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Online teaching and learning in higher education: Lessons learned in crisis situations

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ABSTRACT

In the year 2020, the Covid-19 pandemic turned both private and public life upside down. Teaching and learning at higher education institutions worldwide had to move online on very short notice. This Special Issue focuses on the academic practice of online teaching and learning in higher education in the current time of crisis. Online teaching and learning has been a prominent research topic for the last three decades, but online study programs at universities are still scarce. In this synthesis article, our considerations about online teaching and learning in higher education are positioned in the broad framework of communities of practice (CoPs). We establish a relationship between CoP-concepts and the integrative framework for learning activities involving technology in higher education (the C_h model), as proposed by Sailer and colleagues in this Special Issue. We continue with some initial thoughts on online teaching and learning in higher education in general, and emergency online teaching and learning more specifically. After an overview of the international research compiled in this Special Issue, we derive a number of general insights on online teaching and learning in higher education, emphasizing, for instance, scaffolding of regulation processes or communication platforms as potential artifacts of an online teaching and learning CoP.

1. Introduction

We are now in the middle of the Covid-19 crisis, but it will cease one day. The lessons learned about online teaching and learning in crisis situations should not be forgotten, but kept in mind for other possible crisis situations, and used to develop and improve digital education in normal times. To achieve this, we need to take an overarching perspective on online teaching and learning in higher education. In this vein, our considerations on online teaching and learning are positioned in the very broad framework of communities of practice (CoPs; Lave & Wenger, 1991; Wenger, 1998), which we outline in the following section. As briefly introduced in the next part, practices, activities, and resulting artifacts that may play an important role in higher education communities of practice during emergency online teaching and learning, can be embedded into the integrative framework for learning activities involving technology in higher education (the C_h model; Sailer et al., this issue). We continue with some initial thoughts on online teaching and learning in higher education in general, and emergency online teaching and learning more specifically. The next section

provides an overview of the contributions in this Special Issue, positioning them in the C_h model. We then derive a number of general insights on online teaching and learning in higher education based on the synthesis of the studies in this Special Issue that originate from Chile, Germany, Norway, Romania, Spain, and the U.S..

1.1. Higher education as a community of practice

Based on an anthropological approach (Lave & Wenger, 1991), Etienne Wenger originally defined communities of practice (CoPs) as “a way of talking about the social configurations in which our enterprises are defined as worth pursuing and our participation is recognizable as competence” (Wenger, 1998, p. 5). The notion of community of practice refers to a social process of negotiating competence in a domain over time. That this process ends up structuring social relationships among people involved in various ways is a secondary phenomenon. This structuring process entails a specific type of relationship. For instance, there is a distinction between a community of practice and a team (Farnsworth et al., 2016, p. 146). We propose a revised CoP definition as

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“mutually engaged people interacting with each other over longer periods of time, and sharing a repertoire related to a certain kind of orientation, such as [...] practice (in communities of practice)” (Nistor, Dascălu, Tarnai, & Trăuşan-Matu, 2020, p. 2). This definition also applies to the different people – from university administration and academics to tutors and freshmen – interacting at higher education institutions in the context of teaching and learning.

There are several examples for applications of the theory of CoP to higher education. Viskovic (2006) and Arthur (2016), for instance, applied the CoP framework to describe learning and development of tertiary teachers or university academics, respectively. By reviewing the implementation of the CoP framework in higher education research, Tight (2015) corroborates its usefulness for describing academic disciplines, researchers, tertiary teachers, students as well as their interactions. According to Wenger (1998; also Farnsworth et al., 2016), the relationship between participation in the ongoing practice and reification of the knowledge constructed in this practice is central for understanding the CoP phenomenon. The academic “ways of doing things” are observed, described, evaluated, and competitively established in the international higher education community (e.g., Arthur, 2016). Community knowledge is constructed in practice and being reified, resulting in (material or immaterial) artifacts. These artifacts constitute the key visible products of CoPs and range “from entries in a journal to historical records, from poems to encyclopedias, from names to classification systems, from dolmens to space probes, from the Constitution to a signature on a credit card slip, from gourmet recipes to medical procedures ... etc.” (Wenger, 1998, p. 59). Correspondingly, teaching and learning practices in higher education can be reified in academic titles, personal badges and door plates, in libraries and lecture hall seats, in conference presentations and journal articles, in syllabi and study module handbooks, in educational policies and laws, in instructional methods and learning strategies, as well as in electronic learning management systems or educational management platforms. In all these examples, the practice is reflected in artifacts that either (explicitly) describe and recommend specific activities, or (implicitly) support, enlighten and enhance some kind of activities, while ignoring or hindering others.

In time, practice may change. This can be the result of CoP participants being aware of gradual and cumulative changes of problems, actors, problem solving resources and contexts, which require academic affordances to keep up with the current developments; or changes can be suddenly triggered by unexpected and compelling incidents or accidents that make up crisis situations. An example of gradual and cumulative changes is the current implementation of digital media in academia (e.g., Akbar, 2016; Lai, 2011); an example of a crisis situation is the Covid-19 pandemic. All will cause CoPs to renegotiate the current practices and, correspondingly, to further develop the artifacts used so far (Nistor & Fischer, 2012). Just as blackboard and chalk are replaced over years of technological innovation by video projectors and digital presentations which allow focusing on the communication and explanation of the content, courses in classroom settings may be replaced within days by online courses developed in learning management systems. Both kinds of situations require CoPs to test, evaluate, and adapt their artifacts, but crisis situations, such as the Covid-19 pandemic, are probably the hardest – and therefore most valuable – way to test these artifacts. Crisis situations emphasize the strengths, uncover the weaknesses, and lead to progress in community practices. The studies in our Special Issue “Online Teaching and Learning in Higher Education: Lessons Learned in Crisis Situations” describe, evaluate, analyze, try to understand, and explain activities, practices, and resulting artifacts triggered by a crisis situation.

1.2. Emerging artifacts of (emergency) online teaching and learning in the C₃ model

The review by Sailer and colleagues (this issue) synthesizes practices

based on a large body of educational and psychological research that came along hand in hand with the gradual transition from traditional to digital learning in academia. The authors propose the C₃ model, an integrative, comprehensive framework that identifies contextual facilitators for learning activities involving technology that may influence students’ learning outcomes in both online and offline learning environments in higher education. As illustrated in Fig. 1, these factors that may influence “students’ learning activities involving digital technology” include “higher education teachers’ knowledge, skills, and attitudes”, “higher education teachers’ qualification”, “institutional, organizational, and administrative factors”, “higher education teachers’ digital technology equipment”, “higher education teachers’ digital technology use”, “students’ digital technology equipment”, “students’ knowledge, skills, and attitudes”, and “student-arranged learning opportunities involving digital technology”.

Based on the theoretical framework of CoPs, both specific learning activities involving technology as well as different manifestations of the proximal and distal contextual factors can be conceived of as shaping activities, practices, and emerging artifacts in the context of emergency online teaching and learning. For instance, the way how teachers use technology can reflect an implicitly or explicitly shared practice, which is, among other factors, influenced by higher education teachers’ knowledge, skills, and attitudes.

While the C₃ model offers a macroscopic perspective on potential levers and pathways of change processes in the higher education system in the face of digitalization, the single contributions of this Special Issue provide microscopic views on sudden changes in educational practices covering vast areas over relatively short time. The established structures of the higher education system never before allowed to test and analyze online learning and teaching on that scale. The contributions of this Special Issue can be positioned within the C₃ framework and substantiate it with empirical findings and experiential knowledge from the academic practice in extraordinary times.

1.3. Emergency online teaching and learning in higher education

In the year 2020, public life is considerably restricted to slow down infection rates during the Covid-19 pandemic. All around the globe, university buildings are closed to the public and most courses moved online. Although learning from home is an integral part of higher education systems, having the entire student body learn *only* from home for a prolonged time, a situation described by the term “emergency online learning” (Murphy, 2020), is unique in modern history. The first concern was to ensure the provision of all obligatory courses within study programs – keeping the show on the road. After nearly one year of emergency online learning, however, we can now take a closer look at the different activities and instructional practices implemented during the Covid-19 crisis, from an online higher education professional development course (Bichler et al., this issue) to online problem-based learning (Scheibenzuber, Hofer, & Nistor, 2021), or implemented earlier but bearing reference to the actual situation (e.g., data on online learning in previous stressful times, Chaku et al., this issue; data on medical students using a web-based learning platform, Theobald et al., this issue; or data on individualized online teaching and learning in large lectures, Dietrich et al., this issue), and investigate their effects.

The almost overnight switch from face-to-face to online learning caught many educators and students unprepared. Teachers’ use of digital technology to create valuable learning opportunities for their students can be expected to depend, among other factors, on their knowledge, skills and attitudes towards digital technology (Sailer et al., this issue). There is broad evidence that university educators still rarely adopt digital technology to provide online learning opportunities that go beyond digital slide shows, and often lack necessary competences (e.g., Englund et al., 2017; Schneckenberg, 2009). Likewise, to handle study programs that are completely online, students’ self-regulation ability and learning strategies are more important than ever. Without the

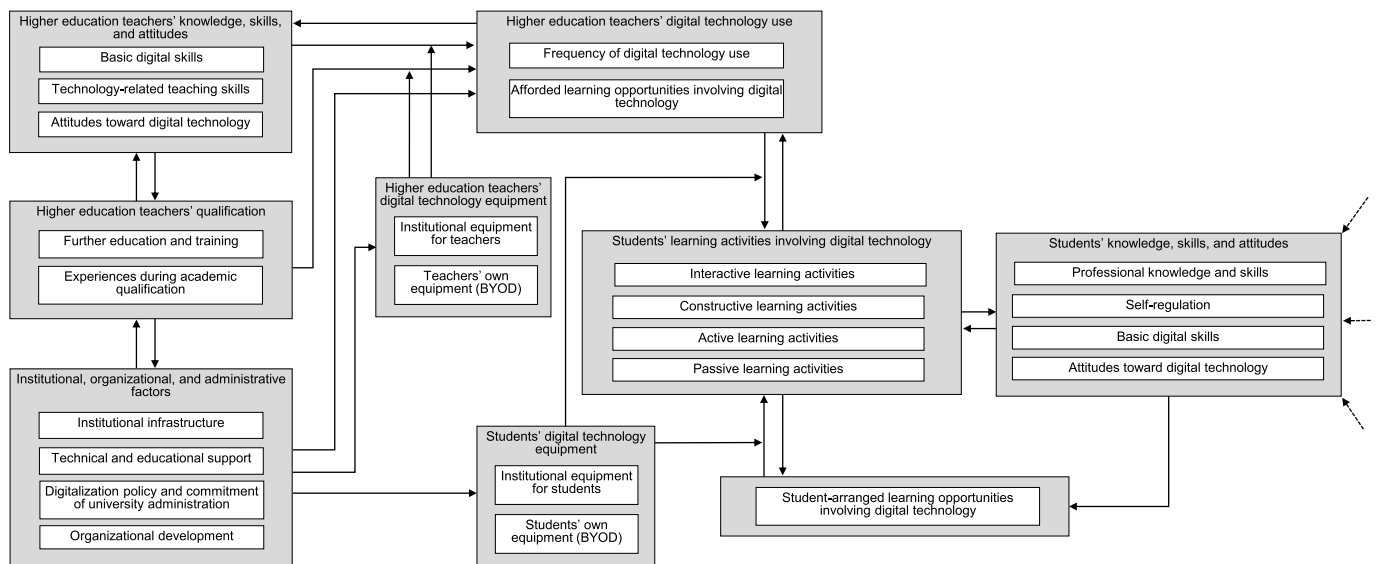


Fig. 1. The C_b-model for both online and offline environments in higher education. The arrows roughly indicate assumed influences and their direction (figure taken from Sailer et al., this issue).

structure of regular classroom meetings and direct external regulation by the teacher, students' learning more strongly depends on meta-cognitive as well as internal and external resource-related strategies that help them to plan, monitor, and regulate their learning processes in a goal-oriented way (e.g., Broadbent & Poon, 2017; Fischer et al., 2020). Closely related, not only teachers but also students require basic digital skills in order to make use of online learning opportunities. Digital skills encompass being able to use digital technology to search for, process, manipulate, and create information and data as well as online communication and collaboration skills (e.g., Carretero et al., 2017). International large-scale assessments, however, indicate that both students' and teachers' digital skill levels vary considerable at secondary school (e.g., Fraillon et al., 2019; Hofer et al., 2019). Accordingly, also at higher education institutions, the student population can be expected to be highly heterogeneous in terms of their pre-conditions to profit from online teaching and learning. Institutional, organizational, and administrative factors, involving digitalization policy, infrastructure and equipment, or support structures, can be conceived of as moderator variables that indicate the boundaries within which online teaching and learning takes place – or not (see Hofer et al., 2019; Sailer et al., this issue; Schneckenberg, 2009). The studies in this Special Issue demonstrate the diversity of possible implementations of online teaching and learning as well as the diversity of the underlying contextual factors.

2. Overview of the contributions

In the following section, we briefly summarize the contributions in this Special Issue and position each of them within the C_b model. We accordingly subsume the studies under subheadings that correspond to different factors addressed in the C_b model.

Higher education teachers' digital technology use (Afforded learning opportunities involving digital technology)

In the article "On Powerpointers, Clickerers, and Digital Pros: Investigating the Initiation of Digital Learning Activities by Teachers in Higher Education", Lohr et al. (this issue) investigate the initiation of digitally supported learning activities and associated factors in the context of higher education teaching in Germany. Although the study was conducted prior to the Covid-19 pandemic, the associations between contextual factors and digitally supported learning activities as specified in the C_b model should be valid for crisis situations as well. Based on survey data gathered from higher education staff, the authors

categorized digital learning activities according to the ICAP framework (e.g., Chi & Wylie, 2014) to estimate their association with personal and institutional factors in line with the C_b model. Structural equation modeling of a sample of 1625 teachers revealed three levels at which they initiated digital learning opportunities. These levels were described as powerpointers (low level), clickerers (moderate level), and digital pros (high level). Additionally, results showed that the most important contextual factors to facilitate digital learning activities were digitalization policy and commitment of the university administration, institutional equipment, technical and educational support, basic digital skills, and technology-related teaching skills.

Cortázar et al.'s (this issue) study „Promoting Critical Thinking in an Online, Project-Based Course“ examines online group-work on five assignments designed to develop critical thinking via video-chat at an engineering school in Chile during the Covid-19 pandemic. Experimental group students received scaffolding for socially shared regulation, while a control group worked on the same assignments without any scaffolding. The results indicate that all 834 students profited from an online project-based course, where they worked in groups with a clear objective, in terms of their critical thinking ability, however, students who received additional socially shared regulation scaffolding improved even more. The authors stress the importance of the quality of the regulation strategy adopted by the group working together to promote learning in an online project-based learning environment.

In the article "Designing for Fake News Literacy Training: A Problem-Based Undergraduate Online-Course", Scheibenzuber et al. (2021) describe and assess the implementation of a mostly asynchronous online course on fake news during the tumultuous summer term of 2020. Undergraduate students of educational sciences in Germany ($N = 102$) learned about fake news, their inner workings and design in a problem-based and mostly self-regulated online environment. Test performances in terms of the accurate rating of fake news credibility strongly improved after the course. Additionally, through focus group interviews, students communicated their acceptance of certain design elements of the course, including the communication structure and frequent feedback, while proposing more guidance and structure to plan and regulate group work as improvements for future iterations.

In Theobald et al.'s (this issue) study "Achievement Emotions Mediate the Link between Goal Failure and Goal Revision: Evidence from Digital Learning Environments", the authors investigate a sample of medical students ($N = 344$) working with a web-based learning platform to prepare for their second state exam in Germany. Data was

not collected during the Covid-19 pandemic. However, since data was gathered in a completely online learning environment in higher education without face-to-face contact and high demands on self-regulation, this study can provide important insights relating to the present situation of emergency online learning. Students started each of the 40 days of online studying by setting daily learning goals and self-monitored their goal achievement without external feedback. Log file analyses indicated whether learning goals were met or not. After self-monitored goal failure, a larger goal discrepancy was associated with more negative emotions, less positive emotions, and sometimes extreme down-regulation of goals. These findings stress the importance of scaffolding students' self-regulation skills including realistic goal setting, performance monitoring, and regulation, to avoid negative emotions and dysfunctional reactions to goal failure during self-directed learning in online learning environments.

Dietrich et al.'s (this issue) contribution „Does an Individualized Learning Design Improve University Student Online Learning? A Randomized Field Experiment“ addresses the question whether an individualized online learning environment can affect German teacher education students' ($N = 438$) performance and motivation. Although data was not collected during the Covid-19 pandemic, the investigation of differentiation methods in online learning environments can be considered even more important in times of pure online teaching and learning without the possibility to adapt classroom instruction on the fly. The digital differentiation grids, as an example of individualized learning design, included sets of tasks varying in complexity allowing students to work on tasks matching their level of expertise. They received personalized feedback and scaffolding during task completion. Control condition students participated in the same course, but received learning tasks and solutions as word documents without any form of interactivity. Results indicated positive effects of digital differentiation grids on the self-concept of students with a tendency to avoid effort. Teacher students' self-efficacy and their attitudes towards inclusive education (a topic addressed in the course) increased in the intervention but not in the control group. There was no effect on student performance. For students to profit from digital differentiation grids, sufficient self-regulation strategies that help them to navigate, choose, and make use of adequate learning tasks might be essential.

In the article “Designing a Remote Professional Development Course to Support Teacher Customization in Science”, Bichler et al. (this issue) discuss the importance of customizing web-based curricula for knowledge integration, especially as many teachers need to redesign their instruction for remote learning during the Covid-19 pandemic. The authors designed a university-based professional development online course for 23 science teachers from 12 different western U.S. middle and high schools that focused on customizing a web-based curriculum to support students' understanding of science while learning from home. Additionally, the authors digitized a customization planning tool and assessed teachers' customization decisions. In order to analyze teachers' customization designs, log-data gained from the customization planning tool was gathered and a bottom-up rubric for customization goals and plans was created. Furthermore, teachers gave notice about their reflections on their students' activities in online learning, resulting in insights into student ideas. In zoom breakout sessions, teachers were able to exchange ideas and learn from each other. Results showed that teachers noticed the struggles their students faced due to online learning, alongside their science concepts, and were able to come up with solutions to help foster their students' learning process using the customization planner.

The contribution by Damşa et al. (this issue) “Teachers' Agency and Online Teaching in Times of Crisis” focuses on teachers' experiences and challenges with designing and delivering emergency online teaching during the Covid-19 pandemic in Norway. The authors investigate differences in learning design practices in regular and emergency circumstances as well as how teachers ($N = 171$) in higher education utilized previously existing resources. Through descriptive statistics, correlation

analysis, and thematic analysis of open answers gained from an online survey, the authors documented digital teaching, the use of different digital tools and pedagogies, challenges with design and teaching, and potential effects on students' learning outcomes. Findings showed that most teachers tried to create learning environments that foster knowledge transfer and interaction through a variety of methods, such as flipped classroom. They faced technical challenges, such as having to use video-conferencing tools for teaching for the first time and having to manage new software, a lack of pedagogical expertise with digital teaching, as well as the private challenges imposed through the pandemic and the resulting lockdowns. These challenges were handled through self-help and collegial as well as specialist support.

Students' learning activities involving digital technology

In Dascalu et al.'s (this issue) study “Before and During Covid-19: A Cohesion Network Analysis of Students' Online Participation in Moodle Courses”, the authors discuss the value of Cohesion Network Analysis, when evaluating Romanian students' online activity in the learning management system Moodle. Comparing student activity and behavior prior to ($N = 202$) and during the Covid-19 pandemic ($N = 117$) through two consecutive yearly undergraduate courses on the topic of Algorithm Design, the authors found a significant increase in online activity as well as more online community interactions among students followed by a decrease towards the end of the semester during the pandemic. Moreover, during the Covid-19 pandemic, the complexity of the exchanged texts increased. Prediction models on student grades based on their behavior in Moodle showed that the model trained on data gained from the course unaffected by the pandemic was only partially generalizable for the year of the pandemic. This further shows substantial changes in student behavior during Covid-19 induced emergency online learning and thus a need to monitor and evaluate those changed behaviors.

The article “The Lonely Struggle with Autonomy: A Case Study of First-Year University Students' Experiences During Emergency Online Teaching” by Eberle and Hobrecht (this issue) focuses on the students' perspective on the Covid-19 crisis and aims at contributing insights how STEM students in bachelor programs at German universities experienced the sudden change from face-to-face to online teaching. Challenges, opportunities, and coping strategies as well as students' need satisfaction were investigated. The authors utilized semi-structured problem-centered interviews with 15 first-year students in chemistry programs, a field with generally high dropout rates and a high degree of on-site activity through lab experiments. They identified five student profiles based on students' first year experiences, two of which were rather resilient (young and well-adjusted students, experienced and structured students) and three were vulnerable (struggling but positive students, at-risk students, foreign students). The resilient students were able to handle most challenges well with no major impediments on their psychological needs, whereas already vulnerable students struggled more with their need satisfaction being heavily impaired. The overall biggest problems for most students were the overwhelming increase in autonomy, which required very good self-regulation skills, and lack of social interaction.

The contribution by Chaku et al. (this issue) – „Individualized Learning Potential in Stressful Times: How to Leverage Intensive Longitudinal Data to Inform Online Learning“ – compares different analytical methods (regressions, multilevel models, and person-specific networks) for the investigation of the effect of external events on longitudinal individual-level data on online learning. Although the data was not collected during the Covid-19 pandemic, it was gathered in the U.S. in stressful times during the 2016 presidential election, hence bearing reference to the actual situation. This data was compared to daily data collected from a matched sample of 26 students in 2017. Person-specific networks (e.g., group iterative multiple model estimation; GIMME) turned out to be particularly promising in modeling and understanding how individual students experience and make use of online learning opportunities as a function of stressful societal events. The authors further conclude that regressions and multilevel modeling

techniques can lead to severe misinterpretations of the data of individual learners.

Students' knowledge, skills, and attitudes

In the article „Students' Coping with the Self-Regulatory Demand of Crisis-Driven Digitalization in University Mathematics Instruction: Do Motivational and Emotional Orientations Make a Difference?“, Reinhold et al. (this issue) investigate how more general motivational and emotional orientations regarding mathematics and ICT-attitudes are related to coping with crisis-driven digitalization of university mathematics in Germany. To assess motivational and emotional orientations, 123 students were asked to answer an online questionnaire as a pretest – 43 of the students also took part in the posttest. Students with more promising orientations regarding mathematics-related interest, self-concept, anxiety, and work ethic as identified by cluster analysis tended to show higher expectation of success in terms of their achievement in university mathematics courses during the pandemic. These students also reported a higher need for social interactions and in-person collaboration with their fellow students and teachers and preferred face-to-face lectures over online courses – in general, this need also seemed to be higher for female compared to male students and for students with lower compared to higher ICT-attitudes. Students indicating higher ICT-attitudes valued the video lectures and the digital learning tasks provided in their mathematics courses more than students with lower ICT-attitudes. These students – and, in general, more male than female students – wanted future mathematics courses to involve more digital technology. The results stress the importance of attitudes towards technology integration and personal characteristics, like gender and emotional and motivational orientations, for understanding how students perceive and make use of online learning opportunities.

Higher education teachers' knowledge, skills, and attitudes

The article „Shifting from Face-to-Face to Online Teaching During Covid-19: The Role of University Faculty Achievement Goals for Attitudes Towards This Sudden Change, and Their Relevance for Burnout/Engagement and Student Evaluations of Teaching Quality“ by Daumiller et al. (this issue) demonstrates the influence of teachers' achievement goals on their way of handling the shift to online teaching during the Covid-19 pandemic in Germany. For this study, data from a larger longitudinal study were used, including 80 teachers' achievement goals in the semester before the shift to online classes, their attitudes towards online learning as well as their experienced burnout/engagement and their teaching quality. The latter was evaluated by their students, in the first online semester after the Covid-19 outbreak. While learning approach goals were associated with experiencing online teaching as a positive challenge and as useful for competence development, performance avoidance goals were related to perceiving such situations as threatening. Educators who tended to feel threatened by online teaching during the Covid-19 pandemic were more likely to suffer from burnout experiences and seemed to provide learning opportunities of lower quality as assessed by the students. In sum, teachers' goals influenced the interpretation of non-routine teaching and learning situations and the outcome of this interpretation, in turn, affected the quality of the afforded learning opportunities.

The contribution by Scherer et al. (this issue) “Profiling Teachers' Readiness for Online Teaching and Learning in Higher Education: Who's Ready?” applies latent profile analysis to identify teacher readiness profiles for online teaching and learning based on an online survey of $N = 739$ teachers from 58 countries. Three different profiles were identified. Teachers in Profile 1 had low self-efficacy regarding teaching online and creating an online presence during instruction. They reported only weak institutional support for online teaching and learning. While Profile 2 showed low ratings on both individual level measures and high ratings in terms of institutional support, Profile 3, with the smallest number of members, could be described as the high-readiness profile with consistently high ratings in terms of self-efficacy and perceived online presence and medium to high ratings of perceived institutional support. Female teachers as well as teachers with prior experiences in

online teaching and learning were more likely to be in the high-readiness profile. Altogether, teachers comprised a heterogeneous group in terms of readiness for online teaching and learning with additional individual and contextual factors in parts influencing profile membership.

Institutional, organizational, and administrative factors

In their contribution “Emergency Remote Teaching and Students' Academic Performance in Higher Education during the Covid-19 Pandemic: A Case Study” Iglesias-Pradas et al. (this issue) analyze the shift to emergency remote teaching and the impact of organizational aspects on students' academic performance in Spain. Data from 43 courses of the Telecommunication Engineering Bachelor's Degree including students' grades from two years prior to the Covid-19 pandemic as well as concurrent data from 2020 and qualitative survey data from the course coordinators ($N = 43$) addressing, among others, teaching methods, digital tool use and types of assessment activities, are analyzed. The authors report a significant increase in students' academic performance during emergency online learning compared to traditional face-to-face instruction. Additionally, the results hint at organizational factors, such as technical infrastructure and support, contributing to the successful implementation of emergency remote teaching. Finally, the authors emphasize the importance of a “true digital transformation” that may have been kickstarted through the abrupt switch to emergency online learning.

3. Synthesis

Just as it is only of limited value to ask whether learning with textbooks, with an abacus, or with digital tools is generally effective, we do not aim at deriving generally valid assumptions on the effectiveness of online teaching and learning formats, which are as diverse and manifold as is analogue teaching and learning. What we can learn from synthesizing the accumulated research on emergency online learning, however, could be framed as insights for future situations of (pure) remote teaching at the higher education level. We relate the insights gained from the synthesis of all studies to activities, practices, and resulting artifacts from a CoP perspective. We hence try to recognize overarching patterns based on the findings compiled in this Special Issue that could be considered as seminal components of a supportive higher education CoP faced with online teaching and learning.

How individual characteristics affect online teaching and learning in higher education: The importance of competence(-beliefs) and appraisals

To start with, the studies investigating the role of students' and faculties' individual characteristics in this Special Issue acknowledge the often complex relations between individual-level factors to understand online teaching and learning at higher education institutions. Person-specific analytical approaches (see e.g., Hickendorff, 2018) model the heterogeneity within and between both learners and educators and include group iterative multiple model estimation as proposed by Chaku et al. (this issue) for intensive longitudinal data or latent profile analysis (Reinhold et al., this issue; Scherer et al., this issue). They allow considering individual learning conditions and systematically occurring sub-groups of students and teachers in combination with their reactions to online education and contextual factors – whereas regressions and multi-level modeling techniques might considerably misrepresent individual-level data, as shown by Chaku et al. (this issue). In the next sections, we take a look at these complex relations – first on the student and then on the faculty level.

Students. The studies in the Special Issue addressing individual student preconditions for online learning in higher education provide some insights which characteristics might be associated with different ways of coping with emergency online learning. Coping becomes important when people feel threatened in a personally stressful situation (see Carver et al., 1989; Lazarus & Folkman, 1984). Having to deal with an unusual situation and, more specifically, the shift from weekly

face-to-face lectures to asynchronous online learning formats, definitely put even higher demands on students' self-regulation, or coping strategies, than regular university courses (e.g., Barzilay et al., 2020; de la Fuente et al., 2015; Rach & Heinze, 2017). This is well in line with findings indicating that many students struggle with self-regulation in the context of technology-supported and online learning (Lajoie & Azevedo, 2006; Lehmann et al., 2014). The contributions in this Special Issue also provide insights into student characteristics that are associated with more or less successful self-regulation or handling of online learning. Reinhold et al.'s (this issue) data suggested students with more promising orientations regarding mathematics-related interest, self-concept, anxiety, and work ethic as well as students with higher ICT-attitudes to be better prepared to handle emergency online learning indicated by higher expectation of success in terms of their achievement in university mathematics courses during the pandemic. In the domain of chemistry, Eberle et al. (this issue) also identified groups of students differing in their resilience. Well-structured and experienced students, and young but well-adjusted students were able to cope with the situation quite well. Accordingly, students who might have experienced increased stress and threat already prior to the Covid-19 pandemic in regular university courses – such as anxious, struggling, low-self-concept, low-achieving, or non-native students – might be overwhelmed by the additional burden and demands of emergency online learning. Many students in both Reinhold et al.'s (this issue) and Eberle et al.'s (this issue) studies expressed the need for social interactions. There is no indication that this need is associated with less beneficial coping strategies. Quite the contrary, in Reinhold et al.'s (this issue) data, students with positive mathematics-related emotional-motivational characteristics who expected to be successful during online learning nevertheless longed for in-person collaboration with fellow students and teachers and preferred face-to-face lectures over online courses.

Well in line with existing findings on the importance of ICT competences and attitudes for online learning (e.g., Carretero et al., 2017; Sailer et al., this issue), positive attitudes towards technology, however, seem to increase students' capacity to cope with emergency online learning independent of emotional-motivational student profiles – or, to put it differently, with higher ICT-attitudes emergency online learning may be considered as less threatening (see Eberle et al., this issue; Reinhold et al., this issue).

The CoP perspective. We believe that two important insights can be derived from all these results. First, in difficult times like the Covid-19 pandemic, more than ever, higher education CoPs have to look out for particularly vulnerable students (e.g., low competence and self-concept, anxious, non-natives) and implement special support structures in time. Such support structures could consist of tutoring programs, mentoring, or digital help-desks, to name but a few. Second, possibilities for exchange and communication with fellow students and teachers that resemble face-to-face interaction should be integrated into completely online learning environments on a regular basis. Otherwise sooner or later many students might feel unsatisfied and particularly highly capable and motivated students might be lost along the way. Both support structures and communication platforms represent potential artifacts of an online teaching and learning CoP helping the different people in the community to learn from each other and to discuss and develop shared knowledge.

Teachers. The importance of the personal experience of threat for understanding consequences of emergency online teaching and learning also becomes apparent in the studies focusing on higher education teachers' knowledge, skills, and attitudes. The teachers in Damşa et al.'s (this issue) study mention technical challenges, such as having to use video-conferencing tools for teaching for the first time or managing new software tools, deficits in technological pedagogical content knowledge (see e.g., Koehler et al., 2013), and private difficulties many of us faced due to the Covid-imposed lockdowns. In this sample of Norwegian teachers, most teachers were able to handle these challenges by

self-study and help-seeking as well as a supportive CoP, trying to offer engaging and interactive digital learning opportunities. Lohr et al. (this issue) took a closer look at both the skills and institutional support structures that can be expected to influence how educators handle the challenge of emergency online learning, and the digital learning opportunities provided. This focus on resources is well in line with Expectancy Value Theory (Eccles et al., 1983; Eccles & Wigfield, 2002; Vroom, 1964; Wigfield & Eccles, 2001), which postulates that the motivation to engage in an activity is affected by a combination of an individual's expectations for success (i.e., competence-related beliefs) and subjective task value in the particular domain. The expectation for success in the context of emergency online teaching can be assumed to depend on competence-related beliefs (internal resources) and external resources. In line with this theory as well as the CoP model, Lohr et al. (this issue) could show that teachers' basic digital skills and technology-related teaching skills, as well as external resources (digitalization policy and commitment of the university administration, technical and educational support, institutional infrastructure) were positively associated with the quality of digital learning opportunities offered to the students (from powerpointers to digital pros). Likewise, Scherer et al. (this issue) identified profiles of teachers determined by their competence-related beliefs (self-efficacy and perceived online presence) regarding teaching online and their perceived institutional support for online teaching and learning. Next to low and high readiness profiles with low or high, respectively, manifestations on all three profile indicator variables, the authors documented an inconsistent profile with high institutional support but low competence-related beliefs, indicating that these internal and external resources are at least partly independent. Or, to put it differently, a supportive environment and adequate equipment is not enough to ascertain that teachers feel ready to make use of these resources (see also Offer-Use-Models in the context of teacher professional development, e.g., Lipowsky & Rzejak, 2015). In Scherer et al.'s (this issue) study, teachers with more prior experiences in terms of online teaching were more likely to be in the high readiness profile, i.e., felt competent enough and prepared for emergency online teaching, substantiating the importance of teachers' digital teaching skills and attitudes documented in Lohr et al.'s (this issue) study (see also Bolliger et al., 2019; Muñoz Carril et al., 2013).

While Damşa et al. (this issue) addressed the behavior of the teachers and Lohr et al. (this issue) as well as Scherer et al. (this issue) their internal and external resources, Daumiller et al. (this issue) focused on underlying achievement goals, attitudes, and feelings. Achievement goals, typically categorized into learning approach goals (goal is developing competence), performance approach goals (goal is being perceived as competent), performance avoidance goals (goal is avoiding to be perceived as incompetent), and work avoidance (goal is avoiding effort) goals (e.g., Butler, 2014), may influence how individuals appraise challenging situations (potential stressors or threats; e.g., Folkman et al., 1986) and are hence associated with attitudes, perceived stress, and uptake or avoidance of professional learning activities of university staff (Daumiller et al., 2020). Substantiating the results of Damşa et al. (this issue), Daumiller et al. (this issue) found that learning approach goals were associated with experiencing online teaching as a positive challenge and as useful for competence development. On the contrary, performance avoidance goals were related to perceiving such situations as threatening, which, in turn, seems to increase the risk to suffer from burnout. And, just as described by Lohr et al. (this issue) and Damşa et al. (this issue), teachers' (perceived) skills and institutional support and, ultimately, their appraisal of the challenges faced in the light of the current crisis situation (as threatening or manageable) also influenced the quality of the digital learning opportunities offered to their students (Daumiller et al., this issue).

The CoP perspective. A supportive, non-evaluative community that offers assistance with unfamiliar technology, shares knowledge on how to use these technologies pedagogically, and emphasizes learning approach goals could help individual teachers to experience remote

teaching as less threatening. Those with more experience and digital teaching skills might particularly contribute their knowledge to the community. Higher education CoPs could explicitly create room for this kind of exchange in the form of regular lunch meetings, online platforms, or workshops. More generally, such artifacts encompass the provision of the external resources (e.g., technical support, infrastructure, a clear digitalization policy) that are conducive (but not sufficient) to successfully teach online.

Online teaching and learning approaches in higher education: The importance of scripting and scaffolding on the group and individual level

The contributions in this Special Issue indicate that instructional approaches that have been proven effective in “normal times” and mostly face-to-face instruction can be successfully translated to (emergency) online teaching and learning (problem-based learning in Scheibenzuber et al., 2021; project-based learning in Cortázar et al., this issue; adaptive teaching in Bichler et al., this issue; and individualized learning in Dietrich et al., this issue). However, it also became clear that some aspects might play an even more important role in online as compared to analogue settings and should hence be considered when designing online teaching and learning environments. Both at group level (Cortázar et al., this issue; Scheibenzuber et al., 2021) and individual level (Dietrich et al., this issue; Theobald et al., this issue), self-regulation appeared to be essential to support learning in remote settings. Students have to know how to (jointly) plan, conduct, monitor, regulate, or evaluate group and individual work, how to set realistic goals and navigate, choose, and make use of learning tasks (Broadbent, 2017; Broadbent & Poon, 2015). As discussed in the previous section, students differ in their motivation and capacity to cope with and regulate learning in digital environments. Corresponding individual- and group-level scaffolding can help learners to develop and make use of adequate strategies in distance web-based learning settings (e.g., Garrison & Akyol, 2013; Lee et al., 2017). Theobald et al.’s (this issue) study impressively documents possible negative consequences of self-monitored goal failure (including more negative emotions, less positive emotions, and sometimes extreme down-regulation of goals) in self-directed learning in a digital environment with high demands on self-regulation and without external feedback.

CoP artifacts for group-level regulation. Particularly in collaborative activities – which are central elements in problem-based and project-based learning approaches (e.g., Barrows & Tamblyn, 1980; Dilekli, 2020, pp. 53–68; Hmelo-Silver, 2004; Kim & Lim, 2018) – co-regulation and socially shared regulation have to be supported in addition to self-regulation (see Järvelä & Hadwin, 2013; Miller & Hadwin, 2015). In the study by Cortázar et al. (this issue), scaffolding was oriented at Malmberg et al.’s (2017) categories for socially shared regulation, i.e., defining the objective of the activity, planning, establishing clear goals, monitoring, and progress evaluation. They used scripts that guided the activities related to these categories of shared regulation in the experimental group. In more general terms, external collaboration scripts can structure and guide regulation processes in online group work when internal collaboration scripts are not yet sufficiently developed (Fischer et al., 2013; Radkowitz et al., 2020). A lack of or suboptimal collaboration scripts may hamper and slow down learning processes (Broadbent & Poon, 2015; Straus & McGrath, 1994; Valkenburg et al., 2016). Online environments allow implementing a number of tools including discussion boards, etherpads, or wikis that can further be used as collaboration and communication resources to facilitate collaborative learning (e.g., Duncan et al., 2013; Zheng et al., 2015). Investigating students’ learning activities in Moodle courses, Dascalu et al.’s (this issue) data suggest that the students in their sample really made use of the opportunity to learn online and transfer community interactions to the virtual space during the pandemic. They used the learning environment to exchange even complex messages and communication content. In Scheibenzuber et al. (2021) study, students’ joint work in group wikis resulted in mostly high-quality output that was

included in the course papers. However, focus group interviews made clear that the provision of collaboration resources is not enough unless it is accompanied by (binding) guidelines or scripts for how to organize and implement group work. While students in Scheibenzuber et al. (2021) study rarely made use of the discussion boards provided in the Moodle environment, students in Dascalu et al.’s (this issue) study seemed to be more engaged in online communication exchange processes. The particular implementation of the learning environments, including specific scripts, instructions, and requirements, as well as the characteristics and composition of the student samples might in part explain these differences in students’ use of online learning opportunities (in line with the C₃ model). However, more systematic research is required in order to disentangle and understand the underlying mechanisms.

CoP artifacts for individual-level adaptation. Along these lines, Dietrich et al. (this issue) and Bichler et al. (this issue) focus on customizing teaching or learning processes, respectively. Bichler et al. (this issue) trained teachers to customize web-based curricula for knowledge integration. To support customized or adaptive teaching, the authors propose a digital customization planning tool that allows evidence-based design decisions based on customization goals and reflections on their students. This planner enabled teachers to plan, switch around and remove or add learning activities within units. By providing them with a color-coded overview of all learning activities (elicit, discover, distinguish, reflect) the tool enabled teachers to adapt their customizations in response to student feedback and over- or underrepresented forms of knowledge integration. The tool helped teachers to facilitate individual learning processes. Accordingly, if customization in remote – and analogue – learning settings is implemented by the educator supported by adequate customization planning tools, it may effectively increase student learning (also see Hardy et al., 2019; Parsons, 2018). Bichler et al. (this issue) investigated a university-based professional development program for educators teaching science at school. If you teach courses at the university level, however, your classes are often considerably larger than at school and the content you are teaching is more diverse. Teacher-led customization might hence not always be feasible. Dietrich et al. (this issue) examined digital differentiation grids as a means to implement student-led individualization in an online learning environment at the university level. Digital differentiation grids allow students to choose from sets of tasks varying in complexity, providing personalized feedback and scaffolding during task completion. Results suggested that although there were some positive effects on motivation and attitudes, for students to really profit from online self-directed customization, again sufficient self-regulation strategies seem to be essential. As long as students do not possess these skills themselves, scaffolds and scripts can help them to navigate, choose, and make use of adequate learning tasks (e.g., de Boer et al., 2013; Lehmann et al., 2014). AI and educational data analytics, as suggested by Iglesias-Pradas et al. (this issue), web-based educational hypermedia systems that automatically accommodate individual characteristics (e.g., Magoulas et al., 2003), and, more general, adaptive learning environments, like cognitive and metacognitive tutoring systems (e.g., Ritter et al., 2007; Roll et al., 2007) or interactive textbooks (e.g., Reinhold et al., 2020), are hence promising ways to provide personalized feedback and realize individualized learning in online higher education (see also Hillmayr, Zierwald, Reinhold, Hofer, & Reiss, 2020). In online teaching and learning environments, scripting and scaffolding can be adaptively and flexibly linked to specific activities, roles, or errors made during task completion, assessed from wherever and whenever needed, and faded with increasing expertise (Gerard, 2015; Kim et al., 2019; Reinhold et al., 2020).

Institutional, organizational, and administrative factors: The importance of strategy

Although the institutional digital infrastructure and, in particular, accessible, stable, and fast WiFi might be less important for online higher education than students’ and teachers’ infrastructure (see also

Gil-Flores et al., 2017), there is no doubt that sufficient internet access, learning management systems, as well as adequate software and hardware are at least conducive to a successful shift to online teaching and learning (e.g., Fraillon et al., 2019; Hofer et al., 2019). Lohr et al. (this issue) and Iglesias-Pradas et al. (this issue) could show that, in addition to personal and other institutional factors, infrastructure turned out to be important for a high level of initiated digital learning activities (Lohr et al., this issue) and the successful implementation of remote teaching (Iglesias-Pradas et al., this issue). In their case-study with engineering students, Iglesias-Pradas and colleagues (this issue) report a significant increase in students' academic performance during emergency online learning compared to traditional face-to-face instruction emphasizing the importance of supportive organizational factors over and above digital equipment. Along these lines, the provision of infrastructure is not sufficient (Hofer et al., 2019), teachers require educational and technical support for online teaching and learning to be effectively implemented (Iglesias-Pradas et al., this issue; Lohr et al., this issue; Scherer et al., this issue). As stressed by Lohr et al. (this issue) and Iglesias-Pradas et al. (this issue), the existence of a coherent and comprehensive strategy of the university regarding online teaching and learning – a strategy for true digital transformation – might be an even more important distal factor comprising, coordinating, and orchestrating other distal factors on the institutional, organizational, and administrative level and enabling (or hampering) more proximal factors on the teacher- and student level that influence effective online teaching and learning. Transparently communicating the strategy and setting up clear expectations on the part of the institution can in general be considered essential for increasing acceptance and commitment towards necessary behavioral changes (see Hofer, Holzberger, & Reiss, 2020). How this strategy should look like might depend on the requirements and resources of the university as well as the culture it is embedded in. In line with Scherer et al. (this issue), the surrounding culture could be conceived of as an even more distal contextual factor contributing to online higher education. The respective culture can be expected to influence how university staff and students approach challenging situations (e.g., Hofstede, 2001), their activities, practices, and, ultimately, which artifacts are established.

4. Conclusion

The integration of digital technology into university teaching and learning bears high potential to create cognitively engaging learning opportunities – not only in the current or future crisis situations (e.g., Chi et al., 2018; Chi & Wylie, 2014; Hillmayr et al., 2020). Due to the greater temporal and spatial/geographical flexibility, online learning environments also allow more diverse students with different constraints (including parenthood, a remote place of residence, or part-time-study) to profit from potentially high-quality university instruction (e.g., Mahieu & Wolming, 2012). The lessons learned in this crisis situation, by synthesizing the contributions of the Special Issue, can be directly transferred to online teaching and learning in normal times. In normal times, digitalization of teaching might not be as general and overarching with no face-to-face contact at all and change processes might be much slower and less inevitable. Despite these differences, we can learn a lot from analyzing teachers' and students' behavior, experience, and cognition in an extreme situation that forces everybody out of their comfort zone and requires immediate action. Based on this global and comprehensive participation in online teaching and learning in higher education, beneficial and detrimental factors become visible in these times more than ever before. While the factors we are talking about are the same, no matter whether we are in a crisis situation or not, fast and rigorous implementation of derived measures is much more crucial in emergency situations. The discussed proximal and distal factors – from basic digital and regulation skills, competence-related-beliefs and appraisals to institutional infrastructure – could undermine or boost potential positive effects of remote learning opportunities at higher

education institutions. Derived artifacts, such as communication platforms, digital differentiation grids, or customization planners, and their continuous reification can help to bolster the higher education CoP against negative effects and support them to make use of beneficial factors in the context of online teaching and learning.

Two main sides of the CoP model are reflected in the contributions of this Special Issue: on the one side, students' knowledge, skills, and attitudes, together with their learning activities, on the other side, faculty's knowledge, skills, and attitudes, together with their teaching activities – all embedded into the institutional culture. These are two organic parts of the higher education CoP in the context of online teaching and learning. Their interrelationship is the essence of higher education practice—and they are connected through a collection of artifacts shaped, continuously tested, and improved in the community practice. As this reification process is very likely connected with CoP participants' artifact acceptance in terms of performance and effort, the collection of studies in this Special Issue confirms and sustains not only Sailer et al.'s (this issue) model, but also Nistor (2012) and Nistor (2015) assertion that developing appropriate artifacts may be a means of fostering CoPs.

The year 2020 may be a wake-up call to show that, up to now, higher education institutions are not yet perfectly prepared to exploit the potential of digital technology for learning and instruction. Maybe the current crisis could be a starting point to create supportive CoPs with artifacts related to online teaching and learning that will eventually become routine.

Credit roles

Sarah I. Hofer: Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing Nic. Nistor: Conceptualization, Writing – original draft. Christian Scheibenzuber: Conceptualization, Writing – original draft.

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Declaration of competing interest

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