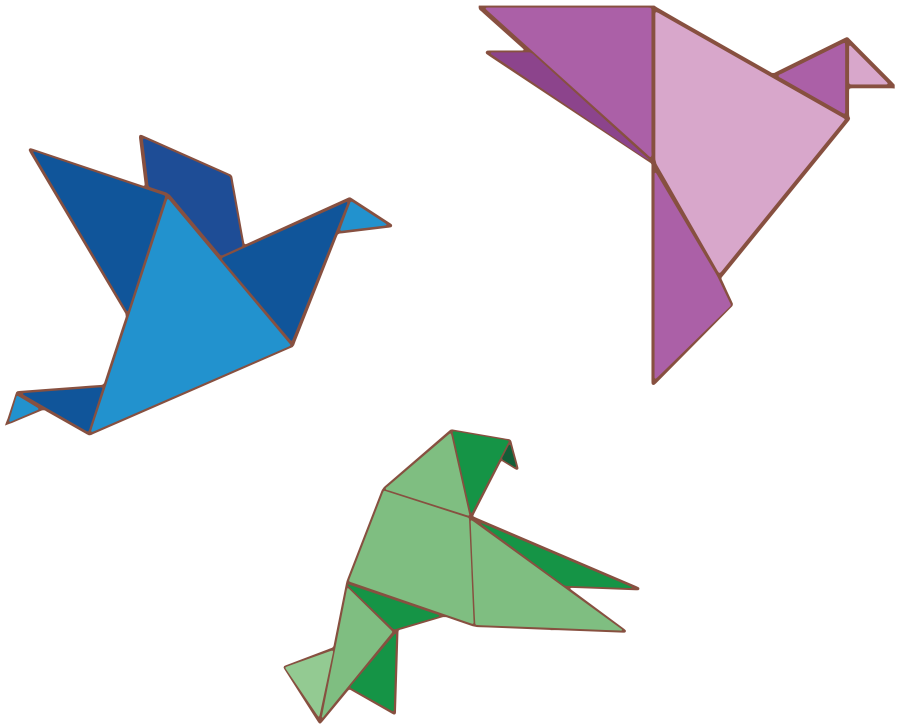

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TEACHING AND LEARNING IN HIGHER EDUCATION

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EDITORIAL

RETHINKING THE ESSENTIAL QUESTIONS IN HIGHER EDUCATION

When discussing quality in higher education study programs, vital questions such as *what* to teach, *how* to teach, and *how* to assess student learning are often neglected while addressing such issues as external accountability, efficiency, and cost-effectiveness. Decisionmakers focus on the structural issues; educators should seek ways to actively engage students in their own learning experience by creating new knowledge and not being mere passive recipients of information transmitted by a lecturer (Hunt & Chalmers, 2021). Ways to maintain and strengthen the quality of higher education will continue to be considered as society changes and particularly as education becomes more informed by research.

The crucial *what* questions arise not just at the level of particular subjects, but also at the level of higher education systems so as to meet the challenges of a more diverse higher education sector (Curaj et al., 2015). Moreover, the number of students in higher education is constantly growing, and the question of *how* to create stimulating environments for a more diversified student population is becoming increasingly urgent (Gorard et al., 2006; Brücknerová et al., 2020). The challenge is to find *how* to transform the still prevalent teacher-oriented instruction into learner-engaging ways of instruction (Weimer, 2002), and *how* to efficiently employ new technologies to support the various needs of diverse learners (Sankey et al., 2010). An additional question to be asked in light of experiences from the COVID-19 restrictions is *how* online educational settings might alter on-site situations (Ali, 2020). All these *how* questions seem to put new demands on the flexibility and openness of higher education decisionmakers, institutions, and of course on the main actors: teachers and students.

The many rapidly changing technological, institutional, and social demands also pose new questions about the role of higher education, educational goals, and higher education teachers' aims, teaching beliefs, and motivation for teaching (McCune, 2019; Smith & Flores, 2019). In other words, as busy as we might be answering *how* questions, the *why* questions should not be left unattended. Such questions constantly reappear, as the values and normative orientations of those involved with higher education continuously co-constitute

the educational reality (Biesta, 2010). Moreover, when unexpected events such as pandemics, war, or lack of resources occur, there is a need to return to questions about the aims and the role of higher education to ensure that the higher education institutions and their actors will be able to face upcoming challenges adequately and with grace.

The articles in this issue capture this fruitful dialogue between *what*, *how*, and *why* questions and offer insights that might support appropriate methodological and instructional approaches and hopefully provoke consideration about aims, beliefs, and values in higher education settings.

Tomáš Lintner and Klára Šeďová, in their article *Aiming for Active Student Participation in Online University Lessons: A Case Study of Two Teachers During Emergency Remote Teaching*, integrate a quantitative approach to classroom discourse analysis, network visualizations, and qualitative data. This approach enables them to offer an in-depth explanation of how the teachers' attitudes and their answers to *why* questions influence their teaching orchestrations and, consequently, the shape of student participation during online lessons. Their findings support the notion that genuine care for student development opens meaningful ways to use IT, not vice versa.

The importance of university teacher beliefs and conceptions are highlighted by Marta Mateus de Almeida, Joana Viana, and Mariana Gaio Alves in their qualitative study *Exploring Teaching Conceptions and Practices: A Qualitative Study with Higher Education Teachers in Portugal*. They show that the shift from a curriculum-centered instructional paradigm to a learning-centered paradigm might still be rare within academia. Nevertheless, the authors indicate that focused teacher training might support such a shift, even online.

Another testimony of fruitful educational practice in online settings is offered by Sami Lehesvuori, Laura Ketonen, and Markus Hähkiöniemi in their study *Utilizing Informal Formative Assessment and Dialogicity During Reflections on Educational Dialogue in Mathematics*. Based on an analysis of video-stimulated joint reflections between mathematics student teachers and a teacher educator, they describe how particular moves during informal formative assessment contribute to the educational dialogue. Their granular analysis shows how the focus on the lesson goal might serve as a valuable tool for navigating between dialogicity and subject accuracy.

A focus on student learning in particular settings is presented by Nicol Dostálová, Libor Juhaňák, and Lukáš Plch in *A Narrative Review of Eye-Tracking Research on Self-Regulated Learning from Multimedia Learning Materials in Higher Education*. They summarize how self-regulated learning processes while learning from multimedia materials have been researched by eye-tracking technology and indicate the areas where this approach might be developed.

Jaroslav Říčan and Roman Kroufek used a different methodological approach in their study *Factor Structure of a Self-Report Questionnaire Determining*

the Epistemic Beliefs of Primary School and Kindergarten Student Teachers in the Science Domain. The authors offer a tool for measuring the level at which student teachers are sure about the truths provided by science, which is a part of beliefs and attitudes that is distinctively mirrored in teacher decisions about teaching.

The issue concludes with the emerging researcher section, containing Barbora Nekardová's *The Role of Peer Learning Among University Teachers in Integrating Digital Technologies into Higher Education Teaching.* Nekardová draws attention to the under-researched area of informal workplace learning among academics. Identifying how university teachers share their ICT knowledge and what the shared contents are stresses the empowering role of peer learning and indicates how pressing *how* questions might suppress asking the right *why* questions.

We hope that this special issue of *Studia paedagogica* will contribute new knowledge and initiate new questions that will enrich the research and practices of teaching and learning in higher education, and thereby improve the quality of higher education.

Kari Smith and Karla Brücknerová
Editors

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AIMING FOR ACTIVE STUDENT PARTICIPATION IN ONLINE UNIVERSITY LESSONS: A CASE STUDY OF TWO TEACHERS DURING EMERGENCY REMOTE TEACHING

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ABSTRACT

While learning is most effective when students are actively engaged, student participation in university classrooms is usually dominated by monologic teacher talk. Digital technologies are often seen as a way to enhance active student participation, yet most reports show that the emergency remote teaching that used digital technologies during the COVID pandemic worsened student participation. We look at active student participation in the synchronous online university lessons of two teachers with shared views on the importance of active student participation but differing approaches to online teaching. We employed a range of tools, including multiple lesson observations over time, line-by-line micro-analysis of the lessons, analysis of discourse moves based on Hardman's coding system, network visualizations of interactions, and interviews with the teachers reflecting on their teaching. With these tools, we aimed to link the teachers' views of online teaching with their teaching practices and with the resulting active student participation in their online lessons. The findings of our study indicate that teachers' views of online teaching can significantly influence their teaching practices. We found that the view that online teaching can serve as a substitute for contact teaching has a detrimental effect on teacher ability to employ the practices necessary for active student participation in online settings. We suggest abandoning the idea of online teaching as a substitute for contact teaching. Instead, online and contact teaching should be seen as two distinct entities requiring different teaching practices. We discuss specific teaching practices that we observed in relation to their role in promoting active student participation in online lessons.

KEYWORDS

emergency remote teaching, online learning, COVID teaching, interactive lessons, case study, mixed design

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Introduction

Student active learning and student engagement in classroom talk have become key topics in educational sciences (Børte et al., 2020). It is understood that learning is most effective when students are actively involved in a dialogic co-construction of meaning (Wells & Arauz, 2006). Empirical studies have indicated that the more students talk, discuss, and argue, the better they learn and the more motivated they are to study (Baber, 2020; Bernard et al., 2009; Kuo et al., 2014). However, investigations across the world have demonstrated that student participation in university classroom dialogue is limited – teachers mainly pose factual questions and students reply with short and rote answers. The current style of teaching in higher education has been characterized as teacher-centered with little space for student active learning and engagement (Børte et al., 2020). Studies investigating student engagement report that few students participate and contribute to class discussions; most remain silent during the lesson (Fritschner, 2000; Howard & Baird, 2000). A typical lesson scenario includes monologic teacher talk combined with short question and answer sequences with brief student utterances (Klerk, 1995; O'Boyle, 2010; Wood et al., 2018).

Hardman (2016) conducted a particularly elaborate study, recording, thoroughly coding, and analyzing interactions in four university seminar lessons. Based on the observed lessons, Hardman created a set of different types of discourse moves occurring in the university setting. The discourse moves represent exchanges between students and teachers based on the "initiation, response, follow-up" (IRF) structure. However, Hardman observed that the IRF can take on very different forms, leading to very different outcomes in student engagement. She therefore expanded the prototypical IRF structure into further subcategories. The initiation moves were categorized into open, closed, and check questions directed toward students and student questions directed toward the teacher. The response moves were categorized into brief (one word, phrase, or sentence) and elaborate answers. The follow-up moves were categorized into acknowledgement (verbally acknowledging or repeating an answer), praise (praising a student answer), negation (disagreeing with or rejecting an answer), comment (building on or expanding an answer), probe (asking the same student to elaborate or justify a previous answer), and uptake (incorporating a previous answer into a new question for everyone). In her study, closed questions comprised 50.3% of the teacher's initiation moves, brief answers made up 86.5% of the student responses, and acknowledgements were 51.7% of the follow-up moves. As closed questions lead to brief answers and acknowledgements do not give space for any further elaboration (whether from the students or the teacher), Hardman (2016) found the interaction in the lessons to be dominated by short question and answer sequences.

The reasons that university lessons are dominated by the prevailing teacher-centered pattern of interaction and the lack of active student participation remain largely unclear. Research has suggested that a number of teacher practices play a crucial role in promoting student active classroom participation. Fischer and Hänze (in press) conducted an extensive study in 80 university courses observing the share of students participating actively in the class discussion. They found the number of teacher questions put to students to be determinative in this regard. The more a teacher asked, the more students participated. The course atmosphere was also found to have an effect. Students participated more when they perceived the teacher as respectful and appreciative, open to other opinions and suggestions, and incorporating student questions and comments into discussions. Similarly, Mustapha et al. (2010) and Abdullah et al. (2012) reported that university students feel more likely to actively participate in the classroom when a teacher encourages them to talk by giving them both verbal and non-verbal cues, calls them by their names, does not scold them for their answers, is not impatient, and accepts and even supports differing opinions.

Previous studies (Abdullah et al., 2012; Fisher & Hänze, in press; Mustapha et al., 2010) have proposed several teacher guidelines aimed at improving active student participation in university classrooms. Teachers should actively pose questions, be welcoming and appreciative of all student contributions, and incorporate student contributions into teaching. The question remains whether such an approach is viable for a higher education environment. Heron (2018) interviewed several university teachers and found that the teachers believed in the crucial roles of class dialogue and discussion in cognitively activating students, empowering their voices, and facilitating their learning. However, at the same time, the teachers felt that various tensions and institutional constraints limited their capacity to establish dialogue in their lessons. These included the tension between valuing student participation and needing to cover specific material. Richards (2006) suggested further constraints limiting active student participation in higher education environments – the power asymmetry in classroom dialogue and the institutional settings that cast students in the roles of passive actors. It has been argued that the space for student talk and active engagement is limited in traditional settings but could be radically enhanced by digital technologies by overcoming some of the institutional constraints – specifically, that digital technologies could be used to facilitate peer learning with the use of online forums and synchronous online group activities and to reduce the power asymmetry between students and teachers by making teachers more accessible (Coorey, 2016; Englund et al., 2017; Wdowik, 2014).

However, a study by Šeďová et al. (2021) suggested that the use of digital technologies in higher education does not necessarily mean higher active

student participation. The study was based on interviews with 34 university teachers at the Faculty of Arts at Masaryk University during the period of emergency remote teaching (ERT) resulting from nationwide COVID containment measures in 2020. As with many other university programs across the world (Mishra et al., 2020; Walker & Koralesky, 2021), Masaryk University was forced to shift to fully online teaching. Compared to established online learning, ERT is unplanned, lacks established infrastructure, and is a direct response to a crisis rather than a deliberate decision (Whittle et al., 2020). The study by Šeďová et al. (2021) suggested that in the ERT period, university teachers fell into two polar categories based on their approaches to online teaching. On one side of the spectrum were functionalists who saw online teaching as a challenge but were willing to overcome the hindrances by changing teaching practices with the aim of passing the required knowledge to students. On the other side of the spectrum were authenticators who also saw online teaching as a challenge but were not willing to change their teaching practices as their central idea in teaching was authentic spontaneous teacher-student communication as a means of creating new knowledge. The study suggested that while the functionalists were mostly content with online teaching and active student participation in their online lessons as they saw that online teaching was bringing new features into their teaching practices, the authenticators were mostly dissatisfied and complained about the quality of active student participation in their online lessons. A key limitation to their study is the fact that the authors lacked data enabling them to assess active student participation in the teachers' online lessons beyond self-reports in interviews with the teachers.

Most other studies dealing with student participation in online lessons during ERT have lacked lesson observations and relied heavily on teacher and student reports. These studies reported decreases in active student participation after the transition to ERT. While some studies reported teachers and students praising the chance to interact with others in chat rooms while hearing a lecture, feeling less stressed during online lessons, and appreciating the opportunity to use chat rooms to ponder before engaging in discussions (Müller et al., 2021; Shim & Lee, 2020), most studies reported more negative aspects of ERT. Some research identified decreases in student engagement (Petillion & McNeil, 2020; Shim & Lee, 2020; Walker & Koralesky, 2021) and decreases in both teacher–student and student–student interactions (Ferri et al., 2020; Le & Truong, 2021; Thurab-Nkhosi et al., 2021) during ERT at universities. Teachers have complained about the inability to read student faces (Mishra et al., 2020), the lack of confidence (Lei & So, 2021), and technical problems (Nambiar, 2020); students often reported being distracted (Petillion & McNeil, 2020; Shim & Lee, 2020; Walker & Koralesky, 2021) and lacking stable internet connections (Shim & Lee, 2020).

1. Present study

While there have been studies investigating active student participation in the context of ERT, they lack data from the lessons that could provide objective measurements of active student participation and link the teachers' perceptions of online teaching with their practices and with active student participation in their lessons. This study aims to address the research gap – the lack of studies providing analyses based on lesson observations. We formulated our research question as *How are teachers' views of online teaching reflected in their teaching practices and what effect do their practices have on active student participation?* We aim to link teachers' views of online teaching during ERT with their teaching practices, and, ultimately, with the outcomes in active student participation in their lessons. We understand teaching practices as specific behaviors – the means by which teachers attempt to impart knowledge to their students. To address the question, we approach the issue as a mixed-design case study of two teachers and employ a range of tools including multiple observations of lessons over time, line-by-line micro-analysis of the lessons (Lefstein & Snell, 2014), analysis of discourse moves based on Hardman's (2016) coding system, network visualizations of interactions, and interviews with teachers with reflections on their teaching. With the selected tools, we aim to provide a detailed image of active student participation in ERT and put it into the wider context of teacher practices and teacher views of online teaching. The cases are two experienced university teachers, both aiming for interactive and dialogic lessons and having no prior experience with fully online teaching. However, the two teachers dramatically differed in their attitudes toward online teaching, in the teaching practices they employed, and, ultimately, in the active student participation in their online lessons.

2. Materials and methods

2.1 Research design

To address the research question, we employed a mixed-design case study approach. A mixed-design approach was used to address the gap identified in previous research from the same institution (Šeďová et al., 2021) that lacked objective measurements of active student participation in the form of observations and relied solely on teacher reports. We utilize both teacher reports and views of online teaching from interviews and complement these with observations of lessons followed by a qualitative analysis of teaching practices and a quantitative analysis of active student participation. This design allowed us to study the interconnectedness of teachers' views of online teaching, their teaching practices, and active student participation in their lessons.

2.2 Context

Our study is based at the Faculty of Arts of Masaryk University – a large public research university in the Czech Republic. Starting in mid-2020, all the teachers at the Faculty had to switch to synchronous online teaching via the Microsoft Teams platform. The teachers were expected to stick to their original schedules and lesson structures, with the only difference being the online mode of delivery. The online mode of delivery continued for the duration of the 2020/2021 school year.

2.3 Study participants

Our cases are two university teachers. We chose the teachers based on the criteria of: (1) having broad and similar teaching experience (mid-career tenure-track assistant professors); (2) being noted by their students and their fellow colleagues as having dialogic and interactive lessons before the COVID outbreak – we made use of student course opinion polls from before the pandemic, and we had talks with the respective departmental heads; and (3) having no prior experience with fully online teaching. The two teachers come from a larger sample of two previous studies – the study aimed at exploring the transition to online learning through teachers' eyes (Šeďová et al., 2021) and a study of four teachers whose lessons had been studied in relation to interactions in online lessons (Lintner, 2021). The two teachers were selected by the authors of this study to address the research question, which is based around making lessons during ERT with active student participation. The teachers had shared views on the importance of active student participation in the classroom, but they differed in their views of online teaching, their teaching practices, and the resulting student participation in their lessons. Hence, the two cases make it possible to illustrate the differences in teaching practices stemming from differing views of online teaching and not from differing views of active student participation. The two teachers occupy two opposite poles of the functionalist–authenticator spectrum constructed in the previous study (Šeďová et al., 2021). We refer to the teachers by pseudonyms: Cora and Ben. Cora has seven years of teaching experience, teaches education to a class of 27 master's degree students, and is a functionalist replacing components of face-to-face teaching with new tools with the priority of passing on knowledge to students in mind. Ben has six years of teaching experience, teaches literature to a class of 32 master's degree students, and is an authenticator prioritizing the idea of authentic spontaneous teacher-student communication as a means of creating new knowledge over a change in teaching strategies. Students in both classes are predominantly Czech and Slovak.

2.4 Data collection

First, we obtained video recordings of three consecutive 90-minute online lessons from both teachers over the span of three weeks. The recordings were obtained in the middle of the fall semester – in November 2020 – which was marked by a transition from on-site and blended learning to fully online learning. We decided to include lessons marked by the sudden mass transition to online teaching to study the context when teachers did not have much time to prepare for the online teaching. We included three consecutive lessons to expand the validity of our findings. The recordings were collected in accordance with the principles of the research ethics of Masaryk University and the data collection was approved by the Masaryk University Research Ethics Committee. The two teachers gave their written consent to the data collection. All students were informed about the purpose of the study and the scale of the data collection. All participants were able to withdraw their consent at any time. All the participants' personal data were anonymized.

We next performed 90-minute interviews with the teachers in the middle of the spring semester, in April 2021. The first part of the interview was focused on the teachers' perceptions of the transition from face-to-face to ERT and their view of online teaching. The aim was to identify: (1) the challenges the teachers faced with the sudden transition; (2) teachers' views of the role of active student participation in online lessons; and (3) what the teachers considered effective strategies in bolstering student participation in online lessons. The second part of the interview was a self-reflection of the teachers' practices based on the recorded lessons. The teachers were shown short excerpts from their lessons consisting of both highly interactive moments with extended IRF structures and moments showing student unresponsiveness and short question and answer sequences. The aim was to see how the teachers perceived their actual practices in relation to their aims for active student participation.

2.5 Data analysis

The first step of the data analysis consisted of analyzing the interviews with inductive open coding identifying codes related to the categories of active student participation in the classroom, online teaching, and teaching practices aimed at maintaining active student participation – comparing and contrasting the teachers' views on the three topics. Then, we analyzed the lesson recordings, focusing on teaching practices and the resulting student participation – we tried to identify how the teachers' practices related to active student participation in their lessons. We transcribed the video recordings of the lessons verbatim and edited them to distinguish the individual turns and their speakers to prepare the data for a subtle qualitative analysis. We followed

the methods of linguistic ethnography (Maybin & Tusting, 2011) aiming toward a description of social practices in specific contexts through a detailed analysis of the use of language. All transcripts were subjected to a line-by-line micro-analysis (Lefstein & Snell, 2014). We studied the video-recorded data to see how and under what conditions students actively participated and compared this material to the situations when students did not participate even if they were invited by the teachers. Next, we synthesized the results from the interviews with the observed teaching practices – linking teachers' perceptions of online teaching with their practices.

Afterward, we performed a series of quantitative analyses aiming at objectively assessing active student participation in the teachers' lessons. First, we calculated the basic metrics of student engagement – specifically, how many students talked at least once in a given lesson – and the duration of both student talk and teacher talk in the individual lessons. We measured student and teacher talk as every utterance related to teaching/learning – not including talk related to organizational issues – in seconds. We included both absolute durations of student and teacher talk in each lesson as well as relative durations by calculating percentages of student and teacher talk relative to all measured utterances in a given lesson. We then coded discourse moves as outlined by Hardman (2016), adding *no answer* as an additional response category (see Appendix I in Hardman (2016) for detailed descriptions of each conversation move). Each utterance was therefore classified as either *initiation* (further divided into *open*, *closed*, *check*, and *student* question), *response* (further divided into *brief*, *elaborate*, and *no answer*), or *follow-up* (further divided into *acknowledge*, *praise*, *negate*, *comment*, *probe*, and *uptake*). Next, we calculated both absolute and relative occurrences of the discourse moves by lessons and teachers. The absolute occurrence of a discourse move refers to the number of times a given discourse move occurred in a lesson. The relative occurrence of a discourse move refers to the percentage of a given discourse move occurring in a lesson. Finally, we visualized the interaction patterns in the individual lessons as social networks consisting of actors (teacher and students) and links between the actors (discourse moves in a given lesson) in a *ggraph* (Pedersen, 2021). The visualization of the interactions as social networks makes it possible to see which students engaged in interactions with whom and intuitively shows which actors the interaction was centered around. Since the teachers took part in most interactions, we used a star layout placing the teacher in the center and the students equidistant around the teacher.

3. Results

The result section is organized as follows: first, we employed the results from the interviews with the teachers to show how our teachers' views on active student participation in the classroom matched, how they differed in their views of online teaching, and how differently they approached teaching in online settings; second, we employed the results from the analysis of the lesson recordings to point out how our teachers' specific practices related to student participation in their lessons; and third, we employed the results from the quantitative analyses to show how the active student participation in our teachers' lessons differed.

3.1 Teacher views on active student participation, online teaching, and teaching practices in online settings

We utilized the data from the interviews to discuss how the teachers perceived active student participation and to identify differences in teacher perceptions of how online teaching should look, aiming to explain how their differing perceptions influenced their teaching practices and led to their (in)ability to maintain active student participation.

Both teachers seemed to value interaction and active student participation as an organic component of their established teaching strategy. For Cora, it is essential to let students discuss the topics raised in the lessons. She teaches education to master's degree students and she wants them to build the competency to practically deal with issues once they start their teaching careers:

> It is not enough when they understand the content. I need them to take a step forward to incorporate it. To link it with their own thinking and experiences. … Therefore, I try to give them space to let them reflect on the content during the lesson. (Cora)

Furthermore, Cora expressed her intention to maintain student multivoicedness (Mortimer, 1998) by not acting as a single authority providing the right answers and by letting the students engage in discussion with others with contrasting views:

> With some topics, I let them (students) challenge others' opinions and my opinions too. If I consider it enriching for the class, I want everyone to figure out their right answers, share them with others, and make everyone think about each others' answers. (Cora)

Ben teaches literature to master's degree students and focused his seminar on interpreting selected stage plays. Before the lesson, all the students read the assigned play and wrote a reading journal about it. The lesson was intended to let students share and discuss their interpretations to grasp the piece more deeply:

> I usually have an idea what they want to talk about, as they have written about it. So I follow up with some questions or introduce some theme and invite them to express their thoughts. … Actually, a major part of the lesson, I am trying to be just a moderator of the discussion. (Ben)

These statements show that Cora and Ben appreciate the verbal participation of students and that their instructional concept relies heavily on student contributions to class discussion. Both teachers are therefore similar in this regard.

Both Cora and Ben also identified the same barriers as accountable for reduced active student participation in online settings. Primarily, they noted the "incompleteness" of the online communication, specifically the absence or imperfection of the non-verbal side of the matter. This had two important consequences for the teachers. First, turn taking did not go smoothly – the students hesitated to raise their voices or, by contrast, to interrupt each other. Second, being spatially separated, students did not create personal bonds and a sense of belonging to the group. On that account, they were less willing to open themselves and share their personal points of view. Altogether, online communication limited student engagement, according to both teachers.

While both teachers were aware of both the importance of active student participation and the barriers of online space making interaction more challenging, the teachers differed in their approaches to overcoming the identified barriers and stimulating student participation and engagement. Ben decided to maintain the methods he had formerly used in his face-to-face teaching in the online setting:

> My idea was to replicate the offline lesson, ok? I feel the creative atmosphere of face-to-face seminars as an ideal and this is my benchmark. … Actually, I did not modify my teaching too much when we moved online. (Ben)

In contrast to Ben, Cora perceived the necessity of transforming her previous teaching methods:

> Shortly after the transition to online, I realized that synchronized online teaching has to be conducted differently from contact teaching. Different methods are needed to engage students and make them work. I learned how to use Padlet, Jamboard, shared documents, etc. These tools helped to hold student attention and interest and push them to contribute to share their thoughts within the group. (Cora)

Cora adopted many tools to overcome the barriers that led to decreased student engagement in smooth turn taking in the online environment. Using these tools, she often invited students to share their opinions in a

written form in real time during a lesson and then she started the discussion from their written contributions.

Cora also cared about belonging and community building in the study group. She established a "cameras on" rule during the lessons in order to maintain eye contact and visual signals within the group. Also, she started every lesson with small talk to create bonds with the students:

> It is a group of forty people with whom I spend the whole semester. They are important for me; I want to see them, and I want to know their moods to predict how our joint work will be that particular day. … Sometimes I take a photo of the screen with their faces and share the photo with them, sometimes I encourage them to wave to each other. It is kind of childish, but they enjoy it. This creates the feeling of community. (Cora)

By contrast, Ben not only did not adopt any of the new specific tools applicable online, he even restricted the repertoire possible to be implemented within Microsoft Teams. Most importantly, he did not insist on switching cameras on during the lessons. Due to this, only a few students were visible for him. Also, in contrast to Cora, he did not call on students by name. Instead of this, he preserved the same mechanisms for student engagement that he used to apply in face-to-face seminars:

> I don't insist on anyone having their camera on and I don't insist on specific people speaking, because it's the people who will then stop joining the online lesson and will start making insane excuses instead. Or they will suddenly start having technical issues and will log out. (Ben)

From Ben's comment, it is apparent that he does not see the online space as enabling student talk, but rather as a space allowing students to avoid talking. This mirrors Ben's view of online teaching as a substitute for face-to-face teaching, but with reduced opportunities for active student participation.

Ben awarded student verbal participation with points included in their final evaluation in the course. He kept this evaluation method in online teaching during the ERT and he often reminded the students of this fact. Furthermore, before the transition to ERT, during face-to-face seminars, he used spatial proximity and silence as a way to push students to contribute. After asking question, he would neither repeat nor rephrase the question, but remain silent and physically come closer to his students. He believed this created an awkward situation where someone would eventually start interacting with him. Physically approaching the students was unfeasible in the online environment, but Ben still continued to use silence as a part of his interactive approach:

> Awkward silences are part of my pedagogical repertoire. I do it consciously and it is based on my personal experience. I think it makes the student say something to end the silence. (Ben)

There are two apparent differences between the two teachers concerning their view of online teaching. First, Cora was working hard to find new tools for online teaching, while Ben tried to replicate his usual teaching in an online setting. Second, Cora strove to keep interaction with the students as personal as possible, while Ben did not. The data from their interviews indicate that both teachers were aware of their outcomes. Cora was satisfied with the interaction; Ben was frustrated and expressed strong discomfort with online teaching:

> My interaction with students during distant teaching was good quality …. For me, the ideal lesson is still the contact lesson. On the other hand, I can imagine that I will integrate some remote online elements into my regular teaching, because it is effective and saves time. (Cora)

> I did not succeed in activating the silent majority. … The expectation that we can deliver the same objectives as we can in contact teaching is just make-believe. … It is kind of a futile effort. (Ben)

These statements reveal that Cora coped with the abrupt change and even capitalized on the situation for her professional development as a teacher. By contrast, Ben did not see any professional enrichment.

The interviews with the teachers reveal that while both teachers valued active student participation and both teachers were aware of the barriers online teaching can pose to promoting active student engagement, the difference came with their approach to the transition and teaching in ERT. While Cora started perceiving online teaching as a practice requiring different approaches, Ben perceived online teaching only as a substitute for face-to-face teaching, complaining of its limitations, but not changing anything from what he was used to doing in a face-to-face mode. We argue that these different perceptions resulted in our two teachers employing different teaching strategies.

3.2 Linking teachers' views of online teaching with their practices

Building on the interviews revealing teachers' differing views of teaching during ERT, we utilized the data from the recorded lessons to identify differences in teachers' practices, aiming to explain what determined their (in)ability to maintain active student participation. We provide excerpts from both teachers' lessons illustrating distinctive exchanges. We discuss the excerpts in connection with practices related to interaction in the classroom in general and in connection with practices specific for online teaching.

We start with an excerpt from Cora's lesson for future educators aimed at discussing the viability of differentiated assessment based on student learning needs. Prior to this part of the lesson, several students had proposed that students should be assessed differently based on their career aspirations and interests.

1. **Cora (teacher)**: You are now talking about a differentiated approach to student assessment. Is there anyone who thinks it's not fair? That someone gets the same marks for less work? There're usually some people who think it's not fair. Anyone want to bring it up?
2. **Lea (student)**: (*starts talking spontaneously*) Well, I just want to say that if a teacher is willing to do that, I really admire that, because at my school, nobody cared about anything like a differentiated approach to assessment. We had a young, inexperienced biology teacher – she wanted all of us to write seminar theses, even though most of us were not aiming for biology A-Levels. She really had this feeling like she needed all of us to do some extra work. And I must say her approach was absolutely mad and if anyone considers student interests and career aspirations, it's great, and we should do the same ourselves.
3. **Cora (teacher)**: Right, you've mentioned two issues here – first, you know, she could've had good intentions there. I mean, if she's young, she might not have been aware of the consequences of such an approach. Then, you agreed with the guys before, that differentiated instruction is an ideal you should aim for.
4. **Paul (student)**: (*pushes the* raise hand *button*)
5. **Cora (teacher)**: I'm gonna pass this to someone else – Paul, you have the floor.
6. **Paul (student)**: Well, I'd like to react to Lea. I also have my own experience – similar to Lea's. The assessment was all very strict and everyone needed to know the same things. Considering differentiated assessment, though, I can't really agree with that if we are talking about academic high schools. I mean, they (students) should have very strong general knowledge, not only specialized knowledge.
7. **Cora (teacher)**: Paul, you are raising the problematic issue of finding a balance between providing specialized and general knowledge at schools. Is that what you had in mind?
8. **Paul (student)**: Yes, that's the thing – where we should draw the line between what everyone should know and what we should require only from some.
9. (*many students push the* raise hand *button*)
10. **Cora (teacher)**: Right… I see Ann, Susan, John, and Matthew want to react – you will all get the floor. Let me just first ask everyone – how would you respond to Paul concerning the line between specialized and general knowledge, and how should it be reflected in student assessments?

Cora started this interaction by posing an open question referring to her students' own experiences, which are thus taken as a legitimate entrance to discussion (line 1). Immediately, student Lea contributed with a long utterance in which she appreciated the discussed differentiated approach to student assessment and at the same time gave a negative example of a past teacher who used a non-differentiated approach and had a very high level of expectation from all her students (line 2). Cora did not evaluate Lea's contribution. Instead, she highlighted the main themes (line 3) and gave the floor to another student – Paul (line 5). Paul responded to Lea with disagreement. He commented that in academic high schools all students have to be expected to meet high academic standards (line 6). Cora again did not evaluate the student's contribution;

instead, she highlighted the main point and made sure she followed the student's argument (line 7). Many students then wanted to enter the discussion (line 9) and Cora made use of Paul's argument as a starting point for another round of student utterances – engaging the students themselves to answer the raised question, instead of simply providing the answer herself (line 10).

It is apparent from the excerpt that the students were willing to enter the discussion; they were confident enough to express their personal positions and supported them with examples. The student utterances were elaborate and long. Moreover, students reacted to each other; multivoicedness was present in the class, with many students presenting differing stands and views (Mortimer, 1998), and the class talk was exploratory (Barnes & Todd, 1978), as the students worked together to construct new knowledge. In this lesson, almost all the students had their cameras on, allowing Cora to call on each person by name and to maintain a personal approach.

Cora's lesson continued into a discussion on how future teachers should communicate with their pupils about expected study outcomes. This excerpt illustrates Cora's ability to maintain high student engagement utilizing Microsoft Whiteboard. During this activity, most student had their cameras off and everyone was looking at the shared digital whiteboard. Students were simultaneously asked to write their notes on the whiteboard and probed to explain their notes and react to others.

1. **Lea (student)**: I think it's important to explain to them (pupils) at the beginning of each lesson what the lesson is based on, like previous lessons, and what they should know at the end of the lesson. Kind of put it into context so everyone knows what the lesson is about. (*starts writing on whiteboard*)
2. **Cora (teacher)**: Lea, I'll let you finish writing now. What Doris said definitely applies to all contexts. Also, it's usually a good idea to always give them (pupils) some time to inquire if anything's not clear to them about that. I am now going to give the floor to someone else.
3. (*several students start writing on the whiteboard*)
4. **Mike (student)**: If I may...
5. **Cora (teacher)**: Yes Mike, go on.
6. **Mike (student)**: Well, we should think of communicating the expectations based on differentiated assessment. I mean if we have pupils and we have different expectations of them, it makes it harder to communicate that to everyone.
7. (*two students push the* raise hand *button*)
8. **Cora (teacher)**: Well… Now I see Paul and Susan. Paul, would you mind?
9. **Paul (student)**: What came to my mind is related to what Mike said and what Lea is writing… I'd like to ask if we actually have time for that. And especially if we do some differentiated assessment.

Here, Cora did not need students to have cameras on, she – along with the students (Paul on line 9) – was drawing cues from the contributions on the digital whiteboard. The whiteboard served as a space for students to share their thoughts with the others as well as to prepare their reactions. As in the previous excerpt, Cora called on students

by name (lines 2, 5, 8) and she did not evaluate student contributions but instead elaborated on them (line 2) or let others provide alternate views (line 8), which led to multivoicedness in the form of Paul questioning the viability of the previous solutions (line 9).

From the excerpts of Cora's lesson, it seems that her views of active student participation and of online teaching – challenging, requiring different practices than contact teaching, but doable – were aligned with the teaching practices she employed – making use of cameras to maintain a personal approach, to see all the students, and to call students by their names; using software beyond basic videoconferencing tools to enhance interaction; and, with many students actively participating, bolstering multivoicedness in her lessons by welcoming students to express differing opinions.

A contrasting excerpt is from Ben's lesson, marked by student silence, brevity, and teacher restlessness. This excerpt is from a lesson aimed at discussing the play *The Octoroon* in relation to melodrama.

1. **Ben (teacher)**: How about positive and negative characters? What do you think their relation is to melodrama?
2. **silence**
3. **Ben (teacher)**: You know, when you think about McClosky, what is his motivation to be such an ass*?*
4. **silence**
5. **Aaron**: Being in charge… Having money…
6. **Ben (teacher)**: Okay, okay… But what about personality-wise? What can we say about his personality?
7. **silence**
8. **Ben (teacher)**: In the moral connection… Anyone? C'mon, c'mon!
9. **silence**
10. **Ben (teacher)**: Does he have any good sides?
11. **silence**
12. **Aaron**: Well… He's ambitious; I mean, he's like goal oriented. He's like, I'm gonna do this, I'll get that, because of his reasons…
13. **Ben (teacher)**: (*interrupts Aaron*) What are the reasons?? What are the reasons?? I'm asking about the reasons…
14. **Aaron**: Well, he wants to get back at people. Like, he wants revenge.

Like Cora, Ben started the interaction with an open question asking the students what they thought about the characters depicted in the drama they read (line 1). Unlike in Cora's lesson, however, the students resisted contributing and stayed mostly silent (lines 2, 4, 7, 9, 11), even when the teacher strove to reformulate the original question (lines 3, 6, 8, 10) and emphatically invited students to participate (line 8). The only student willing to talk was Aaron, who repeatedly attempted to answer (lines 5, 12, 14). When giving feedback to Aaron, the teacher did not comment on what the student said. Instead, he indicated that his question was meant to be answered differently and Aaron's answers were skewed (lines 6, 13). Ben repeatedly invited students to give their opinions, but the students remained mostly silent. When the student answers did appear, they were not utilized to create new knowledge.

The excerpt from Ben's lesson also includes what Ben referred to as an "awkward silence" (lines 2, 4). Here, Ben remained silent for around 20 seconds after asking a question. While Ben was expecting the question to lead to elaborate answers, it only led to a brief utterance from Aaron after reformulating the question. The reason the "awkward silence" did not lead to the expected outcomes was presumably due to the fact that most students had their cameras off, did not feel like part of the conversation, and therefore did not feel the social awkwardness otherwise felt if they had been together in person in close proximity or if they had their cameras on. Only one person in this lesson had their camera on – Aaron – who was also the person most often interacting with Ben. Ben did not call on anyone by name, did not see anyone apart from Aaron, and never attempted to invite any specific student into the discussion by explicitly calling on them. As we discussed in the previous section, this was Ben's conscious decision as he believed that pressuring students to have their cameras on and calling on them by name would cause students to stop attending his online lessons.

From the excerpt from Ben's lesson, it seems that his view of online teaching limited his teaching practices, which then did not match his views on active student participation – the lessons did not develop into smooth turn taking and spontaneous interactions allowing the creation of new knowledge. Ben perceived the online mode of teaching as limiting, a poor substitute for contact teaching, and, believing that the online mode was only a substitute, he did not change his approach to teaching. His employed teaching practices did not bring his desired level of active student participation.

3.3 Measuring active student participation

In the previous section, we indicated some differences in student participation between the lessons of the two teachers. We now provide quantifiable measurements of active student participation in our teachers' lessons aiming to link the two teachers' teaching practices with their success in promoting active student participation. The quantitative part provides evidence that the two teachers' lessons differed in the length of student talk as well as in the number of actively participating students. The quantitative part further breaks communication in the lessons down into the discourse moves described by Hardman (2016) and allows for a comparison of the active student participation between the two teachers' lessons from the point of view of the initiation moves employed by the teachers, the resulting student response moves, and the follow-up moves. Finally, the quantitative part shows active student engagement in the observed lessons in terms of interactions.

The two teachers differ in terms of the output of their efforts to maintain active student participation. Cora was more successful than Ben both in activizing a larger number of students and in maintaining higher ratios

of student talk time. Table 1 shows the verbal engagement rate of the students in the lessons as well as a breakdown of both teacher and student talk. The engagement rates in both teachers' lessons were consistent across the three observations. However, in Ben's lessons, only around a quarter of students engaged at least once during the lesson; in Cora's lessons, it was half of the students. In Each lesson, approximately twice as many students engaged with Cora as with Ben. Similarly, the student talk in Cora's lessons was over twice as frequent as in Ben's lessons, with an average 25.4% of the time in Cora's lessons spent on student talk, compared to 11.7% in Ben's lessons.

Table 1
Student engagement and talk

BEN (32 students)	**lesson 1**	**lesson 2**	**lesson 3**	**average**
engaged students	8 (25.0%)	8 (25.0%)	7 (21.9%)	7.67 (24.0%)
teacher talk	80:35 min (90.6%)	37:30 min (84.6%)	47:35 min (83.4%)	55:13 min (88.3%)
student talk	8:20 min (9.4%)	6:50 min (15.4%)	6:50 min (12.6%)	7:20 min (11.7%)
CORA (27 students)				
engaged students	13 (48.2%)	14 (51.9%)	16 (59.3%)	14.33 (53.1%)
teacher talk	60:15 min (78.5%)	56:35 min (61.4%)	74:00 min (85.1%)	63:37 min (74.6%)
student talk	16:30 min (21.5%)	35:35 min (38.6%)	12:55 min (14.9%)	21:40 min (25.4%)

Both teachers provided comparable and ample opportunities for students to actively participate, yet they greatly differed in the response rates and the number of students engaging with them. Furthermore, the two teachers greatly differed in the use of the follow-up moves. Table 2 gives a breakdown of the discourse moves seen during the observed lessons. Both Ben and Cora employed comparable numbers and types of initiation moves – predominantly open questions – however, in Cora's lessons, student questions were more prevalent. A remarkable difference comes with the response moves. Ben had 34.0% of his questions left with no response, while only 11.1% of Cora's questions were unanswered. Cora (68.4%) also received elaborate answers more often than Ben (44.7%). Differences between the two teachers also appear with the follow-up moves; while Ben most often employed uptakes (30.9%) as a move following student response, Cora mainly employed comments (50.9%). Since uptakes – compared to comments – give students opportunity to actively participate, it becomes even more surprising that Ben had a much lower number of engaged students and a much lower ratio of student talk than Cora.

Table 2
Breakdown of the discourse moves

BEN (32 students)		**lesson 1**	**lesson 2**	**lesson 3**	**average**
initiation		36 (25.4%)	5 (13.2%)	8 (18.2%)	16.33 (21.9%)
	open	21 (58.3%)	4 (80.0%)	7 (87.5%)	10.67 (65.3%)
	closed	6 (16.7%)	0 (0.0%)	1 (12.5%)	2.33 (14.3%)
	check	9 (25.0%)	0 (0.0%)	0 (0.0%)	3.00 (18.4%)
	student	0 (0.0%)	1 (20.0%)	0 (0.0%)	0.33 (2.0%)
response		58 (40.9%)	16 (42.1%)	20 (45.5%)	31.33 (42.0%)
	no	25 (43.1%)	2 (12.5%)	5 (25.0%)	10.67 (34.0%)
	brief	16 (27.6%)	1 (6.3%)	3 (15.0%)	6.67 (21.3%)
	elaborate	17 (29.3%)	13 (81.3%)	12 (60.0%)	14.00 (44.7%)
follow–up		48 (33.8%)	17 (44.7%)	16 (36.4%)	27.00 (36.2%)
	acknowledge	7 (14.6%)	2 (11.8%)	2 (12.5%)	3.67 (13.6%)
	praise	2 (4.2%)	2 (11.8%)	0 (0.0%)	1.33 (4.9%)
	negate	1 (2.1%)	0 (0.0%)	0 (0.0%)	0.33 (1.2%)
	comment	14 (29.2%)	2 (11.8%)	6 (37.5%)	7.33 (27.2%)
	probe	12 (25.0%)	4 (23.5%)	2 (12.5%)	6.00 (22.2%)
	uptake	12 (25.0%)	7 (41.2%)	6 (37.5%)	8.33 (30.9%)
CORA (27 students)					
initiation		20 (22.7%)	11 (10.8%)	16 (17.4%)	15.67 (16.7%)
	open	11 (55.0%)	6 (54.6%)	8 (50.0%)	8.33 (53.2%)
	closed	4 (20.0%)	0 (0.0%)	3 (18.6%)	2.33 (14.9%)
	check	3 (15.0%)	3 (27.3%)	0 (0.0%)	2.00 (12.8%)
	student	2 (10.0%)	2 (18.2%)	5 (31.6%)	3.00 (19.2%)
response		37 (42.1%)	43 (42.7%)	37 (40.2%)	39.00 (41.5%)
	no	6 (16.2%)	4 (9.3%)	3 (8.1%)	4.33 (11.1%)
	brief	8 (21.6%)	5 (11.6%)	11 (29.7%)	8.00 (20.5%)
	elaborate	23 (62.2%)	34 (79.1%)	23 (62.2%)	26.67 (68.4%)
follow–up		31 (35.2%)	48 (47.1%)	39 (42.4%)	39.33 (41.8%)
	acknowledge	5 (16.1%)	0 (0.0%)	5 (12.8%)	3.33 (8.5%)
	praise	2 (6.5%)	0 (0.0%)	1 (2.6%)	1.00 (2.5%)
	negate	1 (3.2%)	0 (0.0%)	1 (2.6%)	0.67 (1.7%)
	comment	16 (51.6%)	27 (56.3%)	17 (43.6%)	20.00 (50.9%)
	probe	4 (12.9%)	15 (31.3%)	7 (18.0%)	8.67 (22.0%)
	uptake	3 (9.7%)	6 (12.5%)	8 (20.5%)	5.67 (14.4%)

The lessons of our two teachers also differed in the ways interaction took place – while Ben's lessons were heavily teacher-centered with student participation taking place mostly with exchanges between Ben and his students, Cora managed to move toward a student-centered instruction model with student participation taking place also with exchanges between the students. To put the active student participation into the context of who interacted with whom, we visualize the interaction patterns in the lessons in the form of social networks (Figure 1). During Ben's first two lessons, all communication was teacher-centered, with communication going from teacher to students and back. In Ben's third lesson, a spontaneous interaction between four students appeared; however, most of the interaction was still teacher–student and student–teacher. Student–student interactions were present in all three of Cora's observed lessons; it was most prevalent during the second lesson, when eleven students were engaged in some form of student–student interaction.

The quantitative part of the study shows several striking differences in active student participation between the lessons of our two teachers. First, it shows that even comparable invitations for students to actively participate may result in dramatically different student engagement. Both teachers provided predominantly open questions, yet the results differed. Twice as many students verbally engaged during a lesson at least once in Cora's lessons compared to Ben's lessons. Furthermore, on average, the student talk in Cora's lessons covered twice as much time as in Ben's lessons. Despite Ben employing more uptakes than Cora – in theory, this should have led to higher student participation as it explicitly gives students space to enter the discussion – it did not have the desired effect. This elaborates what we saw in the lesson excerpts – Ben posed many open questions and he used uptakes and probes when he received answers; however, the students were mostly not receptive, lessons were often filled with silences, and only a small number of students were willing to enter the discussions. The data show that the two teachers also differed in the occurrence of student–student interaction despite providing quantitatively equal opportunities for students to actively participate. This resulted in Ben's failure to achieve his idea of the ideal lesson in which he would be only a moderator of the discussion, while knowledge would be constructed by the students spontaneously engaged in discussions with each other.

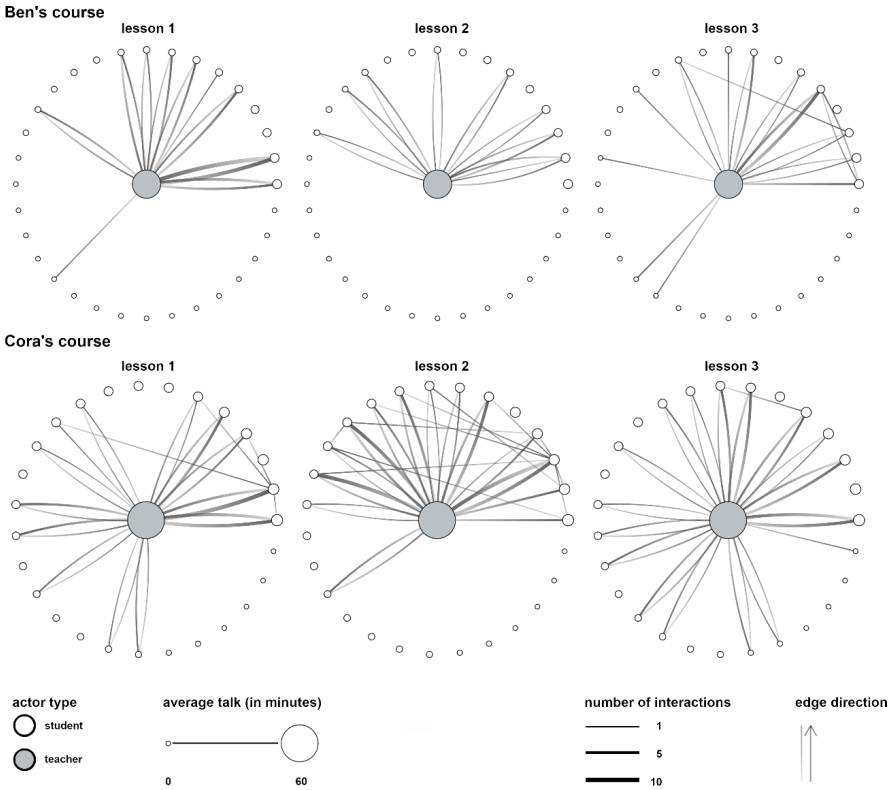

Figure 1
Interaction patterns

Discussion and conclusion

Our study shows that even if a teacher has rich teaching experience, provides ample opportunities for students to participate, and, apart from having no experience with online teaching, possesses all the necessary knowledge and awareness of how to have discussion-rich lessons, it does not mean that the teacher will be able to maintain active student participation in the online mode during ERT. We illustrate this with the cases of two teachers – Cora and Ben – differing in their ability to create online lessons with active student participation. We show that both Cora and Ben had the necessary knowledge of the importance of active student participation, and we show that active student participation in their lessons was a priority for both teachers, as they considered it essential for an effective teaching process. Both teachers also perceived ERT conditions as challenging. However, while Cora saw the necessity to alter her teaching practices in the online mode, Ben saw online teaching only as a deficient substitute for face-to-face teaching, and was

unwilling to change any practices from what he was used to in the face-to-face mode. Our two teachers' views of online teaching reflect the wider functionalist-authenticator spectrum of teachers outlined by Šeďová et al. (2021), with Cora falling into the functionalist and Ben falling into the authenticator side of the spectrum. The two differing views of online teaching influenced our two teachers' practices: Cora decided to change her pedagogical approach and saw the transition as an opportunity for professional development; Ben decided not to change anything, saw online teaching only as a substitute for face-to-face teaching, and considered the idea of online teaching serving as a substitute for contact teaching to be futile. Cora adopted the use of new online learning tools beyond the required Microsoft Teams; by asking the students to have their cameras on and taking pictures of the group, she simulated a face-to-face environment and built a sense of community among the students; by calling on students by name, she tried to keep interaction with her students personal. Ben did not make use of even the most basic tools available – e.g., the cameras – and employed methods that might work in contact teaching but are uncertain in an online setting (such as the awkward silences). The resulting active student participation in the lessons of our two teachers then differed dramatically, with Cora being successful in activizing twice as many students, maintaining twice as high ratios of student talk time, and stimulating student–student interactions much more often than Ben.

Our results concerning teachers' views of online teaching during ERT mirror previous research. Analogously to the statements of the teachers included in the studies by Ferri et al. (2020), Le and Truong (2021), Petillion and McNeil (2020), Shim and Lee (2020), Thurab-Nkhosi et al. (2021) and Walker and Koralesky (2021), both of our teachers perceived student engagement and interaction with students to be more challenging in the online mode than in contact teaching. Also, in accordance with the statements of the teachers included in the study by Mishra et al. (2020), one of the biggest challenges in online teaching for our two teachers was the inability to read student faces. Our results therefore support the condition extensively reported in the previous literature – during the mass transition to online teaching, teachers mostly perceived the online mode as challenging and feared that the online mode would be detrimental to active student participation.

On the other hand, our results concerning the degree of active student participation in university lessons stand in contrast to previous findings. While Børte et al. (2020) reported university lessons to be mostly teacher-centered with little space for student active learning and engagement, we found that both of our teachers provided ample opportunities for students to actively participate, with both teachers posing large numbers of open questions to students in each of the observed lessons. Similarly to Børte et al. (2020), Hardman (2016) found university lessons to be dominated by teacher closed

questions, student short answers, and teacher acknowledgements. However, we found both of our teachers posing mainly open questions, students reacting mostly with elaborate answers, and teachers following up with discourse moves (uptakes, probes, and comments) trying to expand the ongoing discussion. The difference between our teachers and teachers from the studies by Børte et al. (2020) and Hardman (2016) may be the result of both of our teachers having robust knowledge of the importance of active student participation and their strong willingness to make their lessons open to active student participation.

While both of our teachers provided ample opportunities for their students to actively engage – both teachers posed many and mainly open questions – Cora was much more successful in activizing her students than Ben was. This suggests that the key guidelines for teachers on how to provide lessons with active student participation (e.g., Fischer and Hänze, in press) based on actively posing questions and incorporating student contributions into teaching may not be sufficient. Quite the opposite: while actively posing questions and incorporating student contributions into teaching are necessary prerequisites for active student participation, our findings suggest that, in the context of online teaching, further teaching practices are necessary to maintain active student participation.

Our study therefore has several implications for educators seeking to have students actively participating in their online lessons. To maintain active student participation, it is useful to promote multivoicedness by incorporating contrasting student views into discussions. Furthermore, it is important to maintain interactions with students that are as personal as possible, e.g., by calling on students by name or by incorporating activities aimed at building a sense of community among the students. However, maintaining personal interaction is difficult when the students' cameras are off. We therefore suggest that teachers aiming to have interactive online lessons ask their students to have their cameras on, which also makes it possible to read students' non-verbal cues, an issue mentioned by both of our teachers. We also find the use of teaching tools beyond the videoconferencing tools to be useful in promoting active student participation.

Our findings further imply that asking teachers to simply shift contact lessons into an online space – a prevalent approach during the COVID pandemic – does not automatically result in teachers having the same effectiveness in delivering interactive lessons as they may have had in contact teaching. We therefore suggest abandoning the idea of online teaching serving as a substitute for contact teaching. Instead, universities forced to transition into an online mode should perceive online and contact teaching as two distinct entities requiring different teaching practices to achieve the same outcomes, and this view should be shared by the teachers. It is natural that when people find

themselves in situations they had not experienced before, they transfer practices from situations they are familiar with. However, the notion of online teaching being a substitute for on-site teaching was detrimental to active student participation in Ben's lessons. Ben relied on practices he employed during contact teaching, and this limited his ability to create lessons with active student participation as oftentimes these practices were just not effective in online setting.

While our study is based around the ERT during the COVID pandemic, the findings of our study are relevant for any situation in which educators need to shift their teaching into online mode. It is unclear what higher education will look like once the pandemic is over, but with online teaching on the rise even before the pandemic, it is plausible to say that online teaching will continue to play a substantial part. Many teachers' perceptions of online teaching will fall close to those of Ben. Understanding how teacher perceptions influence their teaching practices and ultimately affect active student participation in their lessons will therefore be crucial to ensure quality university education in the future.

Our study is limited in its design – a case study with a sample of two teachers. While we attempt to grasp the problems of active student participation in synchronous ERT at a university from two contrasting viewpoints and suggest what may or may not lead to the desired online active student participation, we cannot generalize. Also, while we link teachers' attitudes toward the online teaching during ERT to the active student participation in their lessons, we do not know how to change teacher attitudes to potentially influence pedagogical outcomes during ERT. Further research would therefore benefit from studies investigating synchronous online interaction on a large scale and from studies investigating how teachers' negative perceptions of online teaching can be changed to influence their teaching practices.

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EXPLORING TEACHING CONCEPTIONS AND PRACTICES: A QUALITATIVE STUDY WITH HIGHER EDUCATION TEACHERS IN PORTUGAL

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ABSTRACT

In recent decades, several international political guidelines have encouraged the reconfiguration of teachers' ways of being and acting, specifically arguing for the rejection of the conception of a teacher who holds and transmits knowledge, with inevitable implications for pedagogical practices. Therefore, it is particularly relevant to gain an understanding of teachers' conceptions and practices, exploring the extent to which they are reconfigured throughout training and professional development processes. With this general objective, a qualitative study is presented, drawing on the content analysis of written testimonies and individual portfolios produced by a group of 24 academics involved in a post-graduate degree course in higher education pedagogy at the University of Lisbon in the academic years 2019/20 and 2020/21. The results suggest a dominant professional conception, embedded in the artisanal paradigm and in line with a teaching conception based on the transmission of knowledge. However, there are signs that teachers challenge this vision of professionalism, revealing diverse conceptions about the profession as well as conceptions about teaching and learning aligned with different types of pedagogical orientation. The study also shows how formal pedagogical training might support changes in teachers' conceptions about their profession and about the meaning of teaching and learning, with effects on teaching practices and on the quality of student learning.

KEYWORDS

higher education, teaching professionalism, conceptions, beliefs, pedagogical orientation

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Introduction

Higher education and the teaching profession have been confronted with increasing challenges in recent decades. The phenomena associated with the information society, the massification of higher education, and the question of bridging education and the world of work in the 21st century are examples of such challenges. Furthermore, the convergence of trends regarding higher education policies led to the creation of the European Higher Education Area (EHEA). The countries involved in EHEA have initiated curriculum restructuring processes in higher education; changes within teachers' professionalism have also been advocated, with a strong appeal to interrupt the hegemony of the instructional paradigm, emphasizing the need to adopt the learning paradigm. Other interventions by international organizations with increasingly important roles in defining public policies for the sector, such as the OECD (2018) and UNESCO (1997, 2009), corroborate this view.

The transnational narrative that values the learning paradigm and stresses the need to abandon the instructional paradigm is widespread across Europe. It is a fundamental key element within the construction process of the EHEA associated with the Bologna Process. Nevertheless, this narrative assumes a pre-existing hegemony of the instructional paradigm that might not be entirely coincident with the ways in which higher education teachers act and think.

These movements in international forums are in line with what the literature has highlighted (e.g. Cid-Sabucedo et al., 2009; Cunha, 2010; Esteves, 2010; Flores et al. 2007; McCune, 2019; Smith & Flores, 2019; Zabalza, 2004). Indeed, in order to reconfigure the ways of being and acting in teaching, the notion of the teacher as someone who holds and transmits knowledge must be quashed. This bears inevitable implications for the conceptions of what it means to teach and learn, to be a student and to be a teacher, and consequently for pedagogical practices.

Despite the enormous pressure on higher education to change teachers' practices, it has been observed that practices do not change simply due to political pressure or normative imposition. Furthermore, these changes are not intended to take place merely at the most superficial level, with occasional recourse to more active methodologies or by incorporating digital technologies in teaching. A far deeper transformation at the core of the professionalism and professionality of the teacher is expected, which implies reaching the level of teachers' beliefs, conceptions, and implicit theories. In fact, it is assumed that teachers structure a personal interpretative framework throughout their professional careers corresponding to "a set of cognitions, mental representations that work as a lens through which they look at their profession, giving it meaning and acting in it" (Kelchtermans, 2009, p.72).

Kelchtermans (2009) argued that two major domains support teachers' thinking and action: the first domain is designated as subjective educational theory (professional know-how) related to the personal system or theory of knowledge and beliefs that acts as a support for decision-making as well as its legitimation; the second domain corresponds to the personal interpretative framework and includes the teachers' conceptions about themselves as teachers.

The influence of beliefs, perceptions, and judgments for teaching performance in the classroom has been supported by several authors (Borko & Putnam, 1995; Clark, 1988; Erickson, 1986; Marcelo, 2009; Navarro, 2007; Nias, 1989; Russell & Kane, 2005; among others), although a variety of terms are reported in the literature with different meanings, sometimes used as synonyms, resulting in a semantic dispersion that makes it difficult to meta-analyze the studies performed. Based on a literature review, Navarro (2007) concluded that, despite the polysemy of the terms, it is possible to find more regularities when using the term "beliefs".

First, it is important to acknowledge the distinction between knowledge and belief. Belief implies judgment and an affective component; knowledge corresponds to theory offered by research. In this sense, beliefs have affective and evaluative functions, acting as information filters that influence the way knowledge is used, stored, and retrieved. Navarro (2007) used Richardson's definition of beliefs: a "set of propositions and assumptions people have about what they consider to be true. Beliefs, unlike propositional knowledge, do not need the refutable truth condition and fulfill two functions in the process of learning to teach: beliefs influence how teachers learn and influence the change processes that teachers can engage in" (p. 15).

Second, to intervene in and define a belief system implies understanding that this system is, in turn, composed of beliefs related to each other and to other cognitive and affective structures of the person (Marcelo, 1998). For example, Navarro (2007) considered that teachers have different beliefs, namely about learning and the teacher's role; about the factors that affect teacher and student performances (attributions, locus of control, motivation); about perceptions of self and feelings of self-esteem (self-concept); about subject areas; and about self-efficacy (degree of confidence placed in one's personal ability to help students learn).

Finally, related to these two ideas, Navarro (2007) highlighted the need to understand the structure of beliefs to improve the quality of the training offer or other practices that induce professional development, as well as to understand or situate the practices implemented by the subjects, since professional development processes should lead to changes in teachers' conceptions and beliefs (Fear et al., 2003; Feiman-Nemser, 2008; Feixas, 2004, 2010; Marcelo, 2009; Navarro, 2007; Russell & Kane, 2005; Trigwell

et al., 2008; Villegas-Reimers, 2003). Research supports the idea that change processes must necessarily accommodate the so-called personal dimension of change, that is, they must pay attention to the impact that the innovation proposal has or may have on teachers' beliefs and values (Fullan, 1992; Marcelo, 1998).

Accordingly, it appears that changes in the practices of higher education teachers will only be possible if a strong component of reflection on the beliefs that support the action are incorporated in the process, taking beliefs as "the thoughts, conceptions and theories that drive the teacher's didactic action" or "teacher trends or dispositions that lead them to teach in a certain way" (Navarro, 2007, p. 33). In fact, the possible need to change teachers' ways of thinking and acting to converge with the learning paradigm in higher education advocated by the political narrative in Europe in the 21st century implies considering teachers' conceptions and beliefs. Thus, it is relevant to understand how a group of academics perceive their professional teaching activity guided by two main research questions: *How do the teachers characterize the roles of the teacher and of the student in higher education?* and *How did the teachers' conceptions change across one particular training experience?* The research reported in this paper contributes to exploring these issues.

1. Teachers' conceptions, beliefs, and practices: theoretical background

According to Navarro (2007), the pedagogical beliefs of higher education teachers might be understood as "personal judgments that allow teachers to articulate their thinking about teaching practice, in a more or less conscious way, to give it meaning" (p. 18); considering these beliefs fosters an understanding of the differences among teachers' practices. This theme has already received considerable attention in the literature regarding non-higher education teachers, but very few studies have focused on this topic in the context of higher education in general and particularly in Portugal.

The relationship between teaching practices and teachers' explicit or implicit beliefs appears to be evident (Navarro, 2007; Russell & Kane, 2005); the intentionality and strategies adopted are associated with a type of pedagogical orientation (Martin et al., 2000) and reveal conceptions and pedagogical orientations (Trigwell & Shale, 2004; Trigwell et al., 2008; Trigwell et al., 2005). Zabalza (2004) also referred to the role of beliefs in the decision-making process, underlining that beliefs are the basis for teachers' performance when they do not have relevant information, that is, validated professional knowledge. Hence, as highlighted in prior research (see, for example, Almeida, 2020, 2021; Alves, 2020; do Ó et al., 2019) the absence of

pedagogical training mechanisms both at entry and during the professional career inevitably leads to intuitive action. This type of action is based strongly on constructed experiential knowledge, and has not been questioned or confronted with theory, resulting in the maintenance of previous and unchallenged professional conceptions.

Teaching approaches correspond to a line of research on teachers' beliefs, understanding these beliefs as framing concerns, problems, and tasks, and thus having implications for practice (Fives & Buehl, 2012). Teachers' diverse professional roles are linked to different conceptions about teaching and learning, as conveyed by proposals such as that presented by Altet (2001). According to Altet, the role of the teacher can be understood in various ways: it can be compared to a master who has handcrafted knowledge for students; it can be seen as a technician whose action is based on the scientific research produced by theorists, with the teachers applying the theory in their practice; or it can be perceived as professionals, acknowledged as reflective practitioners capable of analyzing their own practices, drawing on the practical-theory dialectic and developing their teaching skills at the level of problematization and analysis of practices, reinforcing metacognition.

Similarly, Contreras (2001) highlighted three approaches: the teacher as a technician (technical rationality); the reflective teacher; and the teacher as a critical intellectual. According to Sachs (2009), it is possible to identify the artisan teacher; the teacher as a technician; the reflective teacher; and the autonomous professional teacher. Each of these views is associated with a specific type of professionalism: subservient, controlled, collaborative, and activist, respectively (Sachs, 2009).

Ramsdem (2003) discussed conceptions about teaching and learning (and consequently about the roles of teachers and students) and highlighted three main approaches: teaching understood as transmission or communication; teaching as an organization of student activity; and finally, teaching as making learning possible. These conceptions are also present in the results of the study by Feixas (2010), with reflections on the pedagogical orientation of the teacher, in which two types of orientation are mentioned – teacher/content and student/learning centered – that have been confirmed in studies with large samples of teachers from a multiplicity of disciplinary fields (Postareff et al., 2008; Stes & Van Petegem, 2014).

Considering the typologies presented above, it is possible to identify three main axes around which the teachers' role and pedagogical orientations are positioned, guiding their ways of thinking and acting professionally, namely: i) more centered on themselves and on disciplinary knowledge, where the focus is placed on the domain of the contents to be taught and where students are passive receivers; ii) more focused on methodology, seen as a technique to better guarantee the transmission of contents; and II) aimed at the student

and geared towards learning, where students take an active role in the teaching-learning process. The first type of orientation is more in line with the perspectives of artisanal teaching; the second closer to the understanding of the teacher as a technician, with a strong identification with the instructional paradigm; and the third more consistent with the perspectives of a reflective, autonomous teacher with greater identification with the learning paradigm.

Research on teachers' beliefs, conceptions, and implicit theories has proved to be extremely useful in providing a set of justifications for the fact that many training practices do not have a real and lasting impact on changing teachers' practices (Marcelo, 2009; Russell & Kane, 2005). The work of Kagan (1992), for example, signals the fact that individuals, even before initiating their training or professional activity, already have a set of personal beliefs about teaching and about what they understand a good teacher to be. Therefore, individuals project images of themselves as teachers that are grounded on their personal experience as students. The same author (Kagan, 1992) stressed that training programs are frequently unable to change these types of beliefs.

In fact, reasons for the inefficiency of training proposals may be related to the fact that training collides with entrenched beliefs (Åkerlind, 2007; Navarro, 2007). The research conducted by Åkerlind (2007) with higher education teachers concluded that the relevance given to professional development initiatives or the search for professional development mechanisms really depends on conceptions about their professional role, their pedagogical orientation, and the goals they hope to achieve through training. It is understood that: "teacher development strategies consist of addressing both the teacher's thinking and his/her conduct. Teachers always have some kind of theory of teaching, but it can only be implicit and therefore remains unexamined" (Biggs, 2006, p. 280). Thus, academics need to become more aware of their conceptions about teaching in order to promote reflection and questioning within training and professional development programs (Trigwell et al., 2005). This research contributes to that overall aim.

2. Research context and methodology

Considering the Interrelational Model of Professional Development (Clarke & Hollinsworth, 2002), the complexity of teachers' learning processes is assumed and highlighted. According to this model, change occurs through the mediation of experimentation and reflection processes in four areas: the personal domain (the teacher's knowledge, beliefs, and attitudes), the domain of teaching practices, the domain of consequences for student learning, and the external domain related to stimuli from the wider context.

Thus, professional development can be promoted through teachers' reflection on their practices, through the addition of new knowledge, and through experimentation with new procedures and proof of their effects.

These are the assumptions that underpin the postgraduate degree in higher education pedagogy offered at the University of Lisbon since 2019/2020. This is a non-mandatory formal training course that runs from October to July with 4 hours of classes once a week and entails various curricular units focusing on curricular issues, active learning strategies, student evaluation and supervision, technologies in teaching, and didactics. Classroom observation is promoted across the academic year as a training activity involving all the teachers attending the degree course. The aim of the curriculum design and the diversity of training activities proposed within the postgraduate degree course is to promote the problematization and questioning of teachers' beliefs, theories, and professional practices. The overall intention is to combine solid reflections on beliefs, theories, and practices with knowledge about theory, thus enhancing new ways of being, thinking, and acting as a teacher in higher education.

Within this context, the present study sheds light upon how a group of 24 academics attending the postgraduate degree course in higher education pedagogy at the University of Lisbon in 2019/2020 and in 2020/21 perceived their professional teaching activity, specifically their conceptions about the roles of the teacher and of the student in higher education. Furthermore, we sought to detect changes in the teachers' conceptions throughout their training experience in order to signal change factors associated with experienced training practices.

This group of 24 academics included teachers from various disciplinary areas and with different institutional affiliations (see Table 1).

Table 1
Characterization of the participants in the study

ID	Female/Male	Number of years as HE teacher*	Scientific domain
1	F	5	psychology
2	F	18	dentistry
3	M	26	law
4	F	19	dentistry
5	F	10	fine arts
6	F	11	veterinary medicine
7	F	10	nursing
8	F	34	statistics

9	F	6	veterinary medicine
10	M	9	veterinary medicine
11	M	18	veterinary medicine
12	F	5	pharmacy
13	M	4	veterinary medicine
14	M	10	pharmacy
15	F	12	veterinary medicine
16	F	20	nursing
17	F	15	psychology
18	F	2	pharmacy
19	F	13	law
20	F	1	chemistry
21	F	1	education
22	F	5	education
23	M	1	agronomy
24	F	2	social services

*Refers to the number of years as a higher education teacher when starting the post-graduate degree. Teaching might have been either part-time or full-time, but not including years as a researcher during which responsibilities as teacher (supervising and/or lecturing) were assumed sporadically.

The majority of the participants were women (there were 6 men in the group of 24); seven academics had been teaching for at least 15 years, eight for 6 to 14 years, and nine for 5 years or less, even though the last subgroup may have had sporadic teaching responsibilities while employed as researchers. Thus, the group is relatively inclusive in terms of disciplinary domains and years of experience as teachers, enabling us to focus on teaching and learning in a broad sense. Given that the majority of higher education teachers in Portugal are men (54.2% in 2019/20 according to national statistics on education), it is quite interesting that they were a minority among the postgraduate degree students. This might be linked to a greater investment by women in teaching responsibilities within the various components of academic work, given the conception of teaching as an activity linked to caring for others that is more associated with the social role of women.

An interpretative study was undertaken through the collection of a set of testimonies written at an early stage of the degree course and produced in the individual learning portfolio developed throughout the degree course. The written testimonies were prompted by two questions – "What is the place of teaching within my professional identity?"; "Who am I as a teacher?" – and revisited across the academic year. These documents vary in length between 2 and 5 pages. The learning portfolio was used as a tool for professional

development (Smith & Tillema, 1998, 2001, 2006) and was the result of the work developed in all the curricular units in the postgraduate degree course, conveying a comprehensive overview of the learning process of each teacher. These portfolios were produced following quite different options, including written reports, short videos, websites, and slideshow presentations.

The written testimonies and the learning portfolios correspond to the documentary corpus that was examined using content analysis techniques (Bardin, 2009) based on the following grid (see Table 2). The definition of the categories within the content analysis grid is anchored to the literature review, focusing on the teaching approaches that cover a diversity of conceptions and beliefs about the roles of the teacher and the student in higher education, as well as about teaching and learning.

Table 2
Teaching approaches: content analysis grid.

PEDAGOGICAL ORIENTATION	more centered on themselves and on disciplinary knowledge, where the focus is placed on the domain of the contents to be taught and where the students are passive receivers	more focused on methodology, seen as a technique to better guarantee the transmission of contents	orientations aimed at the student and geared towards learning, where students take an active role in the teaching-learning process
CONCEPTIONS			
Master who handcrafts knowledge for students	A ($n = 11$)	B ($n = 2$)	C
Technician whose action is based on applying the scientific research produced by theorists	D	E ($n = 4$)	F
Professional understood as a reflective practitioner capable of analyzing their own practice	G ($n = 3$)	H	I ($n = 4$)

The content analysis grid made it possible to highlight excerpts from the corpus considering the predominant pedagogical orientation regarding both the way of facing the teaching professionality and the conceptions regarding the professional role of the teacher. A thorough reading of the documents produced by each teacher attending the postgraduate degree course led to that teacher's categorization within one of the quadrants identified in Table 2. This decision took into account the predominant teaching approach arising from the documents produced by each teacher, acknowledging that there is frequently a combination of different views in the same individual.

3. Teachers' professional role and pedagogical orientations: main results

The analysis of the written testimonies and portfolios produced by the academics during the postgraduate degree course reveals a diversity of conceptions and practices and enables an outline of the training practices identified as inducing change. It should be noted that, as expected, the teachers' views are not mutually exclusive and that evidence of different views can be found in the same individual testimony, as revealed in other studies (for example, Postareff et al., 2008).

Globally, a predominance of excerpts located in quadrant A (n = 11) is observed, suggesting the significant presence of a view that combines the role of the teacher as an artisanal master who handcrafts knowledge for students (e.g. Sachs, 2009) with a pedagogical orientation more centered on the teachers themselves and on disciplinary knowledge. According to this view, the focus is placed on the domain of the contents to be taught; the students are passive receivers (e.g. Feixas, 2010; Postareff et al., 2008). The following excerpts illustrate this viewpoint:

> *In these first years, my concern was, without a doubt, to be technically accurate and to transmit technical knowledge in the best way possible.* (ID4, written testimonial)

> *I have particular difficulty in separating being a teacher from being XXXX, not only because a large part of what I teach involves this professional experience, but also because I don't have great training foundations in pedagogy – beyond the training of trainers (…). "Teacher" in the sense of transmitting what I know about my "other" professions.* (ID1, written testimony)

> *As a teacher: I bring specific "knowledge" with me, based on my life experience, my daily work, and its surroundings; I am a transmitter of knowledge, which immediately implies a great responsibility.* (ID18, written testimony)

The predominance of the artisan teacher is particularly significant in the initial phase of the career (teachers with 6 or less years of professional experience) with considerable emphasis on the technical perspective of the profession, and it tends to be related to the teachers' absence of formal pedagogical training. Nevertheless, other excerpts also convey the view of the artisan teacher with a pedagogical orientation more focused on methodology, seen as a technique to better guarantee the transmission of content (quadrant B, $n = 2$), albeit less present in the corpus:

> *Proposal of a new model for practical classes that presents an innovative flipped-classroom with a preparation phase at home and respective evaluation.* (ID6, individual learning portfolio)

This type of orientation is close to the understanding of the role of the teacher as a technician whose action is based on applying the scientific research produced by theorists (e.g. Contreras, 2001; Sachs, 2009). Some excerpts relate this view to a pedagogical orientation that is more focused on methodology (quadrant E, $n = 4$), seen as a technique with the teacher applying the theory to their practice, as may be observed in the following excerpt:

> *(…) I had the opportunity to develop new creative proposals (...), taking into account the bibliography I was reading on the subject and subsequent reflections, I ended up finding this strategy interesting, and in the final survey there are comments from students about this specific aspect.* (ID5, individual learning portfolio).

> *(…) new strategies that I can apply to improve my performance and obtain better results in the reflective skills and knowledge of students.* (ID7, written testimony)

In fact, experimentation supported in the literature is one of the strategies that fosters the development of teachers' pedagogical knowledge across the years (e.g. Almeida 2021; Russell & Kane, 2005), as formalized training is seldom available both at the initial phase of the career and throughout its duration (e.g. Almeida, 2021; Feiman-Nemser, 2008; Feixas, 2004).

A remarkable number of excerpts reveal an understanding of the role of the teacher as a professional who is a reflective practitioner capable of analyzing their own practice. Within this group of excerpts, a clear orientation towards the student and the learning process, where students play an active role is perceptible (quadrant I, $n = 4$):

> *The central role of the teacher as an almost unique source of knowledge is diluted and they become more of an architect of the construction that must be education, a building impossible to build without the contribution and co-responsibility of all those involved. (...) The teacher must reflect on their practices and be open to contributions from others regarding points for improvement, including those of the students.* (ID6, individual learning portfolio)

> *The teacher cannot be just an expert in the specific area he/she teaches, he/she cannot just be a technical genius. (…) considering the student at the center of the teaching-learning process, as an active part of it (…). Assessment has become continuous (...).* (ID4, individual learning portfolio)

These statements signal the rethinking of practices and other ways of facing teaching and learning in individual processes. Throughout these reflection processes teachers progressively assume teaching as their profession, and not as an artisanal or technical activity. Additionally, the quotes suggest an understanding of the role of the teacher as a facilitator of learning, more in line with the learning paradigm that has been advocated within national and international political documents.

However, among those who understand the role of the teacher as a professional who is a reflective practitioner capable of analyzing their own practice, it is possible to find signs of an orientation that is more centered on themselves and on disciplinary knowledge, where the focus is placed on the domain of the contents to be taught (quadrant G, $n = 3$), as the following excerpts illustrate:

> *The feedback from students and their behavior in class is something that feeds and motivates me on a daily basis. Getting a positive response from this is, for me, the feeling that it is possible to do something and that what I do has an impact on someone's life. There are days when, in fact, my answer is not the best. These are days of deep reflection for me.* (ID7, written testimony)

> *As a teacher, the first attitude I adopt to challenge myself is by putting myself in the place of an eternal apprentice, in the logic of a deconstruction-construction, looking for ways to question myself, to understand that individual learning can benefit the collective, be it the educational institution, peers, students, or society in general. (…) And all these missions arising from the profession raise many questions about "what is best for each student and for the people with whom they will one day work" in search of deep respect for the identity of each student.* (ID24, written testimony)

It should be noted that no indication of the viewpoints covered by four of the quadrants (namely C, D, F, and H) arose from the analysis of the corpus. This means that there is no presence within the corpus of a perspective of the teacher as a master who handcrafts knowledge for students with an orientation aimed at the student and geared towards learning, where students take an active role in the teaching-learning process (C). Nor are there signs of a view of the teacher as a technician whose action is based on the scientific research produced by theorists, where teachers apply the theory to their practice with a pedagogical orientation that is neither more centered on themselves and on disciplinary knowledge, where the focus is placed on the

domain of the contents to be taught and where the students are passive receivers (D), nor aimed at the student and geared towards learning, where the students play an active role in the teaching-learning process (F). Also, there are no excerpts in quadrant H, corresponding to a view of the teacher as a professional who is understood as a reflective practitioner capable of analyzing their own practices; in this case the training would be part of the practical-theory dialectic, developing skills in the teacher at the level of problematization and analysis of practices and metacognition, coexisting with a pedagogical orientation that is more focused on methodology, seen as a technique to better guarantee the transmission of contents.

Regarding professional development, the relevance of involvement with other teachers is noteworthy, tending towards the logic of an active search to transform practices and produce new knowledge, following the idea of an autonomous professional in the typology of Sachs (2009). The search for training might reveal a more technical intention, for example arising from the quest for the best teaching technique. However, the following testimony reveals another possibility, since a turning point of sorts is identified and leads to an intention linked to the response to the diversity of students and learning processes:

> *Over the years I have noticed that the challenges are overlapping, overcoming others, revisiting the need for constant adjustment, as a result of the expectations and skills of the students who come to us each year.* (ID7, individual learning portfolio)

Through the analysis of the written testimonies and portfolios produced by the academics, the presence of a diversity of conceptions suggests that they might be in different stages of their professional teacher development. Additionally, changes related to beliefs and conceptions about what it means to be a teacher and about teaching and learning across the years are noticeable, as the following excerpts illustrate:

> *Since the first hour as a teacher, i.e., for about 34 years, I have considered myself to be in a constant learning process (…) This growth in the skills that I have to teach, along with the growing number of students, has prompted me to search for techniques and tools that would allow me to teach students to learn better (…) As a teacher, I see myself as someone motivated to learn in order to better teach my students to learn.* (ID8, written testimonial)

> *The question (…) "How can I get my message across to students?" quickly turned into "How can I make the teaching/learning process meaningful?" and it was developed in reflections that I tested with the creation of new content and approaches in classes (...).* (ID5, individual learning portfolio).

Professional development processes are acknowledged by teachers, in which experimentation and seeing/following the example of others are crucial dynamics to induce questioning and change, in line with the research conducted by Almeida (2020, 2021), Feixas (2004), and Postareff et al. (2008), among others. Another type of evidence of change is related to the integration of (new) teaching strategies, using active learning methodologies and other strategies and instruments for evaluating students or giving them feedback:

> *In the curricular units I teach, I had the opportunity to apply some of our reflections on the curriculum, reviewing the learning objectives, reviewing the teaching strategies (…), and obviously reviewing the evaluation process.* (ID4, individual learning portfolio)

> *The constant search for innovation in pedagogical methodology led me to this training course, in pursuit of the validation of the strategies I use and of new strategies that I can apply.* (ID7, written testimonial)

Overall, signs of significant learning in unique trajectories of professional teacher development were recognized.

Conclusion

Several international political guidelines have encouraged the reconfiguration of teachers' ways of being, thinking, and acting in the last decades, advocating that the learning paradigm is to become predominant in higher education today. However, the results of this study suggest that the ways of understanding the profession in Portugal are still marked by an artisanal view, and that this might be due to the fact that learning processes occur through immersion in practice, without any formal pedagogical training (Almeida, 2020, 2021; Alves, 2020; do Ó et al., 2019).

As for the research question *How do teachers characterize the roles of the teacher and the student in higher education?*, the analysis of teaching approaches indicates that a dominant professional culture associated with the artisanal paradigm is in line with a teaching conception based on the transmission of knowledge. It appears that the prevalence of a professional paradigm characterized by an artisanal nature tends to perpetuate teaching beliefs and conceptions in which the teacher must be the expert who dominates and transmits knowledge while the student has a passive role.

Thus, the results of this study also suggest that there are still significant challenges to overcome the prevalent pedagogical orientation that is more centered on teachers themselves and on disciplinary knowledge, where the focus is placed on the domain of the contents to be taught and where the

students are seen as passive actors. Although this trend has been refuted in many countries and in leading universities (do Ó et al., 2019), the policies that frame the pedagogical training of higher education teachers in Portugal are still underdeveloped.

Nevertheless, academics seek training that helps them to be better prepared for being and acting as higher education teachers. Moreover, as far as the research question *How did the teachers' conceptions change across one particular training experience?* is concerned, it should be noted that the postgraduate degree course appears to have supported changes in the teachers' conceptions about their profession and the meaning of teaching and learning, with effects for teaching practices and the quality of student learning. In fact, the search for training might reveal a more technical intention, looking for the best teaching technique. The importance of the academics becoming more aware of their conceptions about teaching is also clear, so that they may promote reflection and questioning within training and professional development programs (Trigwell et al., 2005).

Indeed, the work developed by teachers throughout the postgraduate degree course expresses strengthened reflection on teaching in higher education, as well as signs of change in terms of beliefs, conceptions, and/or practices, developed at different levels of questioning and problematization, namely: (i) abandonment of certain practices, beliefs, and conceptions; (ii) support of practices, beliefs, and concepts already adopted; (iii) expansion of professional knowledge and skills, and/or (iv) emergence of new questions and problematizations, which induce new (needs for) learning and professional development. This latter aspect is expected to induce further involvement of teachers in their professional development process upon concluding their postgraduate degree.

Among the teachers who participated in the study, an initial shift from the artisanal paradigm to the conception of a professional who understands the teacher as a technician was observed. This conception underlies a search for ready-to-apply strategies and techniques that make them able to transmit knowledge to students. It is not surprising that those professional conceptions are also mixed with conceptions of a teaching-centered approach. That is, even among the teachers who seek pedagogical training and who recognize that the artisanal paradigm is insufficient, the belief prevails that the teachers must equip themselves with the best techniques to be able to transmit the knowledge they master to the students.

However, simultaneously, it is possible to identify signs of an attempt to break away from these conceptions. Some of the academics questioned the ways of understanding their role and evolved towards a view of the teacher as a reflective and autonomous professional; in some cases this was associated with the conception of a teacher approach centered on the student's learning

process in which the teacher acts as a facilitator of learning and the student is an active participant in the learning process.

Thus, the results suggest that formal pedagogical training, such as the postgraduate degree at the University of Lisbon, might ensure greater security in teachers' decision-making, contrary to the prevailing professional culture in which it appears to be sufficient to understand the disciplinary subject to know how to teach. Additionally, use of the portfolio as a professional development tool (Smith & Tillema, 1998, 2001, 2006) may contribute to questioning professional conceptions about teaching and learning in higher education, bringing teachers closer to more student-centered and learning-centered approaches.

Overall, this qualitative study enabled the exploration of teaching conceptions and practices of a group of Portuguese academics on the basis of their reports and written reflections on the approaches underlying their work as teachers. It is a contribution to the development of research on the academic work that has been considered to underdeveloped in Portugal and in other countries (Tigh, 2019). The relevance of focusing on the teaching duties of academics is paramount for the design of pedagogical training courses and justifies further research in order to enhance the changes required to face the current challenges in higher education.

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STUDIA PAEDAGOGICA

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UTILIZING INFORMAL FORMATIVE ASSESSMENT AND DIALOGICITY DURING REFLECTIONS ON EDUCATIONAL DIALOGUE IN MATHEMATICS

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ABSTRACT

In this study, educational dialogue is explored through informal formative assessment and dialogicity. We enhance the understanding of informal formative assessment and dialogicity by considering their relationship. Even though the interconnection of informal formative assessment and dialogicity is acknowledged, it has not been explicitly examined in research on educational dialogue. The data consists of video-stimulated joint reflections between mathematics student teachers and a teacher educator. The reflections were part of a teacher education program integrated in a mathematics pedagogic course. Conversational analysis was conducted to detect interactional patterns and indicators that emerged from the data. The findings show how the presence and absence of single informal formative assessment moves, such as recognizing and using learners' ideas, contribute differently to dialogicity and educational dialogue.

KEYWORDS

educational dialogue, informal formative assessment, dialogicity, mathematics teacher education

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Introduction

The central role of educational dialogue has long been recognized in studies of classroom interactions (Howe & Abedin, 2013). In this study, educational dialogue was applied in the context of mathematics teacher education and addressed through informal formative assessment and dialogicity. Formative assessment is often outlined as a continuous cyclical process that draws out learners' thinking and supports further learning (Bell & Cowie, 2001; Furtak et al., 2016). Regarding informal formative assessment, we focused on the interactive nature of formative assessment taking place in educational dialogue. Informal formative assessment employs specific interactional moves to elicit and use learners' ideas (Ruiz-Primo, 2011). The main point is that informal formative assessment practices involve interactions that go beyond the transmission modes of teaching and encourage learners to take active roles in knowledge building. Consequently, features of dialogicity need to be present in interactions through the consideration of different views and ideas (Ruiz-Primo & Furtak, 2007).

Although the benefits of more learner-centered and dialogic interactions have also been acknowledged in mathematics (Alrø & Skovsmose, 2002; Bakker et al., 2015), the quest for correctness as a driving force in interactions has been distinctly present (Wood, 1994). The work on dialogicity across subject disciplines suggests that the prevailing forms of interaction can be challenged through the explicit consideration of learners' ideas and their integration into discussions (Alexander, 2006). This also rationalizes the discussion on dialogicity in the teacher education context, as introduced in this study. Teacher reflection has been found to be an essential element in developing teaching (Helleve, 2009). In particular, joint reflection on video clips has been considered to foster mathematics teacher development, often with regard to using students' mathematical ideas (Borko et al., 2014). In this study, the reflection discussions focused on aspects of educational dialogue and dialogicity. Facilitating reflection discussions as an interactional process can be similar to facilitating educational dialogue in the classroom. We seek to explore the potential of this parallelism.

1. Theoretical background

Informal formative assessment as a built-in interactional pattern. Interactions in mathematics and science are widely dominated by the triadic IRF pattern (Monteiro et al., 2019), where *I* stands for teacher initiation, *R* for learner response, and *F* for teacher feedback (Lemke, 1990; Mercer et al., 2009; Sinclair & Coulthard, 1975). The subject-centeredness and authorittiveness in mathematics and science may be seen in teacher questioning that aims for correct and expected answers (Chin, 2007). Etched with brief wait times (Chin, 2004) and evaluative teacher feedback (Cullen, 2002; Park et al., 2020), authoritativeness is enforced and there is little space for the authentic exploration of ideas. In contrast to authoritativeness, dialogicity is enabled via teacher follow-ups, such as feedback (F) and probes (P) that push learners further in their thinking. The cultivation of these elements could finally lead to extended dialogue and a chained IRFRF pattern (Lemke, 1990) or IRPRP pattern (Scott et al., 2006).

The introduced feedback turn plays a central role in triadic and derived extended interactional patterns (Cullen, 2002; Scott et al., 2006). The dialogic approach and openness to different perspectives are the starting points for more supportive feedback (Mortimer & Scott, 2003, 2020), meaning that the teacher is sensitive to learners' ideas and efforts. While dialogic interactions are often linked to chained patterns, the cyclical nature of the formative assessment can be addressed through a four-move interaction pattern (ESRU). In the ESRU cycle, the teacher elicits a question (E), the student responds (S), the teacher recognizes the response (R), and the teacher uses (U) the collected information to support learning (Ruiz-Primo & Furtak, 2006). The ESRU pattern has been used to describe the on-the-fly nature of informal formative assessment practice manifesting in instructional dialogue (Nieminen et al., 2021; Ruiz-Primo, 2011). As in dialogicity, the importance of probing feedback is crucial (Ruiz-Primo & Furtak, 2007).

The ESRU structure may not always exist as a uniform pattern; rather, its variations have equal potential to enrich both interactions and learner understanding. Whereas teacher use of learner responses plays a central role when providing feedback that takes thinking and learning further, we consider teacher recognition to be crucial in establishing the dialogic nature of the discussion through neutral or supportive (verbal or non-verbal) recognition of learner responses (Berland & Hammer, 2012). Through this move, a teacher may internally recognize the unveiling of learner misconceptions (c.f., Bell & Cowie, 2001) or potential ideas that may be used and explored further (Nieminen et al., 2021).

The relationship between dialogicity and informal formative assessment. Dialogicity is often approached with principle-level descriptions for dialogic teaching (Alexander, 2006):

- Collectivity: Teacher and learners pursue learning tasks jointly either in small groups or whole-class discussions
- Reciprocality: Teacher and learners listen to each other, share thoughts, and consider different views
- Supportivity: Learners express and justify their ideas without fear of being right or wrong and help each other in meaning-making
- Cumulativity: Teacher and learners build on to each others' ideas and experiences
- Purposefulness: Discussions are meaningful in terms of learning goals

It is possible to introduce teachers to features of dialogicity through these principles (Lehesvuori et al., 2017). However, it is through dialogic indicators that the practice can be meaningfully linked to the principles (Nystrand, 1997; Sedlacek & Sedova, 2017). Some research has addressed how dialogic teaching (Sedova et al., 2016) and informal formative assessment (Chan & Yau, 2021) are viewed by teachers and student teachers. Some results have shown that both teachers and student teachers are able to grasp features of dialogicity within their views in spite of challenges arising in implementation (Lehesvuori et al., 2021).

The connection between dialogicity and informal formative assessment has been acknowledged to some extent (Ruiz-Primo, 2007, 2011). Accordingly, dialogicity has been implicitly brought up as a cornerstone of informal formative assessment (Black & William, 2009). That is, a teacher should facilitate activities and forms of interactions that enable feedback that advances learning. However, there has not yet been an explicit in-depth consideration of this relationship.

2. Research questions

We explore whether and how the teacher (i.e., the university lecturer) orchestrates dialogic interactions when discussing dialogicity through the following research question:

> How are informal formative assessment moves and dialogic indicators present and interlinked in joint reflections on dialogicity?

Three example cases (a, b, c) will be presented. The cases are titled based on the contextual topic of the joint reflections:

a. Providing options for teacher elicitation techniques
b. Getting responses from the pupils
c. Using and building on pupils' incorrect and incomplete ideas and questions

3. Method

3.1 The context

Participants. The mathematics student teacher group of the University of Jyväskylä consisted of twelve student teachers, of which three were involved in this explorative case study. In general, "student teacher" refers to a university graduate who is qualifying as either a class teacher or a subject teacher. The mathematics student teacher participants were conducting their one-year teacher education and practicum, which usually takes place after the Bachelor's subject studies. This format is a very typical path for subject teachers receiving pedagogical qualifications in Finland. The department of teacher education emphasizes research-based and theoretical ideas; the practicum conducted in teacher training school is more related to implementing the ideas in practice.

The program. The program was designed within a larger OPA project funded by the Ministry of Culture and Education, Finland. The aim of the program was the development of pre- and in-service teachers' assessment skills through interactions. The selected themes for the mathematics student teachers were Teacher Sensitivity, Quality of Feedback, and Dialogicity (Figure 1). Teacher sensitivity focuses on creating a positive atmosphere nurtured by closeness and shared emotional expression. This could mean using a warm tone of voice and utilizing eye contact (Pöysä et al., 2021). Some features of the feedback theme are linked to dialogicity. In particular, follow-up questions and seeking elaboration have been addressed before. The theme discussed in this study is dialogicity.

The order of the implementation of the themes was discussed with the university lecturer of pedagogy of mathematics. While dialogicity was perceived as the most challenging (e.g., Lehesvuori et al., 2011, 2017), it was placed at the end of the program. The cyclical program structure and the schedule overview are presented in Figure 1. The program was integrated into a university course addressing the pedagogy of mathematics and student teacher practicum in a teacher training school. Each cycle had three phases:

1. An introductory theoretical workshop;
2. A video recording of a lesson and the selection of an example for reflection; and
3. A joint (online) reflection session on selected examples.

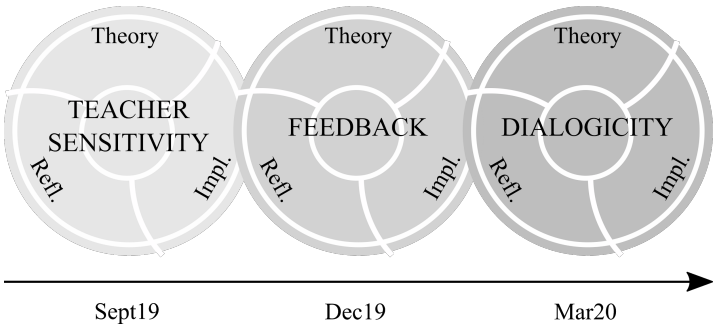

Figure 1
The program for the mathematics group

The structure of a cycle followed a fundamental triad that included crucial elements for teacher development (Westerman, 1991). More specifically, aspects of "knowing," "seeing," "doing," and "reflecting," as introduced by Hamre et al. (2013), were repeated in the program. After each introductory session, there was an average two-month period in which student teachers video-recorded, self-reflected, and selected a video clip example for the joint reflection session. Basically, the reflections followed the principles for a stimulated recall interview in which videos were used to trigger joint reflections (O'Brien, 1993) and theory was bridged to practice (cf. Scherer & Steinbring, 2007; Zhang & Zhang, 2020).

3.2 The data collection and analysis

The data collected in all three cycles included audio-recorded workshops, video-recorded mathematics lessons, and onsite/online audio-recorded reflections of one's own lessons and peer lesson examples. Videos were recorded by GoPro cameras placed in the classrooms by the student teachers themselves. Due to the COVID-19 lockdown, the last cycle, especially the reflection session on dialogicity, was organized differently. Instead of bringing all of the students to the same onsite joint reflection session, the group was divided into five subgroups formed by the student teachers themselves. Three groups included three student teachers, and two groups included two student teachers. The joint reflections took place via Zoom because of the remote recommendations due to COVID-19.

The selection of the group, video clips, and the reflection sessions. The whole dataset of the last cycle, that is, the videos of the student teachers' lessons and the joint reflections addressing the theme of dialogicity, was screened in a previous study when detecting student teachers' noticing dialogic

indicators (Lehesvuori et al., 2021). No further micro-scale or conversational analysis has yet been conducted. There were five groups; we purposefully selected (Patton, 2015) one group for a micro-scale conversational analysis based on the group characteristics revealed in the study on student teachers noticing dialogicity. The group provided the most frequent suggestions related to enhancing informal formative assessment and dialogicity through open questions, probing feedback, and talk distribution. The group consisted of three student teachers (ST1, ST2, ST3). ST1 and ST2 were able to video record their lessons in the last dialogicity cycle; ST3 selected a clip from the lesson video recorded during the second theme period (i.e., feedback). Before their joint reflection sessions, the student teachers screened their videos with the help of an observational form categorizing features of dialogicity (Pöysä et al., 2021). They selected a clip that they believed presented some feature(s) of dialogicity. This clip was then shared with the university lecturer who organized the joint online reflections around the examples. In all of the reflection sessions, the first episode begins with the university lecturer opening the discussion on dialogicity and ends with closing down toward more structured reflections. Thus, the examples build uniform and comparable units for fine-grained analysis.

Analyzing informal formative assessment moves and patterns of interaction. The analysis followed sophisticated conversational analysis techniques for patterns emerging from the data (cf. Hsu et al., 2009). First, the reflection examples were analyzed turn by turn and codes were given for every move (see Table 1). A speaker turn can include several moves (codes). Close attention was paid to the presence and absence of single moves that could play a role in fostering dialogue and idea-sharing. Second, we used coding to depict distinct patterns of interaction. That is, we sought to determine how both incomplete and extended variations of the ESRU cycle link to dialogicity.

There is a need to complement the ESRU cycle (Ruiz-Primo, 2011) in terms of taking into account learners' active role in dialogue. For example, it is not always the teacher who asks the questions and seeks information (elicits); the dialogue may be initiated by a learner wonderment question (Aguiar et al., 2009; Monteiro et al., 2019). However, when linking back to informal formative assessment, the focus is placed on how the teacher recognizes and uses these questions when facilitating extended dialogue and/or the creation of knowledge and understanding. We also differentiate explicit use of learner responses from lecturing, such as when a teacher is moving from learners' ideas to more of a lecture mode when introducing concepts and solutions. Table 1 illustrates examples of the moves considered in the micro-scale analysis.

Table 1
Moves considered in a micro-scale analysis of informal formative assessment

Move	Code	Description	Data extract
Elicitation	E	University lecturer elicitation is typically a question. By nature, the question may be open or closed. Teacher elicitation could be a result of previous moves, yet the teacher is not explicitly using learner responses. (Note: Wait time provided right after acknowledgement should not be considered as an explicit elicitation)	Well, that kind of clip. What kind of ideas came to mind?
Student teacher response	S	Student teacher responds to teacher initiation or elicitation	Well, there was the kind of situation when the student responded a bit wrongly, then she wasn't like, "Not really," rather she asked, "Do you agree?"
Recognition	R	University lecturer recognizes student teacher's response by repeating it or providing (non-evaluative) feedback. Recognition can also be confirmatory or disconfirmatory (i.e., evaluative)	Yeah, that might be true ((wonderingly))
Use	U	University lecturer uses the student teacher's idea in the follow-up turn. Can be followed by initiation on another topic or a subsequent, yet independent, elicitation	So, excellent question in a way. But how can it be formulated in a way that helps achieve the goal of the question?
University lecturer (Teacher) lecture	T_L	University lecturer presenting or lecturing to the whole class. Not explicitly using student teacher ideas; rather, exposition to new ideas. (Note: T_L is coded when university lecturer shifts from using student teacher ideas to a clear presentation mode and explanation of concepts. There is a communicational shift toward a more non-interactive lecture mode)	In a way, when thinking about it, there was quite a long list of those responses. So, are the students able to keep up with what they are disagreeing with?
Student teacher question	S_Q	Student teacher poses a wonderment or clarification question. (Note: Student teacher responding in the form of a question should not be coded as S_Q)	Should we find dialogicity in it or…?
University lecturer response	T_R	University lecturer responds to student teacher's wonderment or clarification question	Yeah, and of course anything else that comes to mind.

Analyzing dialogic indicators. Dialogic indicators (Table 2) are based on the introduced literature. Whereas single informal formative assessment moves take place in every turn, dialogic indicators were coded when being explicitly present. Principle-level interpretations, as described in the theoretical background (Alexander, 2006), were based on the analysis of the prevailing indicators. For example, if the university lecturer facilitated the distribution of the talk to collect ideas and built on this information, then both collectivity and cumulativity are considered to have taken place.

Table 2
Dialogic indicators and their descriptions

Dialogic indicator	**Code**	**Description**	**Data extract**
Open question	OQ	The question is open by nature, seeking student teachers' ideas	Well, that kind of clip. What kind of ideas came to mind?
Wait time	WT	Clearly detectable wait time ranging often from a few seconds to dozens of seconds	Yeah (5-second wait time after which student teacher responds)
Neutral recognition (and/or repetition)	NR	Teacher (university lecturer) recognizes student teacher response without an evaluative tone. Could take place in the form of repetition.	Yeah, that might be true.
Probing feedback	P	The feedback is probing by nature, seeking further elaboration of the previous response	Any other strategic moves coming to mind for Marie or Paula?
Student (teacher) questions	S_Q	See Table 1 for S_Q	See Table 1 for S_Q for implementation

3.3 Research ethics and trustworthiness

Student teachers were informed about the study and their right to take part and withdraw at any point. All student teachers volunteered and signed a written consent form. Similarly, pupils of the video-recorded lessons and their parents were informed and written consent forms were signed. All the names used in the transcriptions are pseudonyms. For the conversational analysis, the coding of the transcripts was done independently by two researchers (Authors 1 and 2). Points of disagreement were discussed until consensus was established. This procedure aligns with researcher triangulation (Miles & Huberman, 1994). The third author was also the facilitator of the joint reflections, and a member check was applied in terms of evaluating the analysis and interpretations (Lincoln & Guba, 1985).

4. Results

The topic and context of each video clip example are introduced by student teachers (STs) themselves, and the reflection examples begin right after the clip. A brief overview of the context of the reflection discussion is provided before the transcription examples. The reflection cases are not presented in chronological order, since the storyline (cases a, b, c) builds on highlighting the moves of the ESRU cycle in order. Thus, in the presentation of the results, the last reflection is addressed first. In terms of temporal considerations, the facilitator (i.e., university lecturer = UL) pointed out the use of wait time in the first presented example (Video clip ST1), so it was already noticed by the STs (Video clip ST2).

Case a – Providing options for teacher elicitation techniques

The first reflection example is based on a video clip in which ST1 reformulated her question in order to seek further elaboration from the pupils. She noticed that she could have formulated the question in a more open way.

Used transcription markers: (text) = talks over, right after or simultaneously, (x) = wait time x seconds, ((text)) = clarification or additional necessary information, (...) = cut off or reformulated sentence

Turn	Reflection transcription	Codes
1	UL: Well, that kind of clip. What kind of ideas came to mind?	E OQ
2	ST2: Well, there was the kind of situation when the pupil responded a bit wrongly, then she wasn't like, "Not really," rather, she asked, "Do you agree?"	S
3	(7) UL: Yeah (5) ((waiting for other responses))	R NR WT
4	ST1: Well, I did notice myself, now when I saw the clip afterward, that if I had a chance to ask the question again, then I would ask it in a way like, "What do others think?" Maybe that would have initiated further comments by others. But, now when I ask, "Does everyone else agree?" then nobody reacted to my question in any way.	S
5	UL: Yeah, that might be true ((wonderingly)). So, excellent question in a way. But how can it be formulated in a way that helps achieve the goal of the question? Maybe it could help if you formulated the question a bit differently. Well, if we focus on that, what alternative question would you have implemented then?	R NR U E P
6	ST1: Well, "What do others think?" Then they could have said more about what they themselves think, rather than merely asking "Do you agree?" with the pupil who just responded.	S

7	UL: All right ((wonderingly)).	R	NR
	So then there would not be a rivalry positioning.	U	
	Any other strategic moves coming to mind for Marie or Paula? (30) ((extensively long wait time until retargets the question))	E	P
	Could there have been a brief wait time? In a way when thinking about… In a way when thinking about it, there was quite a long list of those responses. So, are the pupils able to keep up with what they are disagreeing with? Should it have been explicitly displayed in a way that would help them to see what the pupil responded to? Thus enabling the comparison. And if we would think further in terms of dialogicity, then voting for opinions could have been a possibility if divergent views were clearly present. I'm quite sure there would have been different kinds of selections for polygons emerging. Then voting could make it visible that there are several pupils who have different opinions. Then nobody would be left alone with their opinions. It would create a natural ground for discussions when one sees that there are different opinions.	T_L	

Informal formative assessment and dialogicity. The episode began with an open question. This was a common denominator in all the reflections. The UL's neutral recognition complemented with wait time in recognition turns can be considered as repeating dialogic indicators facilitating an extended ESRESRU structure in turns 1 to 5. The absence of the using move could have triggered ST1's self-reflection in the beginning, leading to a change in the ESRU cycle that finally took place in turns 5 to 7 initiated by the UL asking for further elaboration on ST1's self-reflections. Since they received no further ideas for the last elicitation, UL began lecturing. All in all, dialogicity in this episode was successfully facilitated, as is evident in several indicators, such as neutral recognition, wait time, probing, leading to extended dialogue, and distribution of talk (collectivity). In terms of noticing and learning about dialogicity, ST2 was able to notice that ST1 was not evaluating the pupil response but rather re-formulating the question into a more open form.

Case b – Getting responses from the pupils

The second reflection example is based on a video clip in which ST2 was determined to get responses from the students. This was highlighted in the end by the UL.

Turn	Reflection transcription	Codes
1	UL: All right, what kind of notions on dialogicity? (3)	E OQ
2	ST1: Well, I did notice that there in the last item "providing time for pupils' thinking" ((refers to the observation form)). I think Jonna managed to do this. Although there was a pupil with a raised hand, Jonna did not immediately give them a turn. Instead, she let others think about it also, and only after that did she give them a turn.	S
3	UL: Okay, indeed there was good wait time. (5) ((waiting for further responses)	R WT
4	ST3: Yeah, I noticed the same thing. And I think it was also nice that when a pupil responded, Jonna moved closer to the pupils in a way. This way it seemed that she was actively listening to the pupils and being present in the situation. Like in a way listening well.	S
5	UL: Yeah, yeah (7). And it is also an indicator of active listening that one can clarify pupil responses (2) and extend them. Well it continued like… Well, you clearly understood what the latter pupil responded to, since you were able to elaborate it. (3) Well there were the starters. Let's have a look then, item by item, cumulativity and purposefulness. That is, the discussion is on the topic. Is the focus on understanding? Are you building on the previous? (5) ((moves toward more structured reflection based on the observation form))	R NR WT U E
6	ST1: Well yeah, the discussion stays on the topic and first you calculated the area of one wall and then based on that area of all the other walls. Well, isn't it about building on the previous also?	S
7	UL: Yeah, yeah (14) ((waiting for further responses before shifting to another subtopic)) What about understanding then?	R NR E P
8	ST3: Well, I think that for example when… Or it seemed so, that you ((refers to ST2)) are aiming to actually understand the pupil when he was actually counting on the other wall instead of what Jonna meant to be calculated. Then, Jonna clarified in a way that everyone stayed onboard. Like what was calculated in order to understand where they were going. And also emphasizing that the pupil had understood correctly, and just calculating the unintended part. And had just understood it ((the wall in question)) wrongly.	S
9	UL: Yeah (2). And also pupil turns are building on the understanding, when you think about the latter explanation. It was not only like 2 times 9 multiplied with a sum of 2 times 8 times 4 is some resulting number and a calculation. Rather, it was more about where the numbers came from. Like, what is that 2 times about? It is the kind of interaction in a way, within which the teacher ensures that the idea comes from the pupils themselves. And if not, then the teacher makes sure that she or he formulates the question in such a way that the response comes from the pupil. In this case this was realized right in the beginning. And, then the teacher ((refers to ST2)) clarified where the multiplying by 2 comes from, for example. ((discussion continues to collectivity and reciprocality))	R NR U T_L

Informal formative assessment and dialogicity. After an open question and ST's response, in turn 3, UL merely recognized the ST's response which led to ST3 taking the complementary turn. Thus, when it comes to the informal formative assessment structure, the U move is clearly missing. As in the first example, the neutral acknowledgment and absence of the U move contributed to the development of an extended ESRSRU structure (turns 1 to 5) conforming to dialogic interactions. That is, dialogic space was opened for the ideas of the STs. The key dialogic indicator in this episode is the use of wait time. Beginning from turn 5, UL shifted to more structured reflections manifested through more closed and structured interaction patterns. First, the discussion forms a triadic ESR chain (turns 5 to 7) left open with extended wait time. The last turns form a completed ESRU pattern (turns 7 to 9). In sum, whereas the beginning was more dialogic by nature, it is through using ST responses that the UL more authoritatively brought in the central idea of taking into account pupil perspectives when discussing the construction of knowledge and understanding. Thus, this episode also demonstrates the cumulative structure for meaningful learning through clear opening up and closing down phases characterized by different communicative approaches (Scott & Ametller, 2007).

Case c – Using and building on pupils' incorrect and incomplete ideas and questions

The third reflection example is based on the video clip demonstrating how ST3 reacted to a pupil's incorrect idea. The reflections address the potentiality of these instances.

Turn	Reflection transcription	Codes
1	UL: Well then. What kind of questions or comments emerge from the clip?	E OQ
2	ST1: Should we find dialogicity in it or...?	S_Q
3	UL: Yeah, and of course anything else that comes to mind.	T_R
4	ST2: I think this is a good clip!	S
5	UL: ((after waiting for 4 seconds)) What would you think was especially good about it?	E WT P
6	ST2: Well I think it was nice that when there was a question about whether the diameter could be used to calculate it, then Paula asked the others why it couldn't it be used, and did not just say that no because this and this.	S
7	ST1: Like she would not answer it by herself immediately, rather the question was jointly discussed. In a way, why doesn't it go like that?	S

8	UL: Yeah. It is a very common move that it is worthwhile to remember. In a way, it passes on the question to other pupils. And even in that situation, it's highlighting that it was a good thing to ask that kind of question, like sometimes pupils would think that those kinds of questions are not good questions, because it was wrong, or there were defects in the pupil's thinking. So those kinds of questions are actually welcomed. Any other ideas? (12) Did you interpret that the possible misconception there might have been in the pupil's thinking?	R NR U E P
9	ST2: Do you mean the idea that diameter could be used?	S_Q
10	UL: Yeah, and what was the logic behind?	T_R
11	ST2: Well, it was likely because there was a radius that was 2. And, the square of 2 is the same as 2 times 2. ((UL nods and says "Yeah")) So it would be the same as diameter.	S (R)
12	UL: Yeah, I was thinking that too. And it was also Paula who analyzed it on the fly in the same way. So it just happens to be the case that there would have been the diameter ((in the equation)). Although there isn't, it just looked like it. Now if we think about the principles of dialogicity, then where would you link this where a teacher interprets a possible misconception and then figures out further actions for how to address it? (17) ((STs are reading the form))	R NR U E P
13	ST2: Well, could it go with the last item "strategies and indicators" because the pupil question is acknowledged and what is behind the question is figured out?	S
14	UL: Well yeah, there is acknowledgement in my opinion too. Definitely. What about you Paula, what do you think?	R E P
15	ST3: Yes, I was beginning to think of it another way than previously, but maybe just that the responses are being acknowledged. So that would probably be it.	S
16	UL: Yeah, and I'm quite sure that it goes with something else too. Especially the item at the top, cumulativity. You are like building on the pupil's response. Like on the previous idea that came from the pupil… (moves on to supportivity)	R U

Informal formative assessment and dialogicity. Distinctly, in turns 1 to 3 and 8 to 10, the ES_QT_R pattern consists of teacher elicitation followed by a student teacher confirmatory question and UL's response. After ST3's vague response in turn 4, UL probed for a further response. In this case, as there was literally nothing UL could use, a further and more explicit elicitation was required. Indeed, in terms of orchestrating educational dialogue, UL demonstrated a variety of dialogic indicators to get the discussion going: open question, wait time, probing, and neutral recognition. As a result, the interaction pattern formed to ESSRU (turns 5 to 8) including ST3's and ST1's sequential and complementary responses, which UL then more clearly

recognized and used. This using move is central when highlighting the essential nature of dialogicity and welcoming and making use of pupils' ideas as they are. All in all, the pattern resembles an informal formative assessment within UL further extending and developing STs thinking (Nieminen et al., 2021). When it comes to implementing and noticing dialogic indicators, ST1 and ST3 clearly noticed in the video clip that ST2 tossed the question back to pupils after non-evaluative acknowledgement. This is related to probing for elaboration. Probing was also characteristic for UL's implementation strategy in this episode. While the STs were evidently noticing indicators (probing and pupils' questions), it is the UL who explicitly brought in the principle of cumulativity (turn 16). This was also overarchingly present in the video example building on pupil wonderment question holding in a typical misconception.

5. Discussion

In this study, we examined educational dialogue through the analysis of informal formative assessment and dialogicity. We focused particularly on exploring the on-the-fly nature of informal formative assessment and dialogicity in joint reflections between mathematics student teachers and a university lecturer. The results indicate that the nature of teacher recognition is crucial in establishing the dialogic nature of the discussion. The teacher recognition of learner responses can be neutral or supportive; it can also be verbal or non-verbal (Berland & Hammer, 2012). In terms of the single moves of the ESRU cycle that characterize the informal formative assessment nature of the interactions, the recognition move was characterized by dialogic indicators such as neutral stance and wait time that led to extended dialogues that fostered collectivity. Cumulativity was established by the use of learner responses, especially when drawing on conclusions during using moves. The two moves together are in line with the central role of the congruent feedback and/or probe moves acknowledged in earlier studies (Cullen, 2002; Lemke, 1990; Scott et al., 2006).

In our coding scheme, whereas the recognition move and related dialogic indicators were shown to serve dialogicity especially in terms of collectivity, the using move addressed more the content through cumulativity and purposefulness. Although the using move could serve for dialogicity when probing for elaborated thinking, the absence of the using move was especially important for extended dialogue when the university lecturer elicited for further participation. The university lecturer took responsibility for building meanings via chained interactions, as in the third example when drawing on cumulativity. The university lecturer delayed the using move to avoid

a communicational "U-turn" toward ending the discussion too early, which is likely a planned strategy since it is repeated in the examples (Mortimer & Scott, 2020). Reflecting on this, we shall continue the discussion on communicational balance.

Patterns of interaction, dialogicity and communicational balance in informal formative assessment. The findings show that incomplete and complete ESRU cycles serve different purposes and are linked to different communication stances and moves. The absence of the using move, replaced by neutral recognition, wait time, and probing follow-ups was linked to extended dialogues and dialogicity (Mortimer & Scott, 2003; Scott et al., 2006), whereas complete cycles were associated with the establishment of learning goals (cf. Menon, 2018). These results show that although dialogicity can be essential, especially when seeking information about learners' thinking, authoritativeness (focus on knowledge) carries more weight when heading for purposeful closures via cumulativity. In terms of communicative approaches (Mortimer & Scott, 2003), there is a wave motion between dialogicity and authoritativeness, and teachers should be sensitive about when to open and close discussions (Lehesvuori et al., 2013, 2019). Balancing the different communicative approaches is apparent in the ESRU cycle and its variations in the following ways:

- *Elicitation:* The dialogic approach is cultivated by open questions seeking different ideas and alternatives. Authentic learner questions potentially arise during dialogic interactions. An authoritative approach prevails when the teacher seeks the correct answer or options via closed and/or diagnostic questions.
- *Learner response*: The nature of learner response often aligns with the nature of the question posed. That is, for closed questions, learner responses are often brief and pre-determined, while open questions potentially engage learners in expressing their thinking.
- *Recognition:* In the dialogic approach, recognition takes place through neutral or supportive acknowledgement, which potentially leads to extended dialogues and idea-sharing. In the authoritative approach, the recognition of learner responses takes place with an evaluative and/or directive tone.
- *Using:* In the dialogic approach, the teacher uses learner response in order to stimulate further thinking or the teacher explicitly uses learner ideas when making links between different viewpoints, e.g., between everyday and scientific views (Mortimer & Scott, 2003; Ruiz-Primo & Furtak, 2007). In the authoritative approach, the teacher often uses learner responses to establish correct closures and conclusions.

Ideally, a teacher orchestrates a reciprocal interaction among participants by facilitating extended dialogues through intended forms of recognition and the meaning-making process by focusing on the cumulative building of content (Scott & Ametller, 2007). The latter can take place in the teacher's longer lecturing turns, extending beyond the use of learners' ideas toward more lesson-goal-oriented instruction. The challenge, however, is to balance authoritativeness and dialogicity (Lehesvuori et al., 2019; Scott et al., 2006). Within informal formative assessment, this could mean, for example, that the teacher balances between collecting and presenting information and between neutral recognition and evaluation of learner responses. This is also about reaching the two main aims of the informal formative assessment: first, for teachers to get information on students' learning and adapt their teaching methods accordingly; second, for students to get information on their learning progress and develop their knowledge and skills (Black & William, 2009).

Conclusion, limitations, and future study

First, it is worthwhile to point out that productive dialogic interaction can take place in online settings. In terms of practical issues, the small group sizes in online settings may be essential for the facilitator to be able to recognize and to use both verbal and non-verbal information obtained from video-on conferencing. The extremely extended wait time implemented by the university lecturer could be adopted to onsite and classroom settings, yet learners should also be aware of its function. Of course, while online settings offer other possibilities for getting information in video-off online mass-lectures (e.g., polls and chat), the results of this study speak for small groups when aiming for teaching through interactions as described in existing observation protocols (Pianta et al., 2012).

When it comes to questions about limitations, the reason that the student teachers selected the exact sample they did could not be confirmed. But, as peers and the university lecturer were able to detect features of dialogicity such as wait time and proximity, these features may also have been noticed during self-reflections. The university lecturer helped to go beyond noticing indicators of dialogicity by linking it to the joint creation of mathematical knowledge and understanding in terms of introducing the role of learners in this interactive process. We argue that the structure provided and the on-the-fly feedback provided by the university lecturer were essential features of the program implementation.

All in all, when thinking about student teacher learning in the described settings, the role of videos and the feedback was frequently brought up in supplementary data (i.e., the course feedback) as something that pushed

student teachers' thinking and understanding further (cf. Chan & Yau, 2021). As we have demonstrated that productive educational dialogue can take place in online settings through informal formative assessment and dialogicity, it would be interesting to study its boundaries and possibilities in different contexts and settings. This would provide further information for both teachers and teacher educators on how to set up and orchestrate educational dialogues both onsite and online.

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A NARRATIVE REVIEW OF EYE-TRACKING RESEARCH ON SELF-REGULATED LEARNING FROM MULTIMEDIA LEARNING MATERIALS IN HIGHER EDUCATION

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ABSTRACT

This study provides a narrative review of current eye-tracking research on self-regulated learning from multimedia learning materials in higher education. The main aim of the review is to explore how eye tracking is used in self-regulated learning research when learning from multimedia materials in university students. Other specific aims were established: 1) to identify what self-regulated learning processes are explored with eye tracking while learning from multimedia materials, 2) to determine what methods are used to explore self-regulated learning processes with eye tracking, 3) to find what structures and stimuli are used in eye-tracking experiments when studying self-regulated learning processes, and 4) to investigate what eye-tracking metrics are used to study self-regulated learning processes in learning from multimedia materials. To accomplish these aims, we analyzed 11 empirical studies published between 2012 and 2021. The results show that 1) current studies focus on self-regulated learning processes, such as judgments of learning, metacognitive monitoring, meta-comprehension, and learning strategies, 2) studies are quantitative and use experimental designs, specific stimuli, and distinct structures, and 4) studies are mainly focused on the fixations, saccades, and transitions between selected areas of interest in the data analyses. The results of this narrative review can indicate new directions for future research in this field.

KEYWORDS

self-regulated learning, self-regulatory processes, multimedia learning materials, eye tracking, narrative review

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Introduction

Self-regulated learning has become a recognized and well-established subject of educational research in recent decades (Boekaerts et al., 2000; Zimmerman & Schunk, 2011). It can be described as a learning process that is comprised of cognitive strategies, motivation, and metacognition and is based on student independence and responsibility for their learning (Carneiro et al., 2011). Students' abilities to regulate their own learning are particularly important in the context of online learning since there is a lower teacher presence and therefore higher demands on student autonomy and their ability to study actively and independently (Wong et al., 2019). In the context of online learning and online educational systems, multimedia materials are one of the main modes of information presentation. Research of multimedia learning materials is therefore of great importance because the form and the content of the multimedia materials can enhance or hinder students' self-regulation and thus lead to better or worse learning outcomes.

One of the current and promising approaches to studying student learning from different types of multimedia materials consists of utilizing eye-tracking technology. This approach focuses on the learning strategies that are reflected in where and in what sequence the students are looking while learning from presented materials. Thus, the analysis of student eye movements recorded by an eye-tracking device can provide useful information about student learning from various types of multimedia materials (Alemdag & Cagiltay, 2018). The aim of the current study is to provide a review of recent literature on the use of eye-tracking technology in the context of self-regulated learning and multimedia learning research.

1. Theoretical background

1.1 Self-regulated learning

Self-regulated learning (SRL) is an important concept and area of research within educational and psychological research. Self-regulated learning can be seen as a broad conceptual framework encompassing cognitive, metacognitive, motivational, emotional, and behavioral aspects of learning (Panadero, 2017; Zeidner & Stoeger, 2019). Although different definitions and models of self-regulation and self-regulated learning have been proposed over the last few decades of research, most of the definitions and models agree that SRL is a cyclical process divided into three main phases: the preparatory phase, the performance phase, and the reflective phase (Zimmerman, 2000). Within these phases, specific processes such as selection, strategic planning, and time management take place, shaping the overall approach to learning (Panadero,

2017). In addition to cognitive and metacognitive processes and strategies, most current conceptualizations of SRL also pay attention to the affective and motivational aspects of learning and self-regulation. These include self-motivational beliefs such as self-efficacy, goal orientation, and the subjective value of learning (Wong et al., 2019; Zimmerman & Schunk, 2011).

One of the main reasons the SRL concept has gained increased attention in educational research over the years is its connection to learning outcomes. It has been found that the extent to which learners are able to regulate their learning significantly enhances their learning outcomes. Thus, the relation between SRL and learning outcomes and academic success is a primary focus among researchers in this area, and a large number of studies have presented evidence of the contribution of SRL to student outcomes (Carneiro et al., 2011; Zimmerman & Schunk, 2011). Nonetheless, the research is not yet entirely conclusive; for example, a highly cited meta-analysis by Sitzmann and Ely (2011) did not find a significant relationship between self-regulatory processes and learning outcomes. The conflicting results of research on SRL and learning outcomes are often attributed to the many heterogeneous measurement approaches employed in different studies on this topic. The measurement of SRL is currently one of the most discussed issues in SRL research. So far, most researchers have relied on self-reports and questionnaires, but these measurement methods seem to capture student learning preferences rather than actual learning behavior. There has thus been a shift toward new approaches to measuring SRL in recent years, with eye-tracking technology being one of them (Panadero, 2017; Zeidner & Stoeger, 2019).

Focusing on self-regulated learning in the context of online learning and learning from multimedia materials, it can be argued that research of SRL in an online setting is of high importance due to increased demands on student autonomy and thus on their ability to self-regulate (Wong et al., 2019). However, despite recent developments in SRL research, only limited attention has been paid to the specific context of learning in online environments. At the same time, a specific focus on online learning processes seems to be indispensable for understanding self-regulation in online learning, because existing research findings suggest that online learning involves different regulatory processes than learning in a traditional setting (Broadbent & Poon, 2015).

1.2 Learning from multimedia materials

Learning from multimedia materials is an essential part of online learning and learning in online environments. Multimedia learning materials can present information through a variety of formats. Including text, illustrations, photos, audio, videos, and animation. In order for learning material to be considered multimedia material, it has to incorporate both words and pictures. Accordingly, multimedia learning can be defined as "building mental

representations from words and pictures" (Mayer, 2005). A long line of research has identified the benefits of using multimedia learning materials with multiple forms of representations of information. Aside from positive effects on student engagement, multimedia learning materials can facilitate knowledge acquisition and thus lead to more meaningful learning (Mayer, 2014). On the other hand, a considerable number of studies have demonstrated that simply presenting information in different modes or formats does not necessarily lead to a better understanding of the information or to better learning in general (Hegarty, 2004; Mayer et al., 2005; Moreno, 2004; Ploetzner & Lowe, 2004).

There seems to be a lack of detailed research that would provide a deeper insight into the link between individual cognitive processes, various forms of multimedia learning materials, and learning outputs (Liu & Chuang, 2011). According to Chuang and Liu (2012), this lack of sufficiently detailed research stems from methodological limitations and the difficulty of measuring cognitive processes such as visual attention and cognitive load. Some researchers have therefore turned their attention to eye tracking as a new and promising technology that can be useful for studying cognitive and metacognitive processes during learning from multimedia materials (van Gog & Jarodzka, 2013).

1.3 Eye tracking in self-regulated learning from multimedia research

Eye-tracking technology is based on recording the movement of participants' eyes in relation to a stimulus. This allows researchers to determine which part(s) of the stimulus were interesting for the participant and how the visual attention of the participant was distributed among different parts of the stimulus (Duchowski, 2007). Thus, using an eye-tracking device can enable inferences about the attention processes of the participants and about the stimulus itself (van Gog & Jarodzka, 2013).

In the context of multimedia learning, the stimulus takes the form of materials presented on a computer monitor. A wide variety of measures can be obtained by eye-tracking technology (Holmqvist et al., 2011; Lai et al., 2013), but the two main types are fixations and saccades (van Gog & Jarodzka, 2013). Fixation means a relatively stable gaze at one point in the stimulus. Measurements of the location and duration of the fixations indicate what information is attended to and how intensively that information is being processed. Saccades are the quick eye movements between the individual fixations. They provide information about the changes in the focus of visual attention (Holmqvist et al., 2011; van Gog & Jarodzka, 2013).

Even though eye-tracking technology has become more and more affordable and easier to employ and despite its apparent benefits, the use of eye tracking by researchers in the field of education is still rather rare,

and many researchers have only recently started to use it. Nevertheless, a considerable number of studies have investigated eye movements in the context of learning from multimedia materials, as is evident from a recent systematic review focused specifically on eye-tracking technology in multimedia learning (Alemdag & Cagiltay, 2018). On the other hand, the number of studies that analyze eye movements during learning from multimedia materials with regard to self-regulatory and metacognitive processes is still very low. A useful overview of this area was provided by van Gog and Jarodzka (2013), but the research mentioned in the overview is older. Alemdag and Cagiltay (2018) identified the topic of metacognition as one of the research gaps in the context of eye-tracking research dealing with multimedia learning materials. In their systematic review, only 4 out of 58 studies had investigated the metacognitive processes in multimedia learning. Mayer (2017) similarly found metacognition to be an understudied area in multimedia learning research.

2. Methods

The main aim of the presented narrative review is to analyze and summarize existing empirical research dealing with eye-tracking technology in the context of self-regulated learning and learning from multimedia learning materials. To achieve this aim, we defined the following main research question: "How is eye tracking used in research on self-regulated learning in university students learning from multimedia materials?"

To further elaborate on the issue in question, we determined four specific research questions:

1. What self-regulated learning processes are explored with eye tracking in the context of learning from multimedia learning materials?
2. How are self-regulated learning processes in the context of learning from multimedia learning materials examined with eye-tracking technology, from a methodological perspective?
3. What structure and stimuli are used in the eye-tracking experiments when studying self-regulated learning processes?
4. What eye-tracking metrics are used to study self-regulated learning processes in learning from multimedia learning materials?

2.1 Data sources and search terms

This review was created based on the methodology described by Gregory and Denniss (2018), Ferrari (2015), and, among others, Gasparyan et al. (2011). The steps for conducting the review include: "define topic and audience, search and re-search the literature, be critical, and find a logical structure"

(Gregory & Denniss, 2018). To conduct the presented narrative literature review, the following four databases were searched: Web of Science, Scopus, APA PsycInfo/PsycArticles, and ERIC. Our search terms focused on eye tracking, self-regulated learning strategies, and multimedia learning materials in the higher education environment. For detailed information about the key concepts and the search terms used in all four database searches, see Table 1. The search was conducted on February 9, 2022.

Table 1
Key concepts and search terms used for the search

Key concepts	**Search terms**
Eye tracking	(eye-tracking OR (eye AND track*) OR (gaze AND track*) OR gaze-tracking OR eye-movement* OR (eye AND movement*))
Self-regulated learning	AND (((learn AND strateg*) OR (cognitive AND engagement) OR (critical AND thinking) OR (effort AND regulat*) OR elaborat* OR (goal AND orient*) OR (goal AND set*) OR (help AND seek*) OR monitor* OR (motivational AND beliefs) OR organisat* OR plan* OR rehearsal* OR (resource AND management) OR self-efficacy OR (self AND efficacy) OR (task AND value AND beliefs) OR (time AND management) OR (self-regulated AND learn*) OR self-regulat* OR metacognit* OR (self AND regulat* AND learn*)))
Multimedia learning materials	AND (multimedia OR audio-visual OR learn* OR (learn* AND material*))
Higher education	AND ((higher AND education) OR (tertiary AND education) OR (post-secondary AND education) OR (post AND secondary AND education) OR (third-level AND education) OR universit* OR college* OR (higher AND education AND student*) OR (universit* AND student*) OR undergraduate* OR (college* AND student*) OR bachelor* OR master*)

2.2 Inclusion and exclusion

We limited the search to original peer-reviewed research articles published in the English language between 2012 and 2021 and we retrieved only articles that dealt specifically with eye tracking, self-regulated learning, and multimedia learning materials. Articles were excluded if they did not focus on all three topics (especially self-regulated learning) or if they studied the topic in a different environment than higher education. Inclusion and exclusion criteria are summarized in Table 2.

Table 2
Summary of inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
• Eye tracking • Self-regulated learning • Multimedia learning materials • Higher education	• Language other than English • Document type other than "article" • Documents published before 2012 • Environment other than higher education • No self-regulated learning or self-regulated learning processes

2.3 Screening

Our initial search identified 449 studies. After removing duplicates, 174 studies were included in the screening phase. Subsequently, we screened the titles and abstracts, resulting in 18 records that seemed appropriate. We were unable to retrieve the full text of one article, therefore only 17 articles were assessed for the specified eligibility criteria. After the assessment, a total of 11 articles were suitable for inclusion in the review. A detailed document workflow using a flow diagram of the literature selection process is shown in Figure 1.

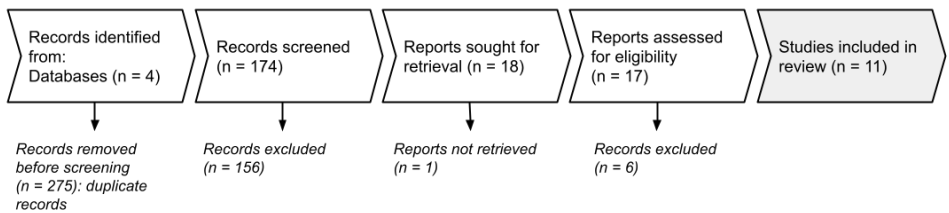

Figure 1
Flow diagram of literature selection process.

2.4 Data Analysis

The analysis of the articles started with an examination of the research goals and questions, the methodologies, and the study results. The relevant data were extracted from the articles and are summarized in Table 3. These data included research goals and questions, study design and methods, sample size, and variables measured (see Table 3). The authors then synthesized all the included papers and presented a narrative description of the findings with regard to the three research questions.

Table 3
Methodological details of empirical studies included in the review.

Authors (year)	**Aims**	**Sample size**	**Design**	**Variables/Measures**	**Eye-tracking metrics**
Antonietti et al. (2015)	investigating students' metacognitive monitoring and control when exploring a multimedia presentation with new information	$n = 20$	experimental + questionnaires	eye movements, psychophysiological measures, learning outcomes, metacognition	visual exploration, fixation length, number of fixations, time to the first fixation
Catrysse et al. (2018)	clarifying students' processing learning contents and its relation to their self-report of learning strategies	$n = 20$	quantitative approach + questionnaires	self-report measures, learning strategies, eye movements	first-pass fixation duration, second-pass fixation duration, total fixation duration in areas of interest
Eitel (2016)	investigating multimedia effect on across study-test cycles and which (meta) cognitive processes are associated with it	$n = 79$ (experiment 1); $n = 55$ (experiment 2)	experimental + questionnaires	study times, judgment of learning, learning outcomes, eye movements	fixation count, mean fixation duration, total fixation time
Fiorella and Pilegard (2020)	investigating how writing an explanation after studying a multimedia lesson influences restudy behavior (eye movements) and learning	$n = 126$ (experiment 1); $n = 65$ (experiment 2)	experimental + questionnaires	learning outcomes, eye movements	dwell time, number of integrative saccades, fixations
Mudrick et al. (2019)	investigating the influence of discrepancy in the learning materials on participants' metacognitive judgments and eye-movement behaviors	$n = 32$	experimental + questionnaires	eye movements, metacognitive judgments, learning outcomes, sequence mining	fixation duration, number of fixations, sequence of fixations
Park et al. (2020)	validating the use of Thinking-Aloud Protocols in learning studies	$n = 120$	experimental + questionnaires	learning success, eye movements, cognitive load, prior knowledge	proportion of fixation duration, transitions between areas of interest

Ruf and Ploetzner (2014)	investigating the effect of presenting cognitive learning aids, self-monitoring questions on the frequency of use of cognitive learning aids in multimedia materials	$n = 60$	experimental + questionnaires	learning performance, use of learning aids, usability of learning environment, eye movements	transitions between areas of interest, sequence of fixations
Scheiter et al. (2018)	investigating the effect of eye movement modelling on improving self-regulated learning from multimedia materials	$n = 50$	experimental + questionnaires	learning outcome, eye movements, domain-specific cognitive prerequisites	fixation time, transitions between areas of interest
Taub and Azevedo (2019)	investigating the impact of prior knowledge on students' fixations in self-regulated learning-related areas of interest and on the sequences of engaging in cognitive and metacognitive self-regulated learning processes with e-learning material	$n = 194$; $n = 30$ (eye-tracking part)	experimental + questionnaires	prior knowledge, proportional learning gain, fixation sequence of SRL, eye movements, sequence mining	proportions of fixations in areas of interests
Trevors et al. (2016)	investigating the relations between epistemic cognition and self-regulated learning	$n = 42$; 20	multi-study; mixed method design	prior knowledge, metacognition, eye movements, study time allocation, connotative aspects of epistemological beliefs	sequence and frequency of two transitions between fixations
Tsai et al. (2019)	investigating the influence of metacognitive intervention supported by eye tracking on the scientific evidence-based reasoning performance during online computer-based scientific reasoning tasks	$n = 80$	experimental	metacognitive intervention, visual attention, eye movements	number of fixations, total inspection time, mean fixation duration, number of saccades, total and mean saccade distance, number of re-readings, total re-reading time, mean re-reading duration

3. Results

A total of 11 empirical studies published between 2012 and 2021 were included in the presented narrative review. The selected empirical studies were originally published in the United States, Germany, Netherlands, Italy, and Taiwan. The outcomes of the narrative review were divided into four thematic areas based on the specific research questions: 1) self-regulated learning processes studied using eye-tracking technology, 2) methodological approaches used to study self-regulated learning processes, 3) structures and stimuli used in eye-tracking research of self-regulated learning processes, and 4) eye-tracking metrics in the study of self-regulated learning processes in the context of learning from multimedia learning materials. These thematic areas will be described in more detail in the following sections.

3.1 Self-regulated learning processes studied using eye-tracking technology

The goal of the first part of this section is to focus on the aspects of self-regulated learning processes that authors included in empirical studies. The authors of selected empirical studies are not unified in this respect; for this reason, the self-regulated learning processes of the given studies will be presented individually.

Antonietti et al. (2015) focused on the use of eye tracking and psychophysiological patterns to investigate self-regulated learning strategies, metacognitive monitoring, overall metacognitive awareness with a focus on memory index, and learning performance in multimedia processing depending on the type of multimedia learning materials (i.e., the differences between learning materials containing only text and images and materials supplemented by sound recording). According to Antonietti et al. (2015), eye tracking and psychophysiological measures can reveal when and why self-regulated decisions are made with respect to the multimedia materials. In addition, the authors anticipated a positive connection between the metacognitive processes and learning outcomes.

A different approach was chosen by Taub and Azevedo (2019) who extended their previous studies and focused on the effects of various levels of prior knowledge on the way learners fixate on authentic multimedia materials. In more detail, the authors focused on sequences in metacognitive and cognitive processes while studying, proportional learning gain, and prior knowledge level in relation to fixation proportions. Taub and Azevedo (2019) also included in their analyses the influence of prompts that appeared to participants during measurements. Catrysse et al. (2018) explored learning strategies during combinations of online and offline measurements using eye tracking technology to observe comprehension processes. In more detail, the authors aimed to investigate whether learning strategies are reflected in eye-tracking patterns.

A different direction was chosen by Mudrick et al. (2019) and Trevors et al. (2016), who focused on specific self-regulated learning processes such as judgment of learning, metacognitive monitoring processes, and meta-comprehension while learning from multimedia materials with a focus on the appearance of discrepancy in these materials (contradictory information in the materials). According to Trevors et al. (2016), discrepancies can induce epistemic cognition, which can have a consequent effect on self-regulated learning. Eitel (2016) focused on judgments of learning and learning outcomes while studying from various versions of multimedia material across a study-test cycle. Eitel (2016) expected higher levels of judgments of learning and learning outcomes when learning from text-and-picture learning materials and reduced learning time in repeated study material observations.

Tsai et al. (2019) focused on metacognitive intervention, specifically how metacognitive intervention can affect visual attention and scientific reasoning performance. Similarities with Tsai et al. (2019) can be found in the study by Scheiter et al. (2018) who focused on eye movement modelling during learning, i.e., on the influence of professional eye movements while learning on the learning outcomes of tested students. Ruf and Ploetzner (2014) concentrated their investigation on learning aids and the impact of self-monitoring questions on the use of learning aids. Ruf and Ploetzner (2014) assumed that students often did not use these learning aids because they were not aware of their own needs. Thus, self-monitoring questions should help identify student comprehension gaps and lead to enhanced use of learning aids.

In this part of our narrative review, we focused on self-regulated learning processes that can be investigated with eye-tracking technology. Based on the selected studies, researchers mainly investigate metacognitive processes and awareness of them, such as judgments of learning, metacognitive monitoring, and meta-comprehension. Studies were oriented on different learning strategies, the sequence of self-regulated learning processes while studying from various types of multimedia learning materials, and subsequent learning outcomes.

3.2 Methodological approaches used to study self-regulated learning processes

The empirical studies included in the narrative review had, in terms of methodology, quantitatively oriented designs. Most researchers used experimental designs to study self-regulated learning and self-regulatory processes, both between-subject designs (e.g., Fiorella & Pilegard, 2021; Scheiter et al., 2018) and within-subjects designs (e.g., Mudrick et al., 2019). The form of the experiment was subsequently adapted to the researched aspects and the authors of the selected empirical studies were thus not very unified in this respect in most cases. For this reason, this section of the narrative review is divided into three parts, in terms of the course of the procedure of the

whole data collection, the structure of the eye-tracking experiment, and the topic of multimedia material.

With respect to the course of the data collection procedure, it is necessary to mention that the studies differed significantly, especially when using additional questionnaires or tasks other than an eye-tracking experiment. In general, the eye-tracking measurement was preceded by a set of questionnaires, which were usually initiated by a demographic questionnaire and followed by a metacognition questionnaire or self-regulated learning questionnaires. For example, Park et al. (2020) used a series of questionnaires that focused on prior knowledge of the topic used in experimental multimedia materials, study motivation, spatial skills, and visual-spatial memory, and then a test of academic success as a post-test. Catrysse et al. (2018) used a self-report questionnaire (Inventory of Learning Patterns-Short Version) that was partially focused on self-regulation in learning. Due to the experimental design of these studies, the authors in some studies created pre-tests (previous knowledge) and post-tests (learning performance) consisting of a series of multiple -choice questions related to the topic of multimedia material designed to verify the learning performance of selected participants (e.g., Fiorella & Pilegard, 2021; Mudrick et al., 2019; Taub & Azevedo, 2019). Catrysse et al. (2018) chose only one open question to explain the content of the learning materials the participants had completed. Antonietti et al. (2015) enhanced their eye-tracking experiment with psycho-physiological measurements, such as skin conductivity and temperature and pulse volume, while assuming better study performance in a group that had completed multimedia materials supplemented by audio recordings that were part of the experiment. Trevors et al. (2016) added log files to the eye-tracking data collection, supplementing the information about the passage through the multimedia learning material. Ruf and Ploetzner (2014), besides using pre-tests and post-tests to monitor learning performance, added a usability questionnaire composed of the ten statements focused on the subjective usability of the learning environment.

When focusing on the eye-tracking experimental procedure itself, the authors selected various approaches in terms of both experimental aims and the procedures. For example, a unique approach to the experimental procedure was adopted by Tsai et al. (2019), whose research group consisted of university students (science majors). Their aim was to complete five online study modules with hyperlinks that linked to each other. The metacognitive intervention took place in the second read of the multimedia materials. In the second part of the measurement, students were shown their own eye movements so that they could cover the areas they had missed during the first part of the measurement. A similar approach was chosen by Scheiter et al. (2018) who

focused on the influence of eye movement modelling on self-regulation and learning performance. The aim was to show the eye movements recorded from an expert learner while learning from text-and-picture learning material to the experimental group and let them study the same material afterward. Meta-cognitive intervention in other studies was created using inference questions on individual pages of multimedia materials (e.g., Mudrick et al., 2019; Trevors et al., 2016). Fiorella and Pilegard (2021) created an experiment that was based on prompts, which were included in the procedure in the form of explanations during the passage through the learning materials. Park et al. (2020) focused on the effect of multiple factors, i.e., think-aloud protocols and the effect of seductive details; thus, they created four groups for the experimental purpose. Ruf and Ploetzner (2014) used three types of learning aids – static (support area is always in the fixed position), dynamic (support area is animated after a certain amount of time) and collapsed (to make the support area visible, learner must click on a start button). Furthermore, in experimental groups, the self-monitoring questions appeared after each learning unit. However, Ruf and Ploetzner (2014) used the eye-tracking device only to monitor whether the learner visited certain learning units and also how many times these learning units were visited.

From a methodological point of view, the majority of the authors decided to design their research quantitatively and used an experimental design for both between-subject and within-subject designs. The experimental procedure in most cases consisted of multiple parts: the questionnaires (e.g., demographic questionnaires, questionnaires focused on self-regulatory and metacognitive processes or learning performance, i.e., pre-tests and post-tests) and additional measurements (e.g., psychophysiological measurements or log-files).

Structures and stimuli used in the eye-tracking research of self-regulated learning processes

Regarding the structures of the experiments and the stimuli used in them, such as the topic of the multimedia learning materials or the graphic design, both artificial learning materials created for the purpose of the experiment (e.g., Antonietti et al., 2015; Catrysse et al., 2018; Mudrick et al., 2019; Trevors et al., 2016) and authentic learning materials (Taub & Azevedo, 2019) have been used. Multimedia materials (both artificial and authentic) were made up of a grouping of a different number of pages, one side of the material then contained a text part, a picture or graph, or an inference question (e.g., Mudrick et al., 2019; Park et al., 2020; Trevors et al., 2016). The number of pages and the position of the text, image, or additional stimuli were always individually spaced, but frequently the text was positioned on the left side of the page and the graph or image was on the right (e.g., Antonietti et al., 2015).

Thematically, the multimedia materials diverged. Antonietti et al. (2015) and Fiorella and Pilegard (2021) decided to create material on a topic for they assumed low knowledge in the studied population. Park et al. (2020) created multimedia material for a study group (psychology students) based on a biochemical topic. A similar approach can be seen in the experimental learning materials of Scheiter et al. (2018), in which university students of study areas other than biology were measured in the multimedia materials on the topic of cell division. Ruf and Ploetzner (2014) decided to create multimedia learning material based on the two textbooks about sailing. The final version of the learning material consisted of text, images, and animations focused on the mechanisms of sailing. Eitel (2016) created multimedia material thematically focused on a toilet flushing system consisting of text and/or a combination of text and picture.

In contrast, Taub and Azevedo (2019) took advantage of an authentic e-learning multimedia environment from a thematic area that was relatively close to the selected measured population. The structure was also adapted to an experimental condition. Mudrick et al. (2019) and Trevors et al. (2016) adapted the multimedia material structure to create content disparity on each side of the material. The experiment thus contained three types of material (without a discrepancy, with a discrepancy between text and text, or with a discrepancy between text and graph). Different types of discrepancies can induce different metacognitive decision-making responses, which will also affect eye movements during learning from multimedia materials (Mudrick et al., 2019). Park et al. (2020) used seductive details, which were made up of additional and highly interesting information, but irrelevant to the learning material.

In conclusion, when focusing on the structure of the eye-tracking experiment and chosen stimuli topic, two methods of experimental preparation appeared: 1) creating artificial learning material adjusted to the research purposes or 2) using authentic (e-learning) material. Thematically, topics both known and unknown to the participants were used. The structure of the multimedia material (i.e., number of pages, amount of text, and number of pictures per slide) varied widely depending on the research questions.

3.3 Eye-tracking metrics in the study of self-regulated learning processes

When using eye tracking to investigate self-regulatory and metacognitive processes during learning, it is also necessary to focus on eye-tracking metrics that enter subsequent data analyses. The selection of eye-tracking metrics may vary according to the chosen methodological approach, but the empirical studies included in the presented analysis were mainly quantitatively oriented studies. In general terms, the authors of the studies focused primarily on the two fundamental metrics that enter eye-tracking analyses most frequently:

fixation and saccades. Fixation is an eye movement during which the eye gaze is maintained in one location and the perception and processing of the observed scene (e.g., reading a text or watching a picture) occurs (Ciuffreda & Tannen, 1995). Saccades are very rapid eye movements that aim to direct the visual axes so that the image of the observed object hits the point of sharpest vision (fovea) (Duchowski, 2007). During saccadic eye movements, a saccadic suppression occurs and no visual information is processed (Ciuffreda & Tannen, 1995).

A key element to mention before analyzing eye-tracking metrics themselves are the areas of interest. These are self-made areas within stimuli that were part of eye-tracking measurements. For example: one slide of multimedia learning material contains a title, a paragraph of text, and a picture. Individual areas of interest (with respect to research purposes) can be created on the title, the paragraph of text, and the picture. These areas of interest make it possible to perform a deeper analysis of eye-tracking metrics (e.g., fixations, saccades, or transitions between each area of interest). Most of the authors of the selected empirical studies worked in their analyses precisely with the areas of interest created, which included key elements for input into the analysis in the stimulus created (e.g., Antonietti et al., 2015; Catrysse et al., 2018; Mudrick et al., 2019). For example, Mudrick et al. (2019) created areas of interest in places that were key to analyzing eye-tracking data (sections with text, graph, and inference questions) within a given stimulus (e.g., tutorial slides). Trevors et al. (2016), whose areas of interest delimited the text and the graph, followed a similar pattern. Scheiter et al. (2018) created two areas of interest on each slide, one area of interest on the picture and the second on the text. The form of experiment and chosen stimuli were discussed in the previous section.

Within the presented areas of interest, it is possible to focus on a deeper analysis of selected eye-tracking metrics. Many authors dealt with the total time spent on the slide (Catrysse et al., 2018) and the time repeatedly spent on the slide (Tsai et al., 2019). The authors also considered the dwell time, which is the total time spent in a given area of interest (Fiorella & Pilegard, 2021; Scheiter et al., 2018). Increased time spent on the site or in a specific area of interest may indicate an increased cognitive load (Scheiter et al., 2018).

Fixations can be considered a key eye-tracking metric for most authors of the selected studies, who subsequently focused on the detailed parameters of fixations. The most recurrent parameter was the fixation duration in given areas of interest (e.g., Antonietti et al., 2015; Catrysse et al., 2018; Fiorella & Pilegard, 2021; Mudrick et al., 2019; Tsai et al., 2019). The fixation duration is related to the cognitive processing of the observed object; excessive fixation duration may indicate the complexity of processing the stimulus for the observer (Antonietti et al., 2015). Depending on the research and analysis needs, the authors worked with the average fixation in interest or with the

total fixation duration in the given areas of interest (Mudrick et al., 2019; Tsai et al., 2019) or on the whole stimulus (Catrysse et al., 2018). Catrysse et al. (2018) and Antonietti et al. (2015) focused on detailed values of fixation duration and distinguished this metric into first-pass fixation duration; Catrysse et al. (2018) also considered second-pass fixation duration in the areas of interest. The ability to orientate oneself in each environment can also be shown by the total number of fixations, both in the given area of interest and on the whole stimulus (Antonietti et al., 2015). The total number of fixations in their analyses was used, for example, by Antonietti et al. (2015), Mudrick et al. (2019), and Tsai et al. (2019). To be able to work with fixations in different areas of interest, the frequency of fixations in these areas was also used. Mudrick et al. (2019) extended their analysis with a sequence of fixations in individual areas of interest, i.e., the order of fixations, which shows how the participant worked and proceeded with the learning material. A different approach was suggested by Taub and Azevedo (2019), who worked with the proportions of fixations, which were calculated from a multiple of the average fixation duration and the fixation frequency divided by the total duration of the experiment. Park et al. (2020) also worked with the ratio of fixation duration to total learning time, with the percentage serving as an indicator of visual attention. Eitel (2016) focused on the number of fixations in specified areas of interest, mean fixation duration on a text, and overall fixation time.

As in the case of fixations, the authors focused on a deeper analysis of the transition between the two fixations (i.e., saccades), although the incidence of this metric was lower than the fixations. Saccades and their more detailed parameters were used only in the analyses by Tsai et al. (2019) and Fiorella and Pilegard (2021). Tsai et al. (2019) focused on the number of saccades and the total and average distance of the saccades. Fiorella and Pilegard (2021) then used the so-called integrative saccades in their analysis, which they described as saccadic transitions between multimedia stimuli on the page (e.g., between text and image). These long saccades between individual areas of interest were also used by other authors who referred to this movements as transitions. Transitions between different areas of multimedia materials (e.g., text and image/graph) can provide more detailed information on learning strategies and are also a suitable indicator of cognitive activity (Park et al., 2020; Trevors et al., 2016). Transitions between different areas of interest (texts and pictures) were used also by Scheiter et al. (2018).

As all the empirical studies included in this review were based on using eye-tracking technology, it is also necessary to summarize the eye-tracking metrics used in them. The focus was mainly concentrated on the fixations, saccades, and transitions between selected areas of interest. In order to analyze the fixations, some detailed parameters were chosen (e.g., fixation duration,

number of fixations, and order of fixations). The occurrence of saccadic parameters was lower than the fixations. However, some authors decided to analyze specific parameters of saccades (e.g., number of saccades, total and average distance of saccades). With longer saccades, the authors also mentioned the transitions, which are basically the saccade between two fixations. This metric measured the number of skips from one area of interest (e.g., text) to another (e.g., picture, graph, or inference question) and can show the different approaches of students to multimedia learning material.

Conclusion

Our narrative review was dedicated to the actual field of using eye-tracking technology to investigate the relation between eye movements and self-regulated learning from multimedia materials. In our review, we discovered that research using eye-tracking technology in the field of self-regulated learning is a new area and the related empirical studies showed a broad spectrum of different methodological approaches to studying this topic.

The presented narrative review has considerable limits. The review includes a limited number of studies published between 2012 and 2021, providing only a bounded insight into the research of using eye-tracking technology to study self-regulated learning processes while learning from multimedia materials. The inclusion and exclusion criteria of empirical studies were relatively strict. However, the criteria make it possible to present a clear view of the selected thematic area.

This narrative review provides a summary of current directions in eye-tracking research dealing with self-regulated learning from multimedia materials. In particular, the results show which self-regulatory and metacognitive processes in learning from multimedia materials are currently the main focus of investigation, how these processes are measured using eye-tracking technology with a special focus on the methodological perspective and experimental structure and stimuli, and what eye-tracking measures are considered useful for data analysis.

The results of our narrative review can offer new insights for investigators researching self-regulated learning from multimedia materials with the use of eye-tracking technology. Future research may explore in more depth the relations among various concepts (e.g., learning strategies, judgments of learning, and learning outcomes) while studying from multimedia materials in connection to recorded eye movements. This may provide further information about self-regulatory processes. This information could in turn improve the quality of the multimedia materials and subsequently help university students with learning processes.

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FACTOR STRUCTURE OF A SELF-REPORT QUESTIONNAIRE DETERMINING THE EPISTEMIC BELIEFS OF PRIMARY SCHOOL AND KINDERGARTEN STUDENT TEACHERS IN THE SCIENCE DOMAIN

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ABSTRACT

The presented empirical study deals with the issue of the epistemic beliefs of primary school and kindergarten student teachers in the science domain. In relation to science education, epistemic beliefs are closely connected with the concept of nature of science (NOS). The aim of the study was to find and analyze the factor structure of the translated self-report questionnaire "Epistemic Beliefs About Science" (EBS) in the Czech sociocultural environment. The EBS was translated as recommended for cross-cultural research and then piloted in March 2021. The main data collection was conducted online via Google Forms in May 2021 through convenience sampling (N = 427) at six universities in the Czech Republic. We performed a confirmatory factor analysis to verify the model. Fit indices reached acceptable or good values for acceptance of the generated model (CFI = .955, TLI = .945, RMSEA = .060, SRMR = .052). Correlations between individual dimensions are also presented. The reliability for both the original form of the instrument and for the resulting model was higher than 0.75 for all subscales. The results are discussed in the context of foreign empirical studies. It can be stated that the modified version of the EBS is applicable in the Czech sociocultural environment for the research sample.

KEYWORDS

science education, epistemic beliefs, factor analysis, student teacher, nature of science

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Introduction

Contemporary life is characterized by almost unlimited access to information sources, albeit with varying levels of reliability. Thus, there are situations in which an individual decides to attribute knowledge to something; in the process of this attribution, the individual considers what the acceptable degree of uncertainty in the knowledge construct is or evaluates their degree of trust in the attributed source.

As Feucht (2017, p. 8) concisely stated, "No matter what knowledge people absorb and for what reasons, they might be challenged to verify the trustworthiness and relevance of the incoming information before making an informed decision or coding it into long-term memory." Bråten et al. (2011) emphasized that when constructing knowledge from a variety of sources, as is currently typical, the starting point is the application of epistemic strategies such as assessing the reliability and quality of the source of information and supporting claims. These epistemic strategies are an essential skill for an individual's future behavior, as subsequent actions – such as preparing for tests, generating arguments, and assuming points of discussion – will depend on how the individual perceives, stores, and then uses the relevant information.

Epistemic beliefs[1] that we, in the context of teaching science, focus on in this contribution refer to individual beliefs about how knowledge and the process of knowing affect and are affected by the learning process, including how knowledge is defined, constructed, and evaluated, where knowledge is stored, and how knowledge emerges (Hofer, 2004). A correlative meta-analysis by Greene et al. (2018) analyzed 132 non-experimental studies involving 55,418 respondents demonstrating a low ($r = 0.16$) but statistically significant ($p < 0.001$) correlation between epistemic beliefs and diverse learning aspects (argumentation, conceptual understanding, declarative knowledge in the subject), with a stronger correlation found in the domain specificity (specificity of epistemic beliefs and specificity of the tool determining the learning performance in the context of the domain) than in the general domain approach. For this reason, we consider it crucial to examine and develop the epistemic beliefs of individuals within the context of the characteristics of a respective discipline.

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[1] In this work, in agreement with Schommer-Aikins (2004) and Muis (2007) and in order to unify the nomenclature, we use the term "epistemic belief" although we are aware of other terms such as "personal epistemology" (Hofer & Pintrich, 1997), "epistemic cognition" (Greene et al., 2008), "epistemic resources" (Hammer & Elby, 2003), and "epistemic thinking" (Kuhn & Weinstock, 2002).

Many experts are engaged in research into epistemic beliefs in science education in connection with various aspects of learning, e.g., self-regulated learning (Pamuk et al., 2017), reading comprehension (Yang et al., 2016), achievement (Alpaslan, 2019), and learning approaches (Chiou et al., 2013). In the context of science education, epistemic beliefs are closely linked to the concept of nature of science (NOS) (Elby et al., 2016), defined as the way of knowing (Lederman, 2007), or directly as the epistemology of science (Tsai & Liu, 2005). In the theoretical part of this text, we discuss individual models of epistemic beliefs with an emphasis on the links between epistemic beliefs and important learning aspects in the context of the subject of science. The empirical part of the study is focused on an analysis of the factor structure of the translated self-report questionnaire "Epistemic Beliefs About Science" (EBS) (Conley et al., 2004) in the Czech sociocultural environment. The EBS is the most commonly used quantitative self-report questionnaire for capturing epistemic beliefs in the science domain (Lee et al., 2021). We believe that it is necessary not only to find new ways to determine the level of epistemic beliefs of individuals, but also to determine the reliability and validity of existing tools in other sociocultural environments.

1. Models of epistemic beliefs

Beginning in the 1970s, research on epistemic beliefs focused on identifying developmental trajectories. In the 1990s, there was a shift in attention towards the potential facilitation of epistemic beliefs in pupil and student understanding, reasoning, thinking, learning, and performance (Hofer & Pintrich, 1997). Greene et al. (2018) presented a classification of four models of epistemic beliefs: developmental, dimensional, academic-discipline informed, and philosophically informed. In the following passages, with some overlaps with other models due to the general theoretical anchoring, we discuss primarily the dimensional model, as the self-report questionnaire used in this study falls into this category.

Developmental models (e.g., Kitchener & King, 1981; Kuhn et al., 2000; Perry, 1970) are based on the (neo)Piagetian tradition emphasizing linear cognitive development. In various terminological nuances, developmental models refer to three epistemic positions (Barzilai & Ka'adan, 2017; Schraw, 2013):

i) Objectivism (realism, dualism, absolutism). At this level, knowledge is perceived as an objective and factual construct that can be excerpted directly from the experience of external observable reality; all individuals share the same knowledge base.
ii) Subjectivism (relativism, multiplism). At the beginning of this level, knowledge is perceived as a unique and individual construct, and for this reason all views have the same weight. There is no absolute truth.

iii) Criterialism (contextualism, evaluativism, objectivism-subjectivism). At this level, knowledge is perceived as an individual and social construct that can, however, be objectified through evidence. This is inextricably linked to the methodological processes of research in a given discipline (coordination of knowing and known processes). This is theoretically the most sophisticated level.

The long-standing assumption that children in the context of the developmental aspect of cognitive development are not capable of a certain type of learning experience (including activation of epistemic strategies) is currently being revised in the context of science teaching (Kawasaki et al., 2004) and also in the context of history teaching (VanSledright, 2002). Gradually, researchers have emerged who argue that epistemic beliefs are a (multi)dimensional construct and that their development is nonlinear: one dimension may be naive; another may be more sophisticated. Schommer-Aikins (Schommer, 1990; the EQ) is considered a pioneer in this direction, postulating a total of five dimensions of epistemic beliefs: stability of knowledge (certainty, stability, certain knowledge – knowledge is absolute, knowledge is static rather than changing); knowledge structure (simplicity, structure, simple knowledge – knowledge is a set of isolated facts as compared to a set of coherent and complex concepts); knowledge source (omniscient authority – knowledge comes from an external authority or is actively constructed by the individual); learning control (innate ability – whether the ability to learn is innate or acquired), and learning speed (quick learning – learning process is quick or gradual). The last two dimensions have not been included in the theoretical framework by some researchers (e.g., Hofer & Pintrich, 1997) who assert that these two dimensions are not epistemic. Schraw and other authors (the EBI; Bendixen et al., 1998; Schraw et al., 2002) followed the five-dimensional model of Schommer-Aikins. Hofer and Pintrich (1997) composed areas of beliefs about the nature of knowledge, consisting of the dimensions of certainty and simplicity, and the nature of knowing, consisting of the dimensions of knowledge source and knowledge justification – evaluation of knowledge claims, i.e., standards and criteria by which people substantiate their beliefs. Perception of knowledge as a coherent concept (Schommer, 1990) and perception of knowledge as a temporary and dynamic construct are seen, within the framework of multidimensional models, as more sophisticated beliefs[2] since the latter allows an individual to open up the

[2] At present, diverse nomenclature is used to refer to a more or less developed level of epistemic beliefs (constructivist or empiricist beliefs: Hashweh, 1996; more or less mature: Rukavina & Daneman, 1996; Stoel et al., 2017; more or less appropriate: Wiley et al., 2020).

possibility of a new interpretation (King & Kitchener, 1994; Kuhn, 1991). Alexander (2005) directly stated that epistemic beliefs should be targeted in teaching in the context of "complexity, sophistication and uncertainty of knowledge" (p. 38). Less sophisticated epistemic beliefs are considered when an individual perceives an external authority, not themselves, as a source of knowledge (Conley et al., 2004). This view is based on the Piagetian tradition in which cognitive development in childhood is mainly determined through one's own experience, rejecting the function of an adult who provides primarily verbal knowledge and second-hand information (Harris, 2001). However, this view is currently being significantly questioned, as people have relied on testimonies and information from others for millennia (Chinn et al., 2011). We emphasize that sophisticated beliefs include flexibility and adaptability reflecting contextual conditions. For example, it is not very sophisticated to doubt that the Earth is (almost) round (Elby & Hammer, 2001). Dimensional models were initially associated with a general domain approach, and the items, measured with Likert scales, in the self-report questionnaires corresponded to this; for example, "Truth means different things to different people" is item # 2 in the Certain Knowledge dimension in the Epistemic Belief Inventory (EBI) (Bendixen et al., 1998). Subsequently, a group of researchers trying to dimensionally contextualize the items in relation to the relevant discipline was profiled. The Discipline-Focused Epistemological Beliefs Questionnaire (DFBEQ) by Hofer (2000) can be considered an initiating instrument, followed by the emergence of other instruments, including the EBS (Conley et al., 2004); the Epistemic and Ontological Cognition Questionnaire (EOCQ) (Greene et al., 2010); and the Justification for Knowing Questionnaire (JFK-Q) (Fergusson et al., 2013). Self-report questionnaires built on the domain-specific nature of epistemic processes already, in a sense, interfere with models based on domains. The nature of academic disciplines has led many researchers in the field of epistemic beliefs to research "connections with understanding of discipline knowledge and specific actions in the discipline, such as scientific research, historical argumentation, or activities related to comprehension of expert texts" (Juklová, 2020, p. 42). This starting point is based on the assumption that a more sophisticated epistemic level in a given discipline is a prerequisite for adaptive (effective) action in a given area. Thus, epistemic beliefs are situational and context sensitive (Muis et al., 2016). Central to these models are problem-solving and critical (strategic) thinking research conducted by experts that to some extent questions the general domain nature of epistemic beliefs, as expert knowledge is primarily domain-specific (Shreiner, 2014). Samarapungavan et al. (2006) demonstrated, using the example of teaching chemistry, that epistemic beliefs and the practices associated with them are specific and cannot be effectively transferred to other sciences. This

corresponds to the results of a qualitative survey by Greene and Yu (2014) among biology and history experts (e.g. in the context of perception of higher order knowledge: biologists – relations x historians: interpretation) and to the conclusions of a meta-analysis by Greene et al. (2018), in which individuals tended to justify knowledge in the domain of history on the basis of authority, but relied on logic in the domain of science. In summary, individuals in different disciplines develop different epistemic positions (Hofer, 2000; Muis et al., 2006). Many researchers are now calling for a deeper grounding of the theoretical basis of epistemic beliefs in educational psychology research into the original philosophical framework (AIR theoretical model[3]; Chinn & Rinehart, 2016; Greene et al., 2008; Murphy et al., 2007). The construct of epistemology in pedagogical-psychological research often focuses on the construct of knowledge, but epistemology involves more than knowledge (epistemic goals, values, structures, outcomes, positions, wisdom, understanding, virtue, …). A significant proportion of researchers focus on the epistemic component of the justification of knowledge; some believe it is "the central question of philosophical epistemology" (Greene et al., 2008, p. 146). This component of epistemology has also been operationalized into self-report questionnaires: justification based on authority, personal perspective, and the use of multiple sources as evidence in the JFK-Q (Ferguson et al., 2013) and similarly in the EOCQ (Greene et al., 2010).

2. Epistemic beliefs in the context of science

An important goal of science education is the development of student scientific literacy, which includes different components: content knowledge, scientific inquiry, and NOS (Peters-Burton, 2016). NOS usually refers to the epistemology of science: science as a way of knowing or the values and beliefs inherent to the development of scientific knowledge (Lederman, 2007). Empirical studies have shown that epistemic beliefs in the context of science predict conceptual change, scientific inquiry, intrinsic motivation, quality of laboratory practices, understanding of science texts, activation of metacognition, and learning practices (Bendixen, 2016; Cano, 2005; Chen, 2017; Ding, 2014; Hsu et al., 2014; Lin et al., 2013; Lising & Elby, 2005; Schiefer et al., 2020; Yang et al., 2016). Interventional studies focusing on the development of the epistemic

[3] Aims and values, epistemic Ideals, and Reliable processes for achieving epistemic ends; the dimension of justifying knowledge falls into the component of epistemic ideals, expressing the standards that individuals should meet.

beliefs of students, shifting from the belief that answers to questions are found with authorities to the belief that answers are obtained through research, showed that successful intervention can be undertaken in first graders (Herrenkohl, 1999; Smith et al., 2000; Solomon et al., 1996), and this also includes work with web interfaces (Herrenkohl et al., 2011). Through self-assessment scales and interviews, Edler (2002) found that both naive and sophisticated levels of epistemic beliefs appear in fifth graders. Pupils perceived theories as potentially evolving, appreciating the roles of thinking, justification, and experimentation in science. However, the interview results indicated that students believed that the purpose of science education was to implement projects and activities rather than explain phenomena. Pupils perceived themselves as passive objects; the sources of knowledge for them were external authorities, such as books, teachers, and family members. Conley et al. (2004), in a 9-week intervention for fifth graders, increased the sophistication levels of the dimensions of source and stability; their study also found that children with lower socioeconomic status had more naive epistemic beliefs.

Research showed that in order to develop an understanding of NOS of primary school pupils, it is necessary for their teachers to have a good understanding of the concept and know how to teach it (Akerson et al., 2009). Some studies demonstrated that both primary school teachers (Hanuscin et al., 2010) and students of primary school teacher training are able to develop strategies for developing their students NOS through deliberate intervention (Akerson & Volrich, 2006; Deng et al., 2011). One important aspect for the development of pupil NOS is the development of the teacher's skills in the field of scientific inquiry, which is not an "an automatic or easily facilitated process" (Herrenkohl et al., 2011, p. 2). Wallace and Kang (2004) demonstrated how teachers' beliefs influenced research inquiry practices in science classes. The sustainability of epistemic standards was documented 3 months after a 4-week intervention (Hatfield, 2015). Pupils, students, and their teachers should develop thinking habits that include these beliefs: scientific knowledge can change over time and is based on empiricism (hypothesis formulation; prediction, critical testing, data analysis, and interpretation; and review and evaluation of evidence and methods); there is no single right research method (it is always partially influenced by the researcher's subjectivity, influenced by imagination and creativity, and is socioculturally rooted; Abd-El-Khalick et al., 2017; Deng et al., 2011). Research in the field of the influence of teachers' epistemic beliefs on the organizational forms and teaching methods used, including their influence on the epistemic development of pupils, has not produced completely clear results. Some studies have demonstrated an influence (Norton et al., 2005; Tsai, 2002); others have not (Schraw & Olafson, 2003). Wu et al. (2020) concluded, on a sample of kindergarten teacher training

students, that the scientific epistemic beliefs of teachers had predicted their beliefs about teaching and subsequently their pedagogical content knowledge. Correlation studies by Deng et al. (2014, 2017) also demonstrated a link between the epistemic beliefs of teacher training students and their beliefs about teaching. A direct influence of teachers' epistemic beliefs on their class work has not yet been extensively studied. One exception is the qualitative study by Barnes et al. (2020), in which teachers evaluated student work through a think-aloud protocol, concluding that teachers' epistemic cognition directs their interpretation and practices in assessment tasks. A study by Barger et al. (2018) further demonstrates that a student-centered learning environment leads to the development of student epistemic beliefs.

Despite the partially ambiguous findings in the influence of teachers' epistemic beliefs on their teaching practices and secondarily on pupils' own epistemic beliefs and performance, we consider it important to pay attention to this phenomenon since, from our point of view, this issue has been poorly developed in the Czech environment. This finding also applies to the of pre-primary and primary teacher training students who are the respondents in this study. This demographic is specific to the Czech Republic for several reasons: i) students are most often recruited from secondary educational schools where science subjects based on a rigorous approach are left behind in favor of soft disciplines, ii) a wide range of skills needs to be developed within the university education of these students because, unlike their second-level and third-level colleagues, they are more holistic about their approach (all or most subjects are taught by one teacher and they must therefore be properly prepared in them), iii) due to the standard profile of kindergarten and primary school teachers, their training at universities is relatively uniform.

3. The issue of the operationalization of dimensional models for measurements in self-report questionnaires

Schraw (2013) listed six methodological approaches (questionnaires, interviews, vignettes, essays, concept maps, and multidimensional scaling methods) that can be used to identify epistemic beliefs. We focus here on self-report questionnaires because the subject of the empirical part of this study is to determine the factor structure of a self-report questionnaire. Greene et al. (2008) drew attention to the use of explanatory factor analysis and listed studies in which this statistical method was used. According to the authors, this caused discrepancies in findings in subsequent studies, especially in situations in which researchers used confirmatory factor analysis (also Hofer & Pintrich, 1997). Factor analyses usually generated fewer than five factors (using the EQ tool without the source dimension: Schommer, 1990; 1993),

factors other[4] than those postulated by Schommer emerged (Jehng et al., 1993: Orderly process; Schraw et al., 2002: Incremental learning, Integrative Thinking). Only some items clearly loaded the postulated dimensions; some items loaded factors with unacceptable reliability (less than 0.70; Schraw, 2013), and structural differences (including failure to confirm the initial dimensionality of instruments) are even more evident when applying an instrument outside English-speaking countries (Bråten & Strømsø, 2005; Bromme et al., 2010; Ordoñez et al., 2009). Both the original and modified versions of the EQ tool and other tools built on similar foundations (EBI – 32 items: Bendixen et al., 1998; within optimization: 28 items: Schraw et al., 2002) usually explain the relatively low percentage of data variability (EQ, EBI – less than 40%; Schraw, 2013) and similar problems with reliability and item loading of factors occur. In the context of EBI, reliability ranges between .58 and .87, and only 15/28 items loaded the factors postulated by Schommer (Bendixen et al., 1998; Schraw et al., 2002). In connection with the use of Likert scales for answering individual items, it is problematic to interpret the mean values, and within the bipolar dimensional concept it has been argued that if an individual expresses their disagreement, it does not automatically mean that they express agreement (Greene & Yu, 2014). Within understanding of more sophisticated epistemic beliefs on a linear level (objectivism – subjectivism – criterialism), it is problematic to interpret the answer to the item "Ideas in science sometimes change" (#15; Conley et al., 2004, p. 203) because subjectivists and even criterialists will agree with the statement. This approach has led some researchers to grasp the positions of objectivism and subjectivism not as bipolar positions, but as two dimensions (Peter et al., 2016). Also, convergent validity within the use of two tools for determining epistemic beliefs does not clearly draw conclusions in the context of correlations between identical dimensions (DFBEQ and EBI – Simplicity dimensions; Cazan, 2013). The findings of Hofer's (2000) research on a sample of university students empirically showed that items from the dimensions of certainty and simplicity factored together, and that it should therefore be a single dimension (similarly Schommer-Aikins et al., 2002). An additional concern is the danger that answers will be generated with a view toward social desirability (Bartels & Magun-Jackson, 2009).

[4] The extraction of factors other than those originally expected also applies to other tools. Within the EBI, for example, definitude and perseverance dimensions are extracted (Bromme et al., 2010).

4. Research methodology

4.1 Aim of the study

The aim of the study was to determine and analyze the factor structure of the translated EBS self-report questionnaire (Conley et al., 2004) in the Czech sociocultural environment and in students of primary school teacher training and of kindergarten teacher training (hereinafter referred to as "students").

4.2 Self-report questionnaire used

The EBS self-report questionnaire was created by Conley et al. (2004) and was originally intended to determine the epistemic beliefs of primary school pupils; however, in subsequent years it was used in its original and/or a modified form with older respondents. It is a four-dimensional self-report questionnaire (Table 1), developed within the framework of a partial adaptation and elaboration of the five-dimensional model by Elder (2002), who had synthesized the conclusions of research on epistemic beliefs in science and postulated seven key points representing the nature of knowledge and understanding (e.g. the role of evidence and experiments).

Table 1
Description of dimensions, number of EBS items, and item examples

Dimension		**Description**	**Number of items**	**Item example**
Nature of knowledge	Development	Science (as a scientific discipline) is unchanging, static (theory does not change) x changes based on new data and evidence (theory changes).	6	#16 *New discoveries can change what scientists think is true*
	Certainty	In science, there is one correct answer x more correct answers to complex problems	6	#6 *All questions in science have one right answer*
Nature of knowing	Source	Belief that scientific knowledge springs from external authorities.	5	#1 *Everybody has to believe what scientists say*
	Justification	Belief in how individuals justify knowledge (in the tool and in the context of the role of experiments for statement evaluation)	9	#24 *Good answers are based on evidence from many different experiments*

The EBS contains 26 items (statements), to which the respondent expresses the degree of agreement through a 6-point Likert scale (1 = strongly disagree to 6 = strongly agree). The EBS was used in its original or adapted form in different countries for diverse age groups[5]. In the section on data interpretation, we discuss the findings of this study in relation to foreign research on university students.

4.3 Translation of the EBS

When translating the EBS, we followed the protocol recommended in cross-cultural research. Cross-cultural validation involves determining whether a tool that originated in a particular sociocultural context is meaningfully applicable and therefore equivalent for use in another sociocultural framework (Huang & Wong, 2014). Klassen et al. (2009) presented three steps: (1) translation and back translation into the original language (translation-back translation process), (2) involvement of bilingual or multilingual individuals who can be considered as experts in the relevant research domain (so that the translation is correct not only linguistically but also valid in terms of its substance), (3) evaluation of whether changes in translations (change of sentence structure and wording) reflect only the consideration of sociocultural and linguistic differences and do not distort the original meaning of the research tool (meaning-based approach). In the first step, we addressed two academics (ISCED 8) with language level C2 (postgraduate study of English). The back translation was again done by two academics (ISCED 7 and 8, both with language level C2). In the second step, we contacted a bilingual translator (ISCED 7) who also teaches at secondary school and is an expert in the field of educational psychology. This expert was also present in the final third step, during which the construct of epistemic beliefs was discussed with an expert (associate professor) engaged in education of foreigners, plurilingualism, Czech language didactics, onomastics, and phraseology. The EBS was piloted (March 2021) on a sample of eight primary school teachers (seven women, one man) and five kindergarten teachers (four women, one man) through a cognitive interview (Karabenick et al., 2007):

[5] For example: a 4-point Likert scale with 29 items for 10th graders in Germany (Kampa et al., 2016); 22 items for 11th and 12th graders in Namibia (Shaakumeni, 2019); merging two scales (C + D) into one in research with German university students (Lang et al., 2020).

1. Understanding the item: asking the participant how they interpret the item.
2. Item-related information: asking the participant to describe the experience, thoughts, and feelings associated with the item and with the concepts in the item.
3. Answer choice: asking the participant to justify the answer they would choose.

4.4 Research sample

The research sample (N = 427) was obtained by convenience sampling and included students from six Czech universities (N_{UJEP} = 79, N_{UK} = 127, N_{MUNI} = 107, N_{UO} = 34, N_{TUL} = 15, N_{UPOL} = 65). In terms of gender, it was, due to the monitored fields, an unbalanced sample with nine men and 418 women. In terms of study focus, 149 respondents studied kindergarten teacher training and 278 studied primary school teacher training. Within the sample, 163 respondents studied in a full-time study program and 264 were in a combined study program. Students of all years of study were included. An idea of the length of teaching experience of the respondents can be obtained from Table 2. The age of the respondents was not monitored. The main data collection was carried out online (Google Forms) in May 2021 during the COVID-19 pandemic[6]. The questionnaire was sent to students by contact persons from the guaranteeing departments of the respective universities.

Table 2
Length of respondents' teaching experience

Length of teaching experience	*N*
none	122
less than a year	118
1–3 years	97
4–6 years	56
7–9 years	26
more than 10 years	8

[6] Pursuant to § 184a of the amendment to the Education Act No. 561/2004 Coll. (Novela školského zákona č. 561/2004Sb, 2004) online education is given by a government decree de lege for all the schools concerned in connection with the applicable government decree. The methodological recommendation of the Ministry of Education, Youth and Sports (information on the operation of schools from April 12, 2021) recommends that schools do not expose students to stress after their return to school and that they pay particular attention to revising the curriculum in the first weeks and months (MŠMT, 2021).

4.5 Data analysis

As the factor structure of the EBS is known from foreign research, a confirmatory factor analysis (CFA) was performed on data from the Czech Republic. Within the CFA, the model fit indices recommended by Brown (2015) were monitored. The following is an overview in which the limit value for a good model fit, as recommended by Hu and Bentler (1999), is always in brackets: Comparative Fit Index (CFI, .95), Tucker-Levis Index (TLI, 0.95), Root-Mean-Square-Error of Approximation (RMSEA, < .06) and Standardized Root Mean Squared Residual (SRMR, < .08). We did not monitor χ^2, the values of which are significantly influenced by the number of respondents. The reliability of the individual subscales of the instrument was determined by calculating the Cronbach's alpha coefficient, both for the original form of the instrument and for the new validated model. The values of the alternative reliability coefficient, McDonald's ω, which is based on factor loadings, are also presented for this model (Hayes & Coutts, 2020). Data analysis was performed in IBM SPSS Statistics 27 and IBM SPSS Amos 27 Graphics.

5. Results

The CFA results based on the factor structure of the complete EBS demonstrate an insufficient model fit (CFI = .876, TLI = .863, RMSEA = .075, SRMR = .072) and thus the impossibility of its use in such a form (see Figure 1).

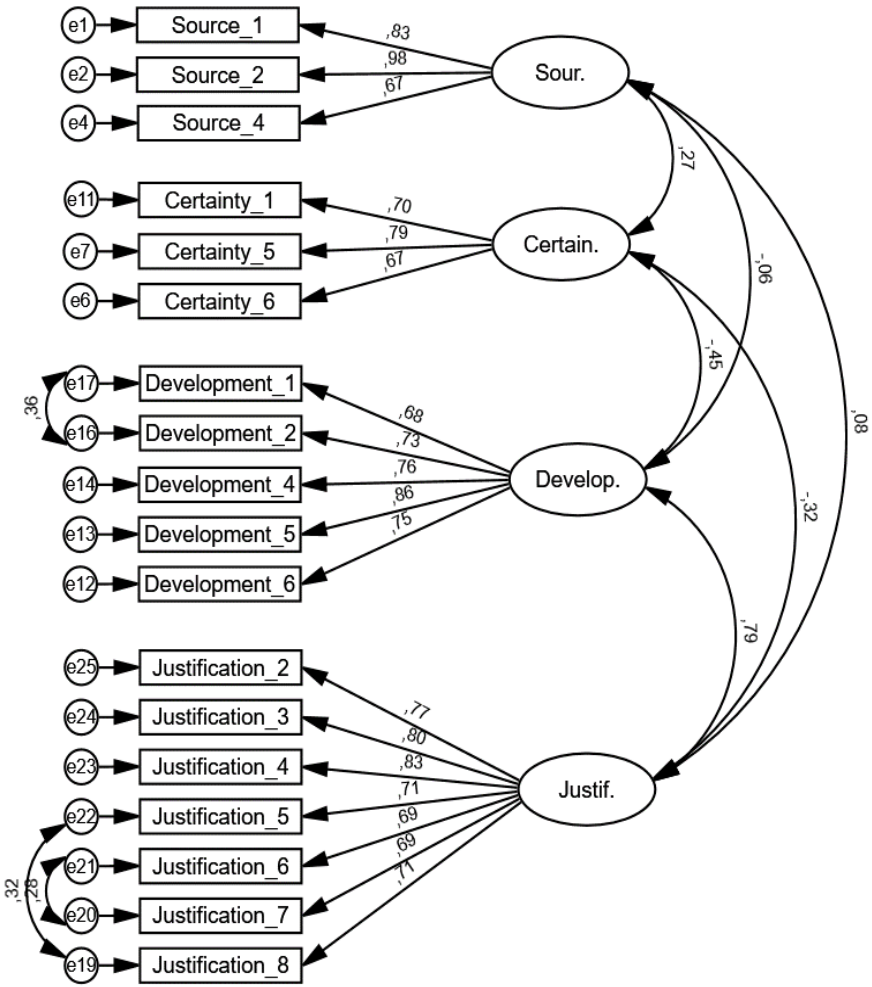

Figure 1
CFA for original version of EBS

Therefore, items with loadings lower than .70 by at least .05 were removed from the model; this limit is considered to be excellent by DiStefano and Hess (2005). The covariance between errors within the same factor was also taken into account when adjusting the model. We took this step primarily to maintain items that are close to each other and thus to maintain a sufficient number of items (items with marked covariance in errors can be redundant to each other; Harrington, 2008). The resulting model can be found in Figure 2.

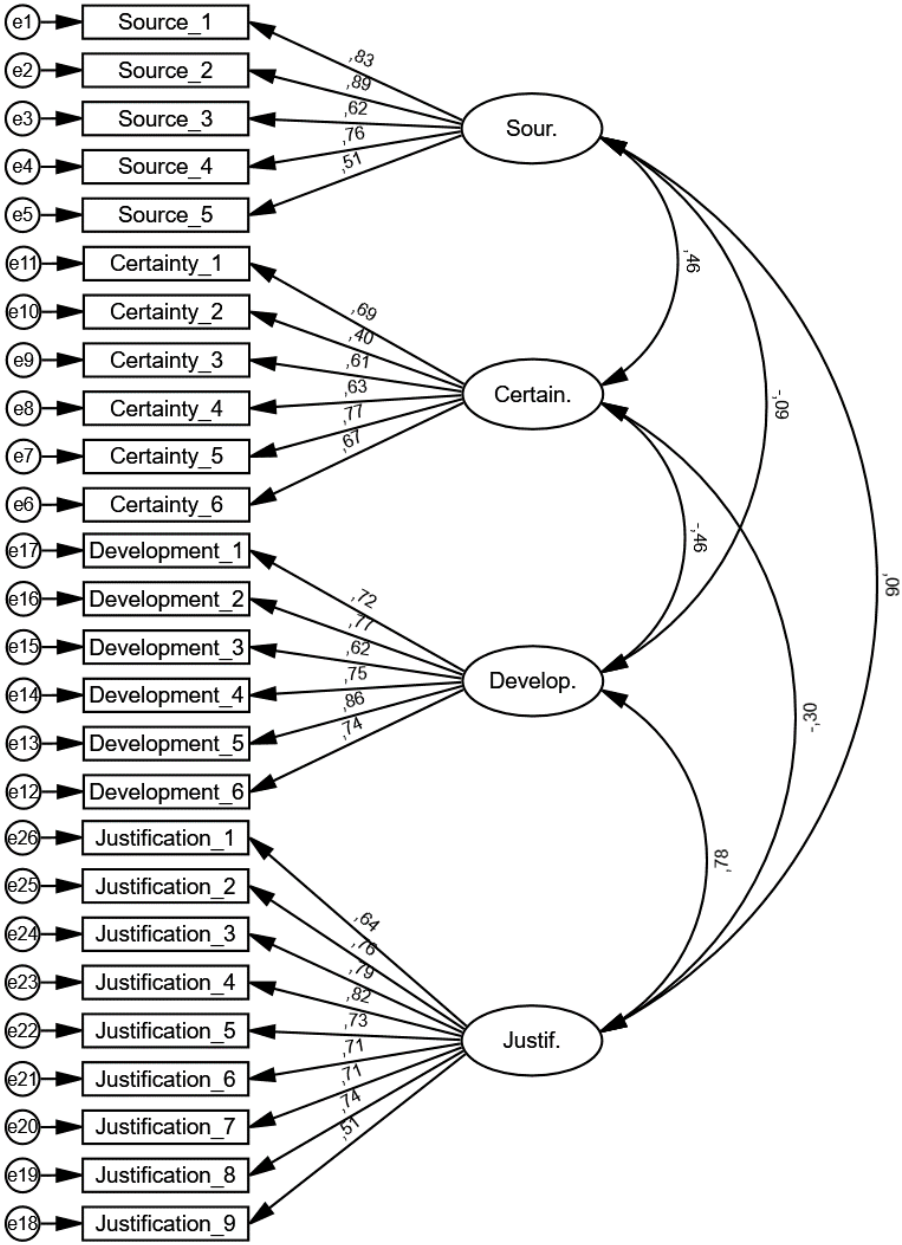

Figure 2
CFA for the final version of EBS

The model fit of the presented model is as follows: CFI = .955, TLI = .950, RMSEA = .060, SRMR = .052. These results reflect a good model fit and are fully acceptable (see Hu & Bentler, 1999). Reliability was determined both for the original form of the EBS and for the newly created model. Table 4 shows that the reliability values reached completely acceptable levels. We also present the values for the Czech version of the whole EBS, as mere high reliability cannot be the only prerequisite for use in research.

Table 4
Reliability values (Cronbach's α, McDonald's ω)

Scale	α (CZ, complete EBS)	α (CZ, new model)	ω (CZ, new model)
Source	.85	.85	.86
Certainty	.77	.76	.76
Development	.88	.88	.89
Justification	.90	.90	.90

In the following analyses, the data obtained in the final form of the EBS (Appendix 1) were used. Table 5 shows the results of the descriptive statistics for the four monitored dimensions. The respondents reached the highest values in the justification dimension and the lowest values in the certainty dimension.

Table 5
Descriptive statistics

Scale	Mean	Std. Dev.	Median
Source	3.56	.93	4
Certainty	2.02	.73	2
Development	4.94	.83	5
Justification	5.03	.74	5

Correlation among the individual subscales is evident from Table 6.

Table 6
Correlation among individual subscales (Pearson correlation). Two correlation measurements from the original study by Conley et al. (2004) of fifth graders are shown in parentheses.

	Source	Certainty	Development
Source			
Certainty	**.29**(**.76**; **.69**)		
Development	−.09(**.29**; **.36**)	**−.37 (.26; .28)**	
Justification	.05 (.12; .17)	**−.26** (.17; .17)	**.66 (.47; .50)**

Note: Bold values are significant at the $p < .01$ significance level. Underlined values are significant at the $p < .05$ significance level.

The individual universities were not compared for several reasons. The numbers of respondents from individual universities were significantly different and furthermore our ambition was not to compare the universities. Another reason was the relative uniformity of the training of kindergarten and primary school teachers; existing differences were unlikely to lead to different results.

6. Data interpretation and discussion

This study aimed to identify and confirm, on a sample of university students of primary school and kindergarten teacher training, the factor structure of the adopted foreign EBS (Conley et al., 2004), which is the most frequently used quantitative self-report questionnaire for determining the epistemic beliefs of individuals in the domain of science (Lee et al., 2021). The original form of EBS is divided into four factors (source, certainty, development, and justification). The same structure of the instrument was proved in the Czech conditions, although the final form of the instrument is shorter than the original. Items that the CFA identified as problematic were excluded from the final Czech version of the instrument due to the low loading of a specific factor. The resulting model consists of these items (number of items retained / number of original items): source 3/5, certainty 3/6, development 5/6, and justification 7/9.

We further relate the results to foreign studies, presented in Table 7. The internal consistency of individual subscales (α) in the new model acquired good values (source .85, certainty .76, development .88, justification .90); this is not the rule in foreign studies (below the value $\alpha < .70$ for the factor of source: Bahçivan, 2014; Liang & Tsai, 2010; for the factor of certainty: Bahçivan, 2014; for the factor of development: Demirbağ & Bahçivan, 2021; Yang et al., 2013; and for the factor of justification: Yang et al., 2013).

Czech students of primary school and kindergarten teacher training tend to trust external authorities as sources of knowledge (source mean 3.56), which is in line with other foreign studies (Bahçivan, 2014; Liang & Tsai, 2010; Yang et al., 2019). We found only one study in which respondents tended to disagree that knowledge came from external authorities (Yang et al., 2013). At the same time, Czech students tend to perceive knowledge more as an uncertain (evolving) construct with the existence of a plurality of knowledge schemes (there is not necessarily one correct answer to scientific questions, nor one most appropriate way to get the right answer; certainty mean 2.02). This result is at variance with foreign studies (Bahçivan, 2014; Liang & Tsai, 2010; Yang et al., 2019). The results of this study are in agreement with Yang et al. (2013). Although the averages of the values obtained from these factors

are to some extent contradictory (source agreement, certainty disagreement), the factors correlate significantly with each other (.29). This can be interpreted as follows: with the growing belief that the originator of knowledge is an external authority (not oneself), the probability increases that the person concerned will perceive knowledge as a stable and unchanging construct (existence of one correct answer). This finding is consistent with the findings of Yang et al. (2013) who found statistically significant correlations between the authority knowledge factor of the modified EQ and the certain knowledge (.52) and simple knowledge (.43) factors of the EBS.

The development factor is in opposition to the certainty factor, which is also supported by the significant negative correlations (−.37) in this study. Development expresses that knowledge is a variable construct (e.g. in the context of time and new discoveries). A statistically significant correlation value was found between the development factor of the EBS and the simple knowledge factor (−.47) of the modified EQ. A negative but not statistically significant correlation value was also found with the certain knowledge factor (−.12; Yang et al., 2013). Czech students expressed a relatively high value of consensus with this concept of knowledge (mean 4.94), similar to other foreign students (Bahçivan, 2014; Liang & Tsai, 2010; Yang et al., 2013, 2019).

The last factor, justification, refers to the way that knowledge is justified (in the EBS, this is narrowed down to the role of experimentation). A statistically significant correlation value was found between the justification factor of the EBS and the simple knowledge factor (−.63) of the modified EQ (Yang et al., 2013). Czech students rated the importance of experimentation for acquisition of scientific knowledge (mean 5.03) relatively positively, which is again in line with other foreign studies (Bahçivan, 2014; Liang & Tsai, 2010; Yang et al., 2013, 2019). This factor showed a significant negative correlation with the certainty factor (−.26), which can be interpreted as meaning that the more an individual is convinced that knowledge is certain (stable and unchanged), the less they will appreciate the role of experimentation in acquiring scientific knowledge. A statistically significant correlation between the justification factor of the EBS and the certainty and authority knowledge factors of the modified EQ tool was not found in Yang et al. (2013).

The factors of development and justification correlated significantly together (.66). Thus, there is a probability that the more an individual is convinced that knowledge is evolving, the more important the role of experimentation will be in acquiring scientific knowledge.

In the context of the correlations found between the individual dimensions of this study (including those cited above) and the original research of fifth graders (Conley et al., 2004), discrepancies are evident. Conley et al. (2004) revealed, in two measurements except for one case, a significant correlation

between the individual dimensions at the $p < .05$ or $p < .01$ level. Proponents of dimensional models (as covered in the section "Models of Epistemic Beliefs") argue that epistemic beliefs are a (multi) dimensional construct and their development is nonlinear (one dimension may be more naive and another may be more sophisticated). It is possible to assume that fifth graders are less able than adult research participants to understand or appreciate the dimensions of potential change in ideas and theories in science (the development dimension) due to its demand for a higher degree of abstraction (#12 D: Some ideas in science today are different than what scientists used to think) including questioning claims from external authorities (source dimension) based on data and evidence through experimentation (justification dimension) (similar to Yang et al., 2013). However, in the justification dimension, significant correlations with the certainty and source dimensions are revealed in the study by Conley et al. (2004) when choosing a significance level of $p < .01$. It is possible that questions (#24 J: Good answers are based on evidence from many different experiments) related to the role of an experiment (justification dimension) are closer to younger students, as primary school students prefer first-hand experience when justifying knowledge (Sandoval & Cam, 2010).

Empirical research shows domain-specific differentiations. Barzilai and Weinstock (2015) state that in sciences built on an exact basis, knowledge is perceived as more certain, more objective, and less based on personal reasoning than in the soft sciences; for example, questioning (uncertainty) occurs sooner in the domain of history than that of biology. This is also supported by proponents of development models. Kuhn and Weinstock (2002) argued that the transition from objectivism to subjectivism would occur earlier in areas in which personal reasoning is on an inexpressible level (aesthetics) than in areas related to the objective judgments of the surrounding world and associated with principles of exact sciences (mathematics). We do not know any cross-sectional study that analyzes the correlates in the dimensions of the EBS tool across diverse age groups. Based on the literature cited above and the figure below (Table 7), we can conclude that epistemic beliefs increase with age (Pirttilä-Backman & Kajanne, 2001) and follow the educational path taken (Greene et al., 2008). We note, however, that cognitive maturation is not the only condition for development; Kienhues et al. (2016) directly stated that "epistemic change might occur quite rapidly and does not depend on cognitive maturation" (p. 319).

Table 7
Epistemic and Ontological Cognitive Development Model

	Ill-Structured Domains			
Age/Educational Level	**Position**	**SC**	**JA**	**PJ**
4–12	Realism	Strong	Strong	Strong
12–early college	Dogmatism or	Weak	Strong	Weak
	Skepticism	Weak	Weak	Strong
Middle to late college	Rationalism	Weak	Moderate	Moderate
Postundergradueate education	Rationalism	Weak	Moderate	Moderate
	Well-Structured Domains			
Age/Educational Level	**Position**	**SC**	**JA**	**PJ**
4–12	Realism	Strong	Strong	Strong
12–early college	Realism	Strong	Strong	Strong
Middle to late college	Dogmatism or	Weak	Strong	Weak
	Skepticism	Weak	Weak	Strong
Postundergradueate education	Rationalism	Weak	Moderate	Moderate

Note. SC = simple and certain knowledge dimension; JA = justification by authority dimension; PJ = personal justification dimension (Greene et al., 2008).

Table 8
Selection of studies in which the EBS was used on a sample of university students. Number of respondents, country of research, and main results in the context of reliability and mean scores (if accessible)

Study	**Respondents**	**State**	**Main results Reliability (mean scores)**
Bahçivan (2014)	310 pre-service science teachers	Turkey	S = 0.68 (3.73) C = 0.66 (3.78) D = 0.71 (3.87) J = 0.82 (4.02)
Demirbağ & Bahçivan (2021)	612 pre-service science teachers	Turkey	S = 0.78 C = 0.75 D = 0.69 J = 0.84
Liang & Tsai (2010)	407 college students	Taiwan	S = 0.69 (3.13) C = 0.76 (3.40) D = 0.82 (3.71) J = 0.77 (3.65)
Yang et al. (2013)	32 university students	Taiwan	S = 0.81 (2.45) C = 0.79 (2.65) D = 0.58 (4.42) J = 0.66 (4.23)
Yang, Bhagat & Cheng (2019)	59 Indian + 67 Taiwanese university science students	India, Taiwan	S = (3.25) C = (3.58) D = (4.29) J = (4.35)

Note: S = Source; C = Certainty; D = Development; J = Justification

In the interpretation of the results, it is necessary to take into account the sociocultural context. Structural differences (including failure to confirm the initial dimensionality of tools) are evident when implementing a tool outside English-speaking countries (Bråten & Strømsø, 2005; Ordoñez et al., 2009), in which case Hofstede's (1991) cultural dimensions theory can be used as a starting point for potential explanations of discrepancies in the field of epistemic beliefs. In a study of 15 countries with a minimum sample of 400 students of primary school teacher training in each country, Felbrich et al. (2012) concluded that individualistically oriented societies (United States, Germany, Switzerland, etc.) showed a higher tendency to perceive mathematical knowledge as a product of social processes open to discussion (mathematics as a dynamic process), compared to collectivist societies (Russia, Thailand), which perceived mathematical knowledge more as the acquisition of fixed sets of concepts and procedures (mathematics as a static science). A review of 106 studies (between 2004 and 2013) conducted by Yang (2016) in the context of epistemic beliefs and science education supported the existence of differences based on different sociocultural systems to the detriment of societies emphasizing collectivism and promoting conformity, which were connected with less sophisticated epistemic beliefs and higher difficulty in changing their epistemic views. A number of studies suggested that most teachers take a subjectivist position in the context of developmental epistemic models, and a minority an objectivist or criterialist position, both in Asia and in Euro-Atlantic countries (Cheng et al., 2009; Deng et al., 2014). Respondents to this study perceived scientific knowledge as a tentative, potentially evolving, and dynamic construct (rather, they refused to perceive scientific knowledge as a stable and certain construct) and appreciated the role of experimentation in acquiring scientific knowledge. Consistent with the studies by King and Kitchener (1994) and Kuhn (1991), it can be concluded that in the context of dimensional epistemic models, the respondents participating in this study are at a relatively sophisticated epistemic level (relatively high average values in the development and justification dimensions and conversely a low average value in the certainty dimension). At the same time, however, it should be noted that the respondents were more inclined to report that scientific knowledge springs from external authorities. According to some authors, this phenomenon indicates a rather less sophisticated level of epistemic beliefs (Conley et al., 2004; King & Kitchener, 1994; Kuhn, 1991); other authors question this interpretation based on the argument that people have relied on testimony and information from others for millennia (Chinn et al., 2011).

6.1 Research limits

In connection with the use of Likert scales in answering individual items, it is considered problematic to interpret the median values; within the bipolar dimensional concept, it has been argued that if an individual expresses their disagreement, it does not automatically mean that they express agreement and vice versa (Greene & Yu, 2014). In this study, for example, it may be a conviction of individuals that knowledge comes more from external authorities (source mean 3.56), which does not automatically mean that knowledge cannot come from dynamic activity of the individual (from themselves). In the intentions of the linear understanding of the sophistication of epistemic beliefs (objectivists – subjectivists – criterialists) it is problematic to interpret the answer to the item "Ideas in science sometimes change" (Conley et al., 2004, p. 203), because both subjectivists and criterialists will agree. This approach led some researchers to grasp the positions of objectivism and subjectivism not as bipolar positions, but as two dimensions (Peter et al., 2016), which in the case of the EBS is evident in the opposing dimensions of certainty and development. In the context of a theoretical background, Greene et al. (2008) pointed out that the nature of knowledge dimension (certainty and development) corresponds to personal ontology rather than personal epistemology. Schraw (2013) listed six methodological approaches (questionnaires, interviews, vignettes, essays, concept maps, and multi-dimensional scaling methods) that could be used to identify epistemic beliefs. Only one of these approaches was used in this study. It would be appropriate for the results of this study to triangulate (validate) with other approaches, even when considering the dangers of social desirability in the genesis of responses (Bartels & Magun-Jackson, 2009). As mentioned at the end of the previous section, the sociocultural context must be taken into account. The questionnaire was taken from a study that took place in the U.S. sociocultural environment. This environment differs significantly from the Czech environment in upbringing, education, and perception and intellectual understanding of the world, which are to some extent determined by culture and language (Hamamura et al., 2008). In this context, despite the rigorous methodological approach to the translation of individual items, it is possible that there was a semantic shift between the original and the translated version. It can be speculated that the interpretation of the meaning of individual items was strongly burdened by the context, e.g. Cam et al. (2012) attributed low values of internal consistency to cultural differences and weak translation.

An indisputable factor in most pedagogical research is the selection of a research sample. Despite our efforts and addressing all relevant universities, it was not possible to obtain all the relevant respondents. Therefore, we had to rely on convenience sampling.

The psychometric properties of quantitative self-report questionnaires continue to be discussed, as does the variability of empirical findings across studies and contexts (Greene et al., 2018).

6.2 Future directions

It was not the ambition of this study to create a specific series of recommendations for the educational reality; however, this is the direction that future research should take. In particular, we propose the search for links between epistemic beliefs and essential aspects of learning and teaching processes (academic achievement / performance, problem solving ability, argumentation, learning and teaching approaches, self-regulated learning, metacognition, and the proper use of research approaches, etc.). Specifically, for example, sophisticated epistemic beliefs of university students predict the quality of evaluations of contradictory scientific information, including the negative link between certainty and performance (Lang et al., 2021). At the same time, it is possible to research the strength of links between the dimensions of the EBS and other self-report questionnaires connected to related/similar disciplines (biology – Epistemic Beliefs in Biology – EBB questionnaire: Liang & Tsai, 2010; chemistry – Epistemological Beliefs Instrument towards Chemistry: Yildiran et al., 2011). Further research could also lead to a verification of the form of the EBS presented by us in other relevant demographic groups (e.g. students of exact sciences teacher training, or younger respondents, as the EBS was originally intended for 5th graders). It could also triangulate the results with other methodological procedures recommended in determining the epistemic beliefs of individuals.

Conclusion

The study presents the Czech form of the Epistemic Beliefs About Science self-report questionnaire, demonstrates its reliability, factor structure, and usability for the target group of university students of primary school teacher training and kindergarten teacher training. In the Czech environment, the EBS has a shorter form (18 items), but retains the same structure (source, certainty, development, and justification factors) as the original EBS.

To understand science, it is necessary to involve epistemic practices such as generating questions, suggesting procedures, collecting and interpreting data, generating claims and evidence, exposing conclusions to critical discussion, comparing ideas from alternative sources, analyzing contributions of others, and considering changes in ideas. There is a need to develop students' epistemic beliefs across ISCED levels by developing scientific arguments based on research processes and to provide students with many

opportunities to defend and debate the results of their own research (Akkus et al., 2007). This approach is not only tied to the domain itself, nor relevant to work in this domain; it is a general cultivation of the human mind. As Scharrer et al. (2012) showed, lay people are more inclined to accept ostentatiously simple arguments than more complex ones, are more confident in evaluating this information, and are less inclined to seek expert help after reading simple arguments as opposed to more demanding ones. We believe that the development of epistemic beliefs is not only important in the context of learning and teaching, but also for the functioning of an individual in a modern democratic society.

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Appendix A

Epistemic Beliefs About Science. Original items and Czech translation

Number of the item and dimension	**Original text of the EBS item (Conley et al., 2004, p. 202–203).**	**Czech translation**
# 1 S*	Everybody has to believe what scientists say.	Každý musí věřit tomu, co vědci říkají.
# 2 S*	In science, you have to believe what the science books say about stuff.	Ve vědě musíš věřit tomu, co o tom říkají vědecké knihy.
# 3 S	Whatever the teacher says in science class is true.	Vše, co učitel v hodinách přírodovědy říká, je pravdivé.
# 4 S*	If you read something in a science book, you can be sure it's true.	Když čteš něco v knize o přírodovědě, můžeš si být jistý, že je to pravdivé.
# 5 S	Only scientists know for sure what is true in science.	Jenom vědci s jistotou ví, co je v přírodovědě pravdivé.
# 6 C*	All questions in science have one right answer.	Na všechny otázky v přírodovědě existuje jedna správná odpověď.
# 7 C	The most important part of doing science is coming up with the right answer.	Nejdůležitější součástí bádání v přírodovědě je přijít na správnou odpověď
# 8 C	Scientists pretty much know everything about science; there is not much more to know.	Vědci poměrně všechno vědí dobře o přírodovědě – již toho není více k objevení.
# 9 C	Scientific knowledge is always true.	Přírodovědná znalost je vždy pravdivá.
# 10 C*	Once scientists have a result from an experiment, that is the only answer.	Jakmile mají vědci výsledek z experimentu, je to jediná odpověď.
# 11 C*	Scientists always agree about what is true in science.	Vědci vždy souhlasí o tom, co je v přírodovědě pravdivé.
# 12 D*	Some ideas in science today are different than what scientists used to think.	Některé současné myšlenky o přírodovědě jsou odlišné od těch dřívějších (co si vědci mysleli v minulosti).
# 13 D*	The ideas in science books sometimes change.	Myšlenky v knihách o přírodovědě se někdy mění.
# 14 D	There are some questions that even scientists cannot answer.	Existují nějaké otázky, na které ani vědci nedokáží odpovědět.

# 15 D*	Ideas in science sometimes change.	Myšlenky v přírodovědě se někdy mění.
# 16 D*	New discoveries can change what scientists think is true.	Nové objevy mohou měnit to, co si vědci myslí, že je pravdivé.
# 17 D*	Sometimes scientists change their minds about what is true in science.	Vědci někdy mění své názory na to, co je v přírodovědě pravdivé.
# 18 J	Ideas about science experiments come from being curious and thinking about how things work.	Informace z přírodovědných experimentů bádání vycházejí z toho být zvědavý a uvažovat nad tím, jak věci fungují.
# 19 J*	In science, there can be more than one way for scientists to test their ideas.	V přírodovědě existuje pro vědce více, než jeden způsob, jak testovat své nápady
# 20 J *	One important part of science is doing experiments to come up with new ideas about how things work.	Jednou z důležitých součástí přírodovědy je dělat experimenty pro nalezení nových nápadů o tom, jak věci fungují.
# 21 J *	It is good to try experiments more than once to make sure of your findings.	Je dobré zkoušet experimenty více, než jednou, aby se zajistila správnost výsledků.
# 22 J *	Good ideas in science can come from anybody, not just from scientists.	Dobré nápady ve vědě mohou vzejít od kohokoliv, nikoliv pouze od vědců.
# 23 J *	A good way to know if something is true is to do an experiment.	Dobrý způsob, jak poznat v přírodovědě pravdu, je dělat experimenty
# 24 J *	Good answers are based on evidence from many different experiments.	Dobré odpovědi jsou založeny na důkazech z mnoha rozmanitých experimentů.
# 25 J *	Ideas in science can come from your own questions and experiments.	Nápady ve vědě mohou pocházet z tvých vlastních otázek a experimentů.
# 26 J	It is good to have an idea before you start an experiment.	Je dobré mít názor před tím, než započneš experiment.

Note: S = Source, C = Certainty, D = Development, J = Justification; * Items resulting from the analysis, recommended for the Czech version of the EBS.

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THE ROLE OF PEER LEARNING AMONG UNIVERSITY TEACHERS IN INTEGRATING DIGITAL TECHNOLOGIES INTO HIGHER EDUCATION TEACHING

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ABSTRACT

The article is based on research aimed at exploring how teachers from the Faculty of Arts at Masaryk University integrated digital technologies into their teaching in connection with the transition to emergency remote teaching. The main research question was aimed at identifying the role played by peer learning among university teachers in integrating digital technologies into higher education teaching. The data were collected through in-depth semi-structured interviews with 34 teachers from the Faculty of Arts at Masaryk University in the fall semester of 2020. The results indicate that although teachers valued the support of a technological workplace, they more strongly considered consultations with and advice from their colleagues. I identified four main roles played by peer learning among university teachers in integrating digital technologies into higher education teaching. The roles are: offering emotional support, understanding needs, providing intelligible advice, and mediating experience. I also address two limitations to peer learning that need to be considered: the limited variety of technological tools and fragmented and unsubstantiated procedures. Studies have repeatedly shown that peer learning plays a long-term role in the process of integrating and adapting technologies into higher education; however, until now we have lacked information on the significance of peer learning for teachers in integrating digital technologies and on its limitations, both of which I address in this study.

KEYWORDS

COVID-19 pandemic, emergency remote teaching, higher education, university teachers, peer learning, digital technologies

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Introduction

The integration of digital technologies into higher education teaching has been a long and gradual process in which, until recently, some teachers participated willingly and others participated less readily or not at all (Naylor & Nyanjom, 2021). In the spring of 2020, there was a swift and extensive transition to distance learning as a result of measures to manage the COVID-19 pandemic, and digital technologies suddenly became a key tool for educators. This sudden shift has been referred to as "emergency remote teaching (ERT)" (Bozkurt & Sharma, 2020; Weidlich & Kalz, 2021). Scherer et al. (2021) used an international survey of university teachers to determine that the vast majority of teachers were explicitly instructed by their schools to switch to online teaching, with an average of less than seven days to prepare for this transition. In this study, I focus on how teachers approached the integration of technologies during the very difficult period of transition to ERT. I present the fact that although teachers valued the external support of a technological workplace, they gave greater consideration to consultations with and advice from their colleagues. I focus on the significance that individual peer learning roles have in integrating digital technologies, and I discuss their limits.

1. Integration of digital technologies into higher education teaching

The integration of technologies into teaching before the COVID-19 pandemic appears to have been low and therefore ineffective (Gronseth et al., 2010; Tondeur et al., 2012). Teachers have played and continue to play a vital role in incorporating technology into teaching. The integration of digital technologies into higher education has long been discussed (Baran, 2016; Buchanan et al., 2013; Ertmer et al., 2015; Schneckenberg, 2009) and teachers' lack of interest in e-learning and their reluctance to adopt online teaching have often been criticized and considered to be major obstacles (Rakes & Dunn, 2015).

Courses and workshops that are insufficiently designed to provide teachers with skills in the field of information and communication technologies were marked as a possible reason that teachers do not involve technologies in their teaching (Chukwunonso & Oguike, 2013; Wentworth et al., 2009). This reason was supported by a study by Baran (2016) indicating that workshops focused on strengthening IT competencies seem to be disconnected from the authentic teaching contexts of teachers. The results of a study by Mercader and Gairín (2020) indicated that the most widespread barriers are professional, and that the most obstacles are perceived in the arts and humanities.

This raises the question of how teachers can be encouraged to meet technological challenges and at the same time achieve the most benefit for themselves and their students. Downing and Dyment (2013) reported that the most beneficial strategy for learning with ICT was individual support from a technological workplace, followed by self-directed (informal) learning such as reading articles and books. It can be assumed that self-directed learning includes (or may include) activities involving peer learning between teachers, which could be beneficial for teacher development in this area (Baran & Correia, 2014). Georgina and Olson (2008) suggested maximizing teacher technology training by using the strategy of small group forums with a trainer. Collaboration in teacher teams is an important approach for facilitating the transition to distance learning (Downing & Dyment, 2013; Naylor & Nyanjom, 2021). Studies conducted by Ramlo (2021) and by Englund et al. (2017) offered different approaches, looking at how subjective teacher beliefs and teaching concepts interconnect with work with technology.

During the spring semester of 2020, teachers at universities faced an unprecedented situation in which full-time in-person teaching was cancelled and teachers and students had to look for ways to teach and learn effectively in unusual conditions. In their study based on an online questionnaire survey of 401 instructors, Alqabbani et al. (2020) reported that the majority of instructors at Princess Nourah Bint Abdulrahman University were actually ready to shift to ERT, which led to high perceived effectiveness. On the other hand, Scherer et al. (2021) assessed readiness for online teaching during the pandemic on a sample of 739 university teachers. Their study showed that most teachers lacked confidence, institutional support, or both. Alvarez et al. (2009) argued that in virtual teaching environments, teachers' roles increase, including planning and design roles, social roles, and instructive roles. They claimed that each of these roles has its own set of required competences, which explains why teachers felt that their workload remarkably increased after teaching moved online. The annotated findings of that study indicated that the situation associated with the transition to distance learning was challenging for teachers.

Liu et al. (2020) suggested that tool adoption is a complex process influenced by learning technologies, academics, context, and strategies. Faculty education and digital literacy initiatives, as well as structural factors including resource provision and technical support, need to be taken into account in order to optimally implement learning technologies. It is clear from these studies that the integration of digital technologies into higher education is proceeding, but not yet very successfully. Different expert sources have suggested various ways to support university teachers who have specific training needs in the process of integrating digital technologies into higher education teaching.

2. Peer learning among university teachers in terms of digital technologies

Peer learning is a reciprocal learning relationship among peers who have similar levels of expertise, for their mutual benefit (Boud et al., 2001). Reciprocity has been identified as a key component of peer learning (Boud & Lee, 2005). In this study, I describe peer learning among university teachers in relation to digital technologies; the teachers' ages and lengths of practice may vary. It has been emphasized that teachers learn in (mostly) informal, unplanned interactions with colleagues (Eekelen et al., 2005). Therefore, the importance of peer learning among university teachers has increased and is often associated with peer observations in teaching, the benefits of which have been extensively discussed (Hammersley-Fletcher & Orsmond, 2006; Hendry & Oliver, 2012; Hendry et al. 2013; Tenenberg, 2014).

The question now remains of what we know about peer learning in relation to technology. In their quantitative study of 87 faculty members (43 of whom responded), Sahin and Thompson (2007) highlighted self-directed informational sources and collegial interaction as the two most significant predictors of the level of technology adoption. Nicolle and Lou (2008) conducted a mixed methodology study using a quantitative survey (n = 117) and qualitative interview (n = 9). Their results, using a path model, indicated that peer support had a significant effect on mainstream faculty members' motivation to integrate technology into teaching and learning. Teachers spoke about peer learning as beneficial and enjoyable when the sharing of experience takes place in informal settings. Shattuck and Anderson (2013) discussed peer learning as communities of practice. The authors collected data using online, asynchronous, threaded discussion groups as focus groups and described communities of practice that create networks of practice: formal and informal, as well as internal (peer communities) and external (in workplaces/professional organizations) communities that support educational technology professional development.

Few studies have focused on peer learning in relation to the integration of technologies during ERT. In their study, Le et al. (2022) reported the interaction patterns of pandemic-initiated online teaching and how teachers from the English department at a university in Vietnam adapted to the situation. Those authors collected data from ten teachers and reported that the teachers received limited online training and had to learn by themselves how to engage students remotely. The results showed that teachers hope for support from a learning management system in their courses to provide peer support and mentoring and from an online community for sharing their best practices. A study conducted by Johnson et al. (2020) that focused on faculty experiences and approaches during the first weeks of the COVID-19

pandemic had similar results. In that study, 897 higher education faculty and administrators from the United States responded to a survey. The results indicated that the need for assistance was related to student support, greater access to online digital materials, and guidance for working from home. Peer support and mentoring were mentioned in open-ended comments related to other options that would be helpful during ERT.

These studies show that peer learning plays a long-term role in the process of integrating and adapting technologies into higher education teaching. During ERT in 2020, peer learning became one of the possible supports in technology integration. However, information has been lacking on the significance of peer learning for teachers and on what limitations emerge from this support. My study seeks to address this lack of information in terms of ERT.

3. Methodology

The presented data were acquired in the fall semester of 2020 for the Centre for Information Technologies (CIT) of the Faculty of Arts, Masaryk University (FF MU). The CIT aims to support FF MU teachers in the use of digital technologies for the needs of e-learning, providing them with educational and counselling services in this area. The aim of the research was thus to explore how teachers at FF MU integrated digital technologies in their teaching in connection with the transition to ERT during the spring semester 2020. In-depth semi-structured interviews with teachers across various workplaces and departments at FF MU were chosen as the method of data collection (n = 34). The rich data material raised several topics. The approach to teaching and technology integration revealed by this data is described in more detail in a study by Šeďová et al. (2021). This article focuses on another topic: the role of peer learning among university teachers in integrating digital technologies into higher education teaching.

3.1 Sample

The sample was created using the snowball method. The respondents gradually provided connections to more teachers who were interested in cooperating in this research and talking about their teaching experiences in the spring semester 2020. All the FF MU teaching workplaces except for three that did not respond to the requests for cooperation are included. The sample had one pair of teachers who taught their subject together. Most respondents were heads of individual workplaces at the faculty, but academics were also involved. It is important to emphasize that user competence alone is not a significant challenge for teachers and that they are diverse in their relations to technology, ranging from fascination to rejection. Yet it is possible to trace their inclinations

to one or the other pole, as shown in the table in the section on approach to the integration of technologies into teaching. I divided the teachers into those who had a rather reserved approach to the integration of technologies into teaching and those who perceived the integration of technologies into teaching as an opportunity. The representation of teachers is shown in Table 1.

Table 1
Description of the study sample

		Number of respondents	Anonymized identification of the respondent
Gender	Female	14	Adel, Anna, Ema, Ester, Hana, Karla, Libuse, Mia, Milada, Sarah, Simona, Tana, Vaclava, Virginia
	Male	20	Adam, Adam and Libor, Boris, David, Dusan, Filip, Frantisek, Gabriel, Igor, Johan, Karel, Leonardo, Matous, Patrik, Pavel, Petr, Radim, Tadeus, Vaclav, Vendelin
Position of employment	Managerial position	13	Adam, Boris, David, Ema, Hana, Filip, Leonardo, Matous, Milada, Patrik, Pavel, Radim, Simona
	Ordinary academic	21	Adam and Libor, Adel, Anna, Dusan, Ester, Frantisek, Gabriel, Igor, Johan, Karel, Karla, Libuse, Mia, Petr, Sarah, Tana, Tadeus, Vaclav, Vaclava, Vendelin, Virginia
Approach to the integration of technologies into teaching	Reserved	14	Boris, Dusan, Filip, Gabriel, Hana, Johan, Leonardo, Matous, Pavel, Radim, Tadeus, Tana, Vaclav, Vendelin
	Opportunistic	20	Anna, Adam, Adam and Libor, Adel, David, Ema, Ester, Frantisek, Igor, Karel, Karla, Libuse, Mia, Milada, Petr, Patrik, Sarah, Simona, Vaclava, Virginia

All the information and the respondents were anonymized, as agreed with the respondents at the beginning of the research. The sampling ended at 34 interviews, when each department (except the aforementioned three) was represented in the research group by at least one interview and at the same time the data began to show obvious signs of theoretical saturation, that is, when the emergence of new topics and information had stopped (Strauss & Corbin, 1998).

3.2 Data Collection

Given that the goal was to map the attitudes and thinking of actors in a new and previously undescribed social situation, a qualitative research methodology was chosen. An in-depth semi-structured interview was used for data collection. My colleague Katarína Rozvadská and I were the interviewers. The pre-prepared interview scheme contained a total of 30 questions. The interviews were conducted in the period from August to December 2020. The interviews were conducted face to face (27 interviews) or online via MS Teams (seven interviews). The average length of the interview was 90 minutes. The interviews were recorded on a dictaphone and then transcribed according to a uniform pattern into a text. The resulting data corpus contained more than 350 pages of text.

3.3 Research questions and analytical procedure

The interviews are a very rich source of data. In this study, I do not attempt a comprehensive analysis of the collected material, but focus on the following research questions:

1) What roles does peer learning among university teachers play in integrating digital technologies into higher education teaching?

The main research question was divided into two secondary ones:

1.1) What significance do these roles have for teachers?
1.2) What limitations emerge from peer learning?

I processed the data in ATLAS.ti software (version 8.0) using several coding procedures. First, I encoded several interviews using the inductive open coding method. I then divided the codes into two categories: *peer learning as support* and *teacher approach to learning with technology*. At the same time, I maintained the level of inductive coding and I marked all passages with more narrow codes chosen ad hoc in the process of open coding: *peer learning: mutual sharing; peer learning: content knowledge; webinars: disconnection from practice;* and *IT technicians: professional language*.

I then performed a comparative analysis across the interviews. By comparing the statements of different respondents, I identified four key roles of peer learning: *offering emotional support*, *understanding needs*, *providing intelligible advice*, and *mediating experience*. I sought the key aspects in which these roles were beneficial for teachers: *mutual support*, *saving time*, etc. I also sought to identify limitations, coded as: *limited use of technological tools* and *limited use of technological procedures*.

The results of this study are organized by first introducing the significance that the individual roles of peer learning have for teachers, and by then focusing on the limitations that emerge from peer learning.

3.4 Study limits

When reading the results, several limitations of this study need to be considered. First, teachers were involved in the research on the basis of their own interest and desire to talk about the topic; it can therefore be assumed that the sample mainly represents teachers who perceive themselves as good teachers who approached the pandemic conscientiously and looked for ways and means to learn in this difficult situation.

The second limitation is that the data capture only the teachers' own view of their learning during the pandemic. This is a consequence of the fact that the primary goal of the research was to obtain information about a situation that had already happened at the time of data collection as the intention was to obtain data on teaching in the spring semester 2020, and it was necessary to report on teaching retrospectively.

The third limitation is the lack of observational data from teaching. It is not possible to determine whether the technologies were really integrated. Here, research based on observation of higher education is relatively rare, as academics are afraid of "making" their teaching practices "visible" (Marek, 2009).

4. Results

4.1 Significance of individual roles

Although the teachers consistently asserted that the support from the technological workplace at the time of the emergence of remote teaching was adequate, they also repeatedly stated in their interviews that they turned to their colleagues for support. Although the support of the technological workplace was appreciated, it did not meet all the needs of the teachers. In the results, I elaborate on the individual roles that peer learning plays in integrating digital technologies into higher education teaching and show the importance of those roles for teachers. The roles are as follows: offering emotional support, understanding needs, providing intelligible advice, and mediating experiences.

4.2 Emotional support

Offering emotional support refers to mutual verbal support or sharing concerns during a challenging situation. The importance of this role is considerable for teachers and was repeatedly emphasized by the respondents. The important aspect is that teachers can share their concerns together; they understand each other and therefore they may then dare to take the next step in the process of integration. Tadeus described this importance of this role:

> It was difficult. I was quite influenced by an article that a colleague from an American university shared. [...] About not worrying so much about it and that it will definitely not be perfect, and that we should not be stressed. And that helped me, because when I started listing what would change, I was a little scared.

In this statement, Tadeus recalled the early days of teaching affected by the COVID pandemic. It was not important for him to immediately find ways to integrate technology into teaching, but he wanted to share in the fears and anxieties that the new situation brought up. He therefore mentioned an article that his colleague had shared that was focused not on how to integrate technology, but how to "survive" the whole situation. The statement "that it will definitely not be perfect, and that we should not be stressed," shows that the first step was not to prepare excellent teaching, but to prepare for a challenging situation.

Another aspect to the role of offering emotional support was described by Ema: "We recorded something yesterday and then we couldn't find it, then we didn't know what we recorded, where we put it, so it was a bit hilarious… like I cannot say that we did not have a good time after all." As in the previous situation, we see the power of mutual sharing. This time, the respondent had consulted with her colleagues on the specific procedure of integrating technology into teaching, more precisely, recording the lesson. Even though the situation was difficult ("we couldn't find it, then we didn't know what we recorded" etc.) the power of mutual sharing managed to turn a desperate situation into a fun one and Ema was able to continue in the process.

Igor's statement presents his communication with a colleague about concerns connected with the further use of technology in teaching:

> You know what, I still don't really know if it's better for me sitting in front of my laptop or if it's better to be in front of an empty classroom with a camera. [...] I was talking about it with a colleague from Olomouc and I asked him what it was like, and he said: "Absolutely horrible, my friend. [...] You're talking to the camera, like in an empty classroom, you pretend that there are students, they're not there, now you're just nervous about it and now imagine that it's recorded somewhere." So… yeah, at this point, I am determined to teach online, synchronously, without recording.

Initially, Igor was not sure if he wanted to record his teaching this way. At the university at one point, the possibility of recording teaching using this approach had expanded. But Igor was considering that this might not be the best way for him. He sought some kind of support for his attitude and

understanding. To find support, he discussed it with his colleague who had a similar attitude and a bad experience. Igor decided not to use this approach, and he found another way to proceed with teaching that fit him better.

4.3 Understanding needs

Understanding needs is linked to the fact that teachers either know each other's teaching or, because they teach themselves, they know the context. As a result, they know exactly how to offer tips on dealing with a particular technology or on which technology tool to use. These tips are tailored and are very time-efficient. The situation was described by Mia:

> So I attended a webinar, it took an hour and a half and it felt like it wasn't enriching for me at all. [...] So the problem with that is that you just have to spend that real time, an hour and a half, and then you don't find out anything you needed and that just reliably discourages me. I appreciate what my colleague did, for example, that you tell him, I need exactly this, and he'll show you exactly that.

Mia contrasts her participation in a webinar with her experience of getting advice from a colleague. Unlike attending the webinar, which was time consuming and did not meet Mia's teaching needs, consulting with her colleague proved effective. Her colleague knew the context of her teaching and provided the specific procedures she needed. Because there are so many options, it can be very time consuming for teachers to seek the right one for themselves. It is easier to ask a colleague who can provide precise advice and instructions.

Karla commented on the situation in terms of technical as well as pedagogical needs in communication with colleagues:

> And we didn't even talk about the technical support; instead, we talked about the pedagogical part. [...] So it was like the bigger challenge than the technical one. That means that when I have a question, I know which colleague to turn to, because he has some kind of mandate to actually advise me.

Karla described a situation in which the sharing of various technological procedures took place within a group of colleagues. As we can see in her statement, the technical problems were not the crucial ones. It was much more important for Karla to link the technical side with the pedagogical side, which was a need that her colleagues could help her with pretty well. At the moment when Karla turned to one of her colleagues, she considered not only whether the person was able to work with technology, but also whether they were able to provide her with advice on the teaching process.

Under these circumstances, it will not surprise most readers that some teachers subsequently proceeded to create guidelines for integrating technologies into teaching according to their experience. Libuse commented on the situation:

> At home, I made some instructions for my colleagues on how to click on something in the informatics system. [...] So I actually made them like the printscreen with the red wheel and click here. [...] And I know that some colleagues really did the online lesson, because the students wanted to.

This statement shows that the shared instructions for other colleagues in this case did not concern any sophisticated instructions on how to use specific digital technologies in teaching, but rather instructions and procedures in the information system of Masaryk University. We can also look at the situation from Dusan's perspective: "For us, actually everything was prepared by our colleague, a younger colleague. He began to instruct us because he had experience with it, because he had already worked with it in some way." Dusan described how instructions were prepared for him by a colleague. Filip described a similar experience in which he communicated with secondary school teachers about the tools used online, as he educates future teachers himself and wanted them to learn to work with a platform that they would use in practice later on. Based on the knowledge of their colleagues' teaching practices and the ability to understand their needs, the provided advice could become "tailor-made."

4.4 Providing intelligible advice

Providing intelligible advice refers to advice and procedures that are shared among teachers using "the same language" and avoiding the uncomfortable situation of not understanding the language of IT specialists. Vaclava said:

> It's not that I have never hear the word "stream" or that I have never registered the foreign expressions that these young people normally work with, but… [...] For me as a user, the training should probably be, sorry, more human. The IT terminology makes me terribly anxious. [...] Because I always scare myself, "God, what do they want from me?"

It might seem that problems with terminology and technology integration would now typically be experienced more by older teachers for whom the language of the technicians may be distant. However, this was not the case. The problem of mutual understanding repeatedly arose with all ages in the procession. Although Vaclava was a teacher with more than 20 years of experience at the university, the problem was not only in ignorance of the

terms, as described, but in the fact that teachers were not able to think in the IT language, nor to understand it and learn in it. Adam described the situation in a similar way:

> Sometimes even in that rhetoric, for example, in the instructive text, I often have to find out what exactly a term means, because after all, it is different when you work in it and develop those things, so it seems very obvious and simple to you, but when the recipient encounters it rarely or for the first time, it is necessary to spend a lot of time understanding how it's done.

Adam, like Vaclava, described how incomprehensible texts are to him and, of course, also time-consuming as individual terms need to be defined. Unlike Vaclava, Adam was speaking of written materials. A colleague's language often seems more user-friendly and comprehensible to teachers, as Libor put it: "I had this mainly from a colleague, therefore pre-chewed, because otherwise I probably wouldn't have made it, as I said, and I still teach at the grammar school." Libor described how the explanations from colleagues became increasingly welcome for him. The comprehensibility of the language presented a time saver for him, as he did not have to spend a lot of time thinking about what each term meant.

4.5 Mediating experience

Mediating experience allows teachers to directly try shared procedures or see their use in teaching. Matous commented: "I have no problem telling him, 'If you have five minutes, come show me' and he tells me, 'Now I tried this here and it just worked for me.' And the little I've picked up, I'll share with my colleagues in turn." Matous described the advantage of being able to meet with a colleague and try the described procedures. At the same time, he described mutual learning and stated that he would not have a problem working in the same way with a colleague. Similar experiences were shared by Gabriel: "I wrote to a few colleagues in person [...] and a couple of times, as colleagues, I helped put some things into the presentations and we started some recording. So yes, we helped each other." The value of the opportunity to try out different technological practices is undeniable.

Peer learning does not necessarily take place in direct interaction. Due to the pandemic, the materials that teachers prepared for teaching became more "visible" to others and their teaching became more accessible. Teachers could therefore share recordings of their teaching and learn from them: "And that's how I managed to create several types of output, which was also practical, and I probably wouldn't have thought of it without looking at what other teachers were doing." (Sarah) Sarah was describing a situation in which she observed a recording of another teacher's teaching and imitated the procedures

she saw, thus integrating not only various technological tools, but also teaching methods. This was also described by Peter:

> Such a course was offered for free at the faculty, at the Faculty of Law in Olomouc, and it was just like that, he inspired me with the style that they are like those lessons, such as law, and they are also divided into such short blocks so that one does not have to stare at it. So I was inspired by this, as well.

Peer learning thus takes place not only face to face, but also through the sharing (in this case) of instructional videos, on the basis of which teachers learn intuitively (imitation).

Adam also talked about the possibility of using instructional videos from other teachers for inspiration:

> If it were possible to process it with a demonstration or something like that, if it were possible to actually see what can be done, what it looks like, what it leads to if something like this succeeds, I think it would be useful.

Adam thus described a situation in which it would be possible to evaluate what tools could be used on the basis of the recording and to look at what effect the tools have in teaching. Peer observation of teaching can lead to its improvement; at the same time, it is much more understandable for teachers than instructions and recommendations prepared by technicians. This is mainly because teachers understand each other's teaching practices and can subsequently implement the observed procedures or can consult with colleagues. Yet, it is essential to realize that while peer learning has significant benefits, it also has visible limits, as addressed in next section.

4.6 Limits of peer learning

In the following lines, I address the two identified limits that peer learning entails and that need to be considered. The *limited variety of technological tools* indicates that although many teachers in the sample were not technological dilettantes, they were not full experts. Their knowledge of technological tools remains limited as they share and recommend or discourage their use. The *fragmented and unsubstantiated procedures* indicates that the procedures shared between teachers were limited by their knowledge of the tools and often remained at a basic level.

1) *Limited variety of technological tools:* Adel said: "They say it's better over Zoom than over MS Teams. So I'll try Zoom. Because not only do I actually teach, but now I will even have an interview with a supervisor via Zoom." Teachers shared tips on different technological tools and applications that they adopted from each other, often not seeking other options. Just as

positive experiences were shared, so were negative ones, as teachers established for each other what worked and what they used. An interesting moment occurred when one teacher shared an experience that did not work for him. Virginia said:

> A colleague said that he was trying to record in the room… yeah normally in the room where the lessons were supposed to take place, but just lecturing for the empty chairs, so it wasn't quite the thing, yeah so he left it and just went straight to a PowerPoint recording, so we more or less did it all the same.

Virginia described the situation in which her colleague tried to record a lecture for the students at the faculty. This was during a time when the students were not allowed to enter the building and some teachers made recordings in empty classrooms. Virigina's colleague's experience was not good; Virginia then stated that the teacher abandoned the process and the other teachers followed. If the tools that teachers tried at the beginning of pandemic worked, they often remained unchanged, at least in part.

2) *Fragmented and unsubstantiated procedures:* At a time when teachers were not aware of the wide range of possible technological tools, they certainly did not know the variations of the different procedures. In such circumstances, procedures that are adopted can become fragmented and reproduce unsubstantiated assumptions about what procedures are desirable and effective. Vaclava said:

> Speaking for myself, I thought that if I could handle the lowest level, I would be able to sign up for that meeting in some way, organize it in some way and provide students with some materials [...] that would be enough for me.

Vaclava described the situation when she learned some basic procedures with technological tools; she described it as sufficient. Milada described a similar situation: "A colleague and I made short PowerPoint presentations [...] but at the moment when I was recording, I got stuck on every other word. [...] and I didn't figure out how, in that PowerPoint, how to manage the timing. Maybe there's some technical…way but I just didn't discover it." Milada was describing the situation in which she and her colleagues collaboratively prepared study materials for students by recording PowerPoint presentations; however, this had the disadvantage of requiring repeated recordings due to frequent speech errors. Boris described the situation as "We will keep doing the same thing until the end and we will not create anything." This could be interpreted as reflecting not only a limited knowledge of more precise procedures, but also as a limited will to learn new procedures.

5. Discussion

The aim of this study was to describe the role of peer learning in the process of integrating digital technologies into higher education teaching and show what significance it had for teachers and what limitations this way of learning entails. It is important to highlight that the context of this study was during a period of ERT that placed a greater time burden and a greater degree of stress on teachers than traditional full-time teaching (Marek et al., 2021) and during a time when teachers had only limited space to develop their technological competences (Cameron-Standerford et al., 2020).

I identified four main roles that peer learning among university teachers plays in integrating digital technologies into higher education teaching. *Offering emotional support* refers to mutual verbal support in a challenging situation, encouraging teachers to take the next step in the integration process. *Understanding needs* is when teachers share tips and the support is tailored and very time-efficient, as teachers know the context of each other's teaching. *Providing intelligible advice* refers to advice and procedures shared among teachers using "the same language" and avoiding the uncomfortable situation of not understanding the IT specialists. *Mediating experience* allows teachers to directly try shared procedures or see their use in teaching.

I also addressed two limitations that peer learning entails. The *limited variety of technological tools* refers to the fact that although many teachers in the sample were not technological dilettantes, they were also not full experts. As a result, their knowledge of technological tools remained limited as they shared and recommended or discouraged their use. The *fragmented and unsubstantiated procedures* indicates that the procedures shared among teachers were limited by their knowledge of the tools and often remained at the basic level.

The question arises as to how to relate the results to the findings of other researchers. Studies have long suggested that one reason technologies are not integrated into higher education is insufficiently designed courses and workshops (Baran, 2016; Chukwunonso & Oguike, 2013; Wentworth et al., 2009). Eekelen et al. (2005) reported that teachers learn in (mostly) informal, unplanned interactions with colleagues and described their learning as non-linear; Sahin and Thompson (2007) and Nicolle and Lou (2008) observed collegial interactions to be significant predictors of the technology adoption level. The results of this study confirm these findings. In contrast to webinars and other sources of support, in peer learning teachers perceive mutual and targeted support that happens to be effective for them. I consider the fact that teachers cannot find "the same language" with the IT technicians who generated most of the support for teachers to be an important finding. Webb et al. (2002) showed that in order for the help offered to the learner

to be beneficial, the learner must understand the explanation, have the opportunity to apply what they understood, and use this opportunity. In this context, Horsburgh and Ippolito (2018) argued that it is important to think in the language of a particular discipline.

Studies focused on peer learning in relation to the integration of technologies during ERT are still rare. Le et al. (2022) showed that teachers hoped for the support of a learning management system in courses, to provide peer support and mentoring, and for online communities to share their best practices. A study by Johnson et al. (2020) showed that peer learning was a sought-after source of support and that it had clear benefits for teachers. This can certainly be agreed, but it is essential to realize that while peer learning surely has significant benefits, it also has visible limits. At a time when teachers are looking for support among themselves, there is a high risk that they will be left with limited opportunities to use technological tools as well as insufficiently learned procedures that specialized IT technicians would be able to pass on. In addition, teachers may share mistrust for certain technological tools and practices and thus not integrate technologies into teaching effectively, or only at the basic level. Lintner (2020) mentioned the use of social network analysis to examine teacher relationships and also their collaboration. As far as we know, teachers are diverse in their relations to technology, ranging from fascination to rejection; it would be interesting to look at how networks between teachers work (or are created) and whether teachers create networks among other teachers with the same attitudes and how this further shapes their professional development.

Conclusion

This study presented teachers' approaches to integrating digital technologies into higher education teaching during ERT. Teachers used peer learning as a main source of support. I identified four roles of peer learning and its significance for teachers as well as its limitations. This study can be seen as contributing to the debate on conducting webinars and offering support for higher education teachers in integrating technologies into their teaching. However, it is important to recall that the study is based on data that reflect a period of ERT and that teachers quite logically looked for the most effective and easiest way to teach in this challenging period.

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