public universities. A total of 810 lecturers responded: 404 lecturers from universities in France (n=360 from one French university and n=44 from a second French university), 162 lecturers from a university in Switzerland, 154 lecturers from a university in Germany, and 90 lecturers from a university in the United Kingdom.

Genders were approximately evenly distributed across countries, 388 (47.9%) were female and 395 (48.8%) were male. Overall, 27 (3.3%) respondents preferred not to choose a gender or preferred to self-describe. Most lecturers were between 25 and 65 years old. A few lecturers were younger than 25 (9; 1.1%) or older than 65 (19; 2.3%) years old. Most respondents taught in non-STEM disciplines (492; 60.7%), and a smaller proportion taught in STEM disciplines (311; 38.4%). Detailed information about the respondents is depicted in Table 1.

Data analysis

SPSS 27 was used for the statistical analysis of the data. Descriptive statistics and t-tests were computed to identify significant differences in educational technology use before and during the COVID-19 measures. Cohen's *d* was used to report effect sizes, with $d = 0.2$ being a small, $d = 0.5$ a moderate and $d = 0.8$ a large effect (Cohen, 1988). Analysis of variance (ANOVA) was used to compare universities. Assumptions for the one-way ANOVA were tested with measurements for normality and equality of variances. Effect sizes were reported using η^2 (small = .01; moderate =

.06; large = .14) (Cohen, 1988). If the assumptions were met and significant differences between the groups emerged, the groups were then examined using a Tukey post-hoc test. However, if the assumption for homogeneity of variances was violated, the Welch test was used instead to determine significant differences between the groups, followed by the Games-Howell post-hoc test.

Lastly, multiple linear regression analysis was used to examine the relationship between the lecturers' experience, attitude and online teaching self-efficacy and their use of educational technology during the COVID-19 lockdown. In addition, demographic and professional characteristics such as age, gender, teaching load, and discipline were added to the regression. Cronbach's alpha was used to check the internal consistency of the OTSE scale. Cronbach (1951) considers a consistency coefficient from $\alpha = .70$ as "fairly large". Internal consistency proved satisfactory across the university subgroups (Cronbach's alpha=.82-.88). Moreover, the factorial structure proved to be unidimensional across subgroups.

Results

Educational technology use before and during the first COVID-19 lockdown

Lecturers reported on their usage of educational technology for teaching before and during the COVID-19 measures (For further analysis and better comparability of the subsamples, a sum score was calculated for educational technology use before and during the COVID-19 measures. Unsurprisingly, the total score "during" was significantly higher than the total score "before", $t(633) = 18.06$, $p < .001$, $d = 0.72$. This pattern was found among lecturers from the UK ($t(82) = 4.70$, $p < .001$, $d = 0.52$), France ($t(293) = 9.04$, $p < .001$, $d = 0.53$), Germany ($t(127) = 15.37$, $p < .001$, $d = 1.36$), and Switzerland ($t(128) = 10.12$, $p < .001$, $d = 0.89$). Measured by the effect size, lecturers from Germany achieved the highest increase in the use of educational technology and lecturers from the UK the lowest, because the latter had the highest "before" score (Although educational technology was used more extensively during the lockdown, most differences between universities remained significant. First, lecturers at the English university reported that they used educational technology more extensively ($p < .001$) than the lecturers from France ($\Delta M = 3.80$, 95%-CI[2.55, 5.05]) and Switzerland ($\Delta M = 2.83$, 95%-CI[1.51, 4.15]). Second, lecturers from France reported that they used educational technology less extensively than those from Germany ($\Delta M = -3.09$, 95%-CI[-3.92, -2.26], $p = .007$) and Switzerland ($\Delta M = -0.98$, 95%-CI[-1.82, -0.13], $p = .016$). Third, lecturers at the German university reported that they used educational technology more extensively than those at the Swiss university ($\Delta M = 2.11$, 95%-CI[1.18. 3.05], $p < .001$)

Table 2).
Figure 2; 1 = not at all, 4 = to a large extent). In particular, the synchronous teaching mode using WCS gained relevance among lecturers due to the COVID-19 measures, $t(714) = 21.11$, $p < .001$, $d = 0.79$. In decreasing order of effect size, the following educational technologies for asynchronous teaching were also used more extensively: Discussion forums, $t(703) = 11.03$, $p < .001$, $d = 0.42$, LMS for material provision, $t(735) = 9.70$, $p < .001$, $d = 0.36$, self-produced videos, $t(684) = 8.55$, $p < .001$, $d = 0.33$, and presentations, $t(719) = 2.05$, $p = .041$, $d = 0.08$. Conversely, the use of selected educational videos did not differ significantly, $t(705) = -0.15$, $p = .879$.

Table 1
Sample description

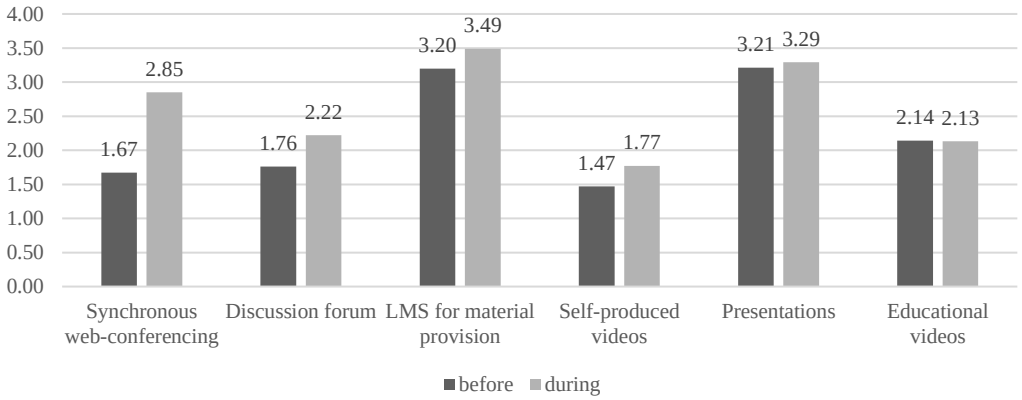
	Geographic location				
	UK	France	Germany	Switzerland	Total
Gender					
Female	46	178	78	86	388
Male	41	215	69	70	395
Other	3	11	7	6	27
Age in years					
< 26	0	6	1	2	9
26-35	5	40	51	46	142
36-45	26	107	44	38	215
46-55	30	151	31	39	251
56-65	19	95	20	35	169
> 65	10	3	5	1	19
Disciplines					
STEM	14	195	30	72	311
Non-STEM	76	204	123	89	492
Teaching experience in years					
< 6	12	55	49	54	170
6-11	22	68	34	32	156
12-17	23	97	32	33	185
> 17	33	182	37	41	293
Lessons taught per week					
1-2	5	41	44	69	159
3-6	17	136	50	64	267
7-11	39	151	48	23	261
> 11	28	74	11	4	117
Total	90	404	154	162	810

For further analysis and better comparability of the subsamples, a sum score was calculated for educational technology use before and during the COVID-19 measures. Unsurprisingly, the total score "during" was significantly higher than the total score "before", $t(633) = 18.06$, $p < .001$, $d = 0.72$. This pattern was found among lecturers from the UK ($t(82) = 4.70$, $p < .001$, $d = 0.52$), France ($t(293) = 9.04$, $p < .001$, $d = 0.53$), Germany ($t(127) = 15.37$, $p < .001$, $d = 1.36$), and Switzerland ($t(128) = 10.12$, $p < .001$, $d = 0.89$). Measured by the effect size, lecturers from Germany achieved the highest increase in the use of educational technology and lecturers from the UK the lowest, because the latter had the highest "before" score (Although educational technology was used more extensively during the lockdown, most differences between universities remained significant. First, lecturers at the English university reported that they used educational technology more extensively ($p < .001$) than the lecturers from France ($\Delta M = 3.80$, 95%-CI[2.55, 5.05]) and Switzerland ($\Delta M = 2.83$, 95%-CI[1.51, 4.15]). Second, lecturers from France reported that they used educational technology less extensively than those from Germany ($\Delta M = -3.09$, 95%-CI[-3.92, -2.26], $p = .007$)

and Switzerland (ΔM = -0.98, 95%-CI[-1.82, -0.13], p = .016). Third, lecturers at the German university reported that they used educational technology more extensively than those at the Swiss university (ΔM = 2.11, 95%-CI[1.18. 3.05], p < .001)

Table 2).

Figure 2
Educational technology use before and during the COVID-19 measures.



A one-way ANOVA was conducted to determine if the lecturers' use of educational technology before and during the COVID-19 measures differed significantly by country. As summarized in Although educational technology was used more extensively during the lockdown, most differences between universities remained significant. First, lecturers at the English university reported that they used educational technology more extensively (p < .001) than the lecturers from France (ΔM = 3.80, 95%-CI[2.55, 5.05]) and Switzerland (ΔM = 2.83, 95%-CI[1.51, 4.15]). Second, lecturers from France reported that they used educational technology less extensively than those from Germany (ΔM = -3.09, 95%-CI[-3.92, -2.26], p = .007) and Switzerland (ΔM = -0.98, 95%-CI[-1.82, -0.13], p = .016). Third, lecturers at the German university reported that they used educational technology more extensively than those at the Swiss university (ΔM = 2.11, 95%-CI[1.18. 3.05], p < .001)

Table 2, data from the four countries differed significantly from each other in terms of educational technology use before (Welch's F(3, 276.97) = 25.96, p < .001) and during (Welch's F(3, 259.70) = 42.04, p < .001) the lockdown. Games-Howell post hoc analysis revealed that lecturers at the English university used educational technology more extensively before the pandemic than lecturers in the other countries (p < .001): France (ΔM = 4.08, 95%-CI[2.85, 5.30]); Germany (ΔM = 3.04, 95%-CI[1.79, 4.30]); Switzerland (ΔM = 3.71, 95%-CI[2.42, 4.99]). Another significant difference was found between lecturers from France and Germany (ΔM = -1.03, 95%-CI[-1.86, -0.21], p = .007). Regarding educational technology use during the pandemic, differences were found between most universities, except for the combination of the UK and Germany (p > .05).

Although educational technology was used more extensively during the lockdown, most differences between universities remained significant. First, lecturers at the English university reported that they used educational technology more extensively ($p < .001$) than the lecturers from France ($\Delta M = 3.80$, 95%-CI[2.55, 5.05]) and Switzerland ($\Delta M = 2.83$, 95%-CI[1.51, 4.15]). Second, lecturers from France reported that they used educational technology less extensively than those from Germany ($\Delta M = -3.09$, 95%-CI[-3.92, -2.26], $p = .007$) and Switzerland ($\Delta M = -0.98$, 95%-CI[-1.82, -0.13], $p = .016$). Third, lecturers at the German university reported that they used educational technology more extensively than those at the Swiss university ($\Delta M = 2.11$, 95%-CI[1.18. 3.05], $p < .001$)

Table 2
Educational technology use before and during the COVID-19 measures per country.

	Educational technology use									
	Before		During		p-value of difference					
	N	*M(SD)*	*N*	*M(SD)*	France		Germany		Switzerland	
UK	89	10.61(3.97)	84	12.18(4.00)	<.001	<.001	<.001	n.s.	<.001	<.001
France	330	6.53(3.88)	314	8.38(3.53)			.007	<.001	n.s.	.016
Germany	144	7.56(2.85)	135	11.47(2.94)					n.s.	<.001
Switzerland	142	6.90(3.06)	145	9.35(3.13)						
Total	705	7.33(3.77)	678	9.67(3.71)						

Online teaching self-efficacy

Descriptive statistics and Cronbach's alpha for the OTSE scale are presented in Table 3. An ANOVA revealed significant differences between lecturers on online teaching self-efficacy ($F(3,722) = 12.425$, $p < .001$, $\eta^2 = .05$). Tukey post-hoc analyses show that online teaching self-efficacy was significantly lower in the French sample compared to the German ($\Delta M = -0.23$, 95%-CI[-0.37, -0.10]) and the Swiss ($\Delta M = -0.28$, 95%-CI[-0.41, -0.14]) sample. The English score did not differ from the other scores.

Table 3
Descriptive statistics and Cronbach's alpha of online teaching self-efficacy per country.

	N	*M*	*SD*	*Min*	*Max*	*α*
UK	86	2.99	0.54	1.00	4.00	.88
France	323	2.85	0.57	1.00	4.00	.86
Germany	126	3.07	0.50	1.00	4.00	.88
Switzerland	146	3.13	0.47	2.00	4.00	.82
Total	681	2.97	0.55	1.00	4.00	.86

Attitude towards educational technology

The lecturers' attitude and perception scores are summarized in Table 4, presented by country. A one-way ANOVA showed that the countries' sample scores did not differ significantly on the

attitude toward educational technology integration item ($p > .05$), but did so on the perceived success of the first synchronous online lesson during the lockdown item ($F(3,647) = 6.383$, $p < .001$, $\eta^2 = .03$). Specifically, a Tukey post-hoc test showed that the score from the Swiss university was significantly higher than the score of the French university ($\Delta M = 0.44$, 95%-CI[0.20, 0.69], $p < .001$). Significant differences were also found for lecturers' intention to adapt teaching practices based on the experience gained during the lockdown (Welch's $F(3,286.94) = 11.857$, $p < .001$). In comparison, lecturers at the English university scored significantly higher compared to those at the French university ($\Delta M = 0.50$, 95%-CI[0.27, 0.73], $p < .001$) but also than those at the Swiss university ($\Delta M = 0.41$, 95%-CI[0.16, 0.66], $p < .001$). Lecturers at the French university scored the lowest on the "intention to adapt" item and therefore differed significantly from the German university lecturers ($\Delta M = 0.27$, 95%-CI[0.06, 0.49], $p = .006$).

Table 4

Attitudinal and perceptual variables per country.

	Attitude (1-4)			Perceived success (1-5)			Intention to adapt (1-4)		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
UK	89	2.82	0.82	84	3.14	0.89	84	3.21	0.70
France	351	2.74	0.90	294	3.01	0.95	354	2.71	0.87
Germany	145	2.81	0.77	129	3.17	0.92	154	2.99	0.85
Switzerland	149	2.64	0.90	144	3.45	0.92	162	2.81	0.75
Total	734	2.74	0.87	651	3.16	0.94	754	2.85	0.84

Relation between Educational Technology Use, Teaching Self-Efficacy and Attitude

Table 5

Pearson correlations between educational technology use, OTSE and attitudinal variables

	2	3	4	5	6	7	8	9
1. EdTech before	.63***	.30***	.38***	.21***	.18***	-.07	.12***	.13***
2. EdTech during		.33***	.32***	.26***	.25***	-.15***	.16***	.17***
3. OTSE			.29***	.45***	.26***	-.16***	.09*	-.01
4. Attitude				.18***	.28***	-.01	.00	.07*
5. Perceived success					.13***	-.06	-.01	-.03
6. Intention to adapt						-.12***	.06	.04
7. Gender							-.21***	.06
8. Discipline								.08*
9. Teaching load								

Note. *$p < .05$ (2-tailed). ***$p < .001$ (2-tailed).

Table 5 shows that educational technology use before the pandemic, online teaching self-efficacy ($r = .30$, $p < .001$) and attitudinal variables (attitude: $r = .38$, $p < .001$, perceived success: $r = .21$, $p < .001$, and intention to adapt: $r = .18$, $p < .001$) were positively correlated. In addition, the use of educational technology before and during was strongly correlated ($r = .63$, $p < .001$). The latter showed more substantial correlations with online teaching self-efficacy ($r = .33$, $p < .001$), perceived success of the first synchronous online lesson ($r = .26$, $p < .001$) and the intention to adapt teaching in the future ($r = .25$, $p < .001$) than was the case for educational technology use before the pandemic.

Furthermore, self-efficacy correlated with both gender (r = -.16, p < .001) and discipline (r = -.21, p < .001) of the participants. Specifically, women reported higher scores on the self-efficacy scale. Non-STEM lecturers also scored higher on the self-efficacy scale than STEM lecturers. Moreover, teaching load was positively associated with the use of educational technology. Thus, lecturers who taught more than six lessons per week used educational technology before (r = .13, p < .001) and during (r = .17, p < .001) the pandemic more extensively. They also had slightly more positive attitudes towards use of the educational technology for teaching (r = .07, p = .050).

To examine the relationships between educational technology use, online teaching self-efficacy and attitudinal variables, a multiple linear regression analysis was computed. The total score represents all universities combined. Looking at the total score in **Error! Not a valid bookmark self-reference.**, the strongest predictor was use of educational technology before the pandemic. Besides this strong predictor, age and teaching load also predicted the use of educational technology: Older lecturers used educational technology to a lesser extent than did younger lecturers. Also, teaching load was a significant factor: More lessons to teach meant increased use of educational technology. Moreover, lecturers' online teaching self-efficacy beliefs, the perceived success of the first online lesson, and lecturers' intention to adapt their pedagogical practice in the future predicted the use of educational technology during the first COVID-19 wave. The R^2 for the total score model was .43, indicating high goodness-of-fit according to Cohen (1988).

Table 6

Results of the multiple regression analyses by use of educational technology during COVID-19

	UK		France		Germany		Switzerland		Total Score	
	β	*p*	*β*	*p*	*β*	*p*	*β*	*p*	*β*	*p*
Gender	0.10	.274	-0.01	.927	**-0.25**	.019	-0.12	.192	-0.02	.675
Age	-0.05	.556	**-0.24**	< .001	-0.23	.066	-0.14	.149	**-0.18**	< .001
Discipline	**0.24**	.012	-0.09	.120	0.04	.668	0.01	.935	0.05	.178
Teaching load	**0.19**	.037	**0.19**	< .001	0.22	.068	0.06	.526	**0.15**	< .001
EdTech before	**0.65**	< .001	**0.38**	< .001	**0.41**	< .001	**0.50**	< .001	**0.48**	< .001
OTSE	0.10	.368	0.11	.085	0.01	.885	0.00	.981	**0.10**	.010
Attitude	-0.06	.551	0.11	.102	0.05	.618	0.03	.724	0.03	.494
Perceived success	0.08	.382	**0.14**	.016	0.07	.520	0.08	.376	**0.11**	.005
Intention to adapt	-0.02	.856	0.07	.228	0.06	.552	**0.22**	.016	**0.12**	.001
Adjusted R^2	.51		.38		.31		.31		.43	
F	(9, 64) = 9.59 *p* < .001		(9, 213) = 16.36 *p* < .001		(9, 79) = 5.30 *p* < .001		(9, 93) = 6.07 *p* < .001		(9, 479) = 42.21 *p* < .001	

Across countries, age showed significance only for lecturers at the French university. Gender was a significant predictor at the German university, meaning that women reported they used more educational technology than did men. Teaching load, conversely, was a significant predictor at the English and French universities. Besides the control variables, self-efficacy was not a significant predictor of educational technology use at the different universities. For lecturers at the French university, the perceived success of the first online lesson during the pandemic was positively associated with educational technology use. For lecturers from the Swiss university, the intention to adapt teaching in the future significantly influenced the extent to which they used educational technology. Consistent with the total score and across all universities, the extent to which

educational technology was used before the pandemic proved to be a substantial predictor for educational technology use during the pandemic. Overall, the multiple regression was highly significant for each university. The adjusted R^2 ranged from .31 to .51, indicating high goodness-of-fit across universities.

Discussion

This study examined lecturers' use of educational technology during the first COVID-19 wave at four European universities. Specifically, predictors of educational technology use were extracted to identify facilitating and inhibiting factors for switching to online teaching. Although the above findings suggest that self-efficacy and attitude played an important role in the use of educational technology, the comparative approach of the study allows for refinement of the results. The results are therefore discussed along the three dimensions *educational technology*, *universities,* and *lecturers*, as depicted in The aim of this study is to analyse the transition lecturers made during the first COVID-19 university lockdown. Therefore, the focus lies on individual and institutional factors that facilitated or inhibited the switch from conventional teaching before the pandemic to online teaching during the lockdown.
Figure 1.

Educational technology

The reported use of educational technology before and during the pandemic differed significantly across all participating universities. Lecturers adapted their teaching by intensifying the use of educational technology. This is clearly because a bridge had to be built from conventional offline to emergency online teaching. The toolbox for this bridge therefore included different types of educational technology to cope with the difficult teaching situation created by the pandemic (e.g. Mishra, Gupta, & Shree, 2020; Sieber et al., 2020; Sarfaraz et al., 2020; Marek, Chew, & Wu, 2021). In this way, the continuity of university teaching could be ensured, even if it was initially only a temporary solution. This finding was also reflected in the usage patterns of educational technology. For instance, WCS were used to a significantly greater extent to conduct teaching in a synchronous mode. These findings suggest that WCS were particularly suited to replacing pre-pandemic university teaching (Kehrwald & Parker, 2019) in an online mode (Hodges et al., 2020; Littlejohn, 2020; Rapanta et al., 2020; Göbel et al., 2021).

Universities

Despite the consistent findings in this study about the use of educational technology, universities differed in the extent to which lecturers integrated educational technology into their teaching. Differences in the digital maturity of the universities investigated became evident here. In comparison, lecturers at the English university reported that they were already using educational technology extensively before the pandemic. They were therefore in a position to build on this advantage and thus reported the highest score of educational technology use during the pandemic. The other three universities reported a rather low of use of educational technology before the pandemic. The development at the universities during the pandemic hence could not have been more different.

First, the lecturers from France made small steps toward adopting educational technology. Second, lecturers at the Swiss university reported a mediocre extension of their usage. Third, the German university made a surprising digital turnaround. Lecturers from the latter reported a significant increase in the use of educational technology. It is therefore likely that the institution was a decisive factor in the switch to online teaching (e.g. Martin et al., 2020). Based on this, it can be assumed

that, prior to the pandemic, universities had different strategies for the digitalization of university teaching. Furthermore, it can be assumed that the universities provided their lecturers with varying levels of technological and pedagogical support during the pandemic. Thus, lecturers may have had unequal resources at their disposal to cope with the extraordinary demands. In summary, universities had different starting points for online teaching, which may have had implications for the adaptation of educational technology and the quality of online teaching (Baran & Correia, 2017; Alemu, 2015; Reid, 2012; Gannon Cook et al, 2009).

Lecturers

When compared by university, lecturers differed in their self-efficacy beliefs. Lecturers from Switzerland scored the highest, followed by Germany, the UK and lastly France. Moreover, lecturers from Switzerland perceived their first synchronous online lesson during the pandemic as more successful than their colleagues at the other universities. The correlation between online teaching self-efficacy and perceived success corresponds with Bandura's (1986) reflections on self-efficacy. According to Bandura, this finding can be explained by one of the four information resources of self-efficacy beliefs, namely performance accomplishments. Therefore, experiencing success influences mastery expectations. Conversely, repeatedly experiencing negative situations with online teaching would influence lecturers' mastery expectations. This finding is also in line with previous studies (Horvitz et al., 2014; van der Spoel et al., 2020).

Furthermore, looking at the intercorrelation matrix in Table 5, online teaching self-efficacy also correlated positively with attitudes towards educational technology and intentions to adapt pedagogical practices in the future. These relationships are indications of the importance of attitudes towards digital tools for online teaching, in particular, under the assumption that high self-efficacy beliefs have a beneficial effect on the quality of teaching (e.g. Klassen & Tze, 2014). Moreover, female lecturers were more confident in online teaching during the COVID-19 measures than their male colleagues. This finding is surprising, as previous studies tended to find higher (online) teaching self-efficacy beliefs for men (Guillén-Gámez & Mayorga-Fernández, 2020; Hemmings & Kay, 2009; Klassen & Chiu, 2010; Scherer & Saddiq, 2015).

The present study also found that the use of educational technology was substantially predicted by the extent to which lecturers had used educational technology before the pandemic. Multiple linear regression showed that variance in the intensity of educational technology use could be explained by the extent to which lecturers were accustomed to the use of educational technology. This finding proved to be significant for all universities in this study. In the same vein, previous studies examining predictors for educational technology use have found experience with educational technology to be a decisive factor (Semerci & Aydin, 2018; Scherer & Teo, 2019): Not only were experienced lecturers more apt to extend their technological repertoire, but they were also more satisfied and felt more competent in online teaching (Liesa-Orús et al., 2020; Marek, Chew, & Wu, 2021).

In line with the literature reviewed, the present study also found that online teaching self-efficacy significantly predicted the use of educational technology. Following Bandura's theory, it is likely that lecturers with high self-efficacy can cope with difficult situations and can accept unexpected challenges better than lecturers with low self-efficacy (Bandura, 1986). The results of the present study suggest that lecturers with high self-efficacy beliefs were able to adapt their teaching by integrating educational technology, despite the difficult circumstances. While this held true for the total score, the significance faded when the multiple regressions were computed for the specific universities. Looking at attitudes and perceptions, contrary to the theoretical assumption (Ajzen &

Madden, 1986), it appeared that attitude toward educational technology did not prove to be a significant predictor of usage behavior. Nevertheless, the intention to adapt teaching practice has had a significant influence. This is in line with Ajzen and Madden's theory that behavioral intentions can have a direct influence on action.

In addition to personal factors, external factors also had a significant impact on educational technology use: A high teaching load went along with an increased use of educational technology, while older lecturers tended to make less use of it, as a recent study also showed (Culp-Roche et al., 2020).

Conclusion

Having a background in online teaching facilitated the switch to emergency online teaching during the first COVID-19 wave in Europe. This finding is very aptly illustrated by a lecturer who commented on his experience in the questionnaire: “My situation did not change much. I have been teaching online courses since 1998 when I was the language teacher”. Even though this is an extreme example and the transition to online teaching was challenging for most lecturers, certain factors appear to have helped. In addition to experience with educational technology, a positive attitude and high self-efficacy beliefs were found to have facilitated the switch to online teaching.

Certainly, these personal factors cannot be changed overnight in a desired direction. However, the lessons learned from the COVID-19 pandemic can help in shaping the post-pandemic university. The digitalization push needs to be used to create sustainable structures for offline, blended, and online teaching at universities. As a result of the COVID-19 pandemic, immense resources have been used at universities for this purpose. Now it is important to evaluate what has been implemented and build on what has been tried and tested. Therefore, time and quality are crucial factors. First, universities need a long-term strategy for the digital transformation of university teaching in order to achieve a meaningful integration of educational technology at universities (Getto, 2020). This strategy must include targeted professional development programs for lecturers that build online teaching competences and allow for positive experiences with educational technology in teaching. Furthermore, individual pedagogical as well as technical support is crucial. Lastly, innovation of the individual or group in university teaching need to be encouraged and achievements shared.

In this way, lecturers can acquire secure self-efficacy beliefs in relation to educational technology and online teaching. This not only serves as protection against further unexpected events like the COVID-19 pandemic, but also benefits the quality of teaching (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998). Furthermore, this study shows that universities as institutions can adapt in a very short time. This could be interpreted as a characteristic of the new “Online & Digital University” (Strielkowski & Wang, 2020). Therefore, universities, as flexible learning institutions, should start learning from each other. The practices of university teaching, recently implemented educational technology, and the general digitalization strategy are some of many areas lending themselves to universities learning from one another.

Limitations

The study has several limitations. As it is an ad hoc COVID-19 study, the sampling procedure could not provide a representative sample, neither for the universities included nor for the respective countries. Although the invitation to the survey was sent to all lecturers and a reminder was sent after two weeks, the response rate was low. In addition, the comparison of universities was made at the expense of group size, so that the results need to be interpreted with caution. Another limitation involves the cultural bias and (in)equivalence which come from using the same questionnaire, even

though carefully translated and back-translated (language and country wise), and constructs across culturally distinct populations. The final limitation is the methodological approach: The cross-sectional study design only allows for an exploratory examination of the research questions.

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