

Development of University Teachers' Professional Vision of Students' Prior Knowledge During a Short Pedagogical Training

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To support university students' learning, teaching should build on students' prior knowledge. Therefore, teachers need skills to pay attention to students' knowledge in teaching-learning situations. Teachers' underlying conceptual knowledge affects the way they see and interpret situations in classrooms, which is called professional vision. This study examined university teachers' ($N = 53$ from different faculties, current and future faculty) professional vision and misconceptions from the perspective of the role of prior knowledge in learning, when watching and interpreting short videos of teaching-learning situations at the start of and after a short pedagogical training. Additionally, participants' conceptions, beliefs, and approaches to teaching and learning were investigated with a questionnaire. The results show that before the training, there were differences between the teachers from different faculties, but after the training all the teachers scored better in their professional vision concerning prior knowledge. Prospective teachers' professional vision developed even more than those of current faculty. Furthermore, more developed professional vision was related to more constructivist beliefs of learning. The results show that even short pedagogical interventions can improve teachers' pedagogical vision. Pedagogical implications of the results are discussed.

In order to improve the quality of higher education, more attention needs to be paid to the quality of teaching and thus to the availability of teachers' pedagogical education (European Commission [COM], 2011, 2016). Attending pedagogical training has often been available solely for university staff who already have university teaching duties, excluding doctoral students, who may receive teaching duties in their near future. This leads to a typical situation where new faculty begin teaching at the university without any pedagogical training (Knight, 2002), which may also make their first teaching experiences unnecessarily difficult and emotionally burdensome. A lack of pedagogical education may have harmful consequences for teachers' conceptions of teaching, such as forming transmissive beliefs about the teaching-learning process and a content-focused approach to teaching rather than constructive beliefs on learning and a learning-focused approach to teaching (Postareff & Lindblom-Ylänne, 2008). Previous research has shown that pre-service and novice teachers tend to have limited understanding of the role of prior knowledge in learning (Meyer, 2004). Prior knowledge that contradicts the knowledge to be acquired typically hinders learning; hence, instructional support is needed to reach scientific understanding (Vosniadou, 2013). However, novice teachers seem to be more willing to change their conceptions related to learning and teaching than teachers with more teaching experience (Postareff & Nevgi, 2015; Vilppu et al., 2019), implying that pedagogical training should ideally be available to novice teachers even before their first

teaching tasks. New digital solutions, such as the Finnish platform UNIPS (University Pedagogical Support), which was used in the current study, offer universities ways to organize short pedagogical trainings for a larger number of participants, allowing pre-service teachers to attend as well. However, more evidence is needed if these typically short trainings are able to foster teachers' pedagogical expertise development.

Teaching is a complex cognitive skill that is determined by the nature of a teacher's knowledge system (Livingston & Borko, 1989), requiring the transformation of subject-matter knowledge into forms that are pedagogically powerful yet adaptive to the variations in ability and background presented by students (Shulman, 1987). The theory of teachers' professional vision (Sherin, 2001, 2007) suggests a tool for examining how teachers notice the conditions that may hamper students' learning. Probably the most important one, and the focus of this particular study, is teachers' ability to notice the role of students' prior knowledge in teaching-learning situations. Prior knowledge has been shown to be one of the most central factors in students' knowledge-building processes despite being poorly understood by teachers (Meyer, 2004); thus, it should also be at the center of teacher education and teachers' later actions. Nevertheless, the relationship between higher education teachers' professional vision and their beliefs and conceptions of learning together with approaches to teaching and learning is still a neglected research area in higher education.

Teachers' Professional Vision of Prior Knowledge

Even in short sequences of classroom teaching, a myriad of teaching and learning acts occur. Some are particularly important for student learning while others are not. Seeing and understanding the meaning of classroom events appears to be paramount for effective classroom management and instruction (Doyle, 1985). Previous analyses of teaching have suggested that effective teachers make use of finely tuned observational skills and perceptual abilities in their teaching (Carter et al., 1988). In this vein, the situations and events teachers direct their attention to while observing a classroom sequence serve as the first indicator for the activation of teacher knowledge (Seidel & Stürmer, 2014).

A promising indicator for "integrated" teacher knowledge can be found in the concept of professional vision (Goodwin, 1994; Seidel & Stürmer, 2014). In our research, we draw on Sherin's (2001, 2007) conceptualization of teachers' professional vision, including two main subprocesses: (a) noticing and (b) interpreting a particular situation. Hence, for teachers, professional vision is the skill of noticing and interpreting relevant pedagogical incidents and features of classroom situations (van Es & Sherin, 2002). Noticing entails processes of selective attention in the complex classroom environment, where several things compete for the teacher's attention; it is the knowledge-guided identification of those significant classroom teaching and learning situations with the potential to influence student learning (Blomberg et al., 2011). Teachers' professional vision affects instructional quality and student learning (Kersting et al., 2012; Sherin & van Es, 2009). As a knowledge-guided process (Palmeri et al., 2004), professional vision is comprised of skills like perception (noticing) together with related interpretations that are connected to one's beliefs, knowledge, and conceptions (Ericsson & Pool, 2016; Meschede et al., 2017; Roose et al., 2019; Stürmer et al., 2013). High-level professional vision is assumed to act as an indicator of more sophisticated, professional opinions about the learning required for teachers to respond flexibly to students' understanding and reasoning at any given moment (Berliner, 2001). Nevertheless, there are relatively few studies related to higher education teachers' professional skills in focusing on relevant incidents in classrooms and supporting the learning of their students accordingly (see Seidel & Stürmer, 2014).

Findings from research have shown that well-developed professional vision is primarily a characteristic of experienced teachers (Berliner, 1991; Pouta et al., 2020; Wolff et al., 2017). The differences between expert teachers and novices show that experts tend to explain and evaluate classroom events, whereas novices often only describe them (Wolff et al., 2015).

Furthermore, experts "were shown to engage in deeper, knowledge-based interpretations about the visual evidence they perceived" (Wolff et al., 2017, p. 297). Future or novice teachers, in contrast, are typically less able to identify relevant events and to predict their effects (Seidel & Prenzel, 2007). They also tend to describe classroom situations in a rather limited way using 'naïve' concepts, such as considering learning as "assimilation of knowledge" (Carter et al., 1987; Wolff et al., 2017).

Nevertheless, it is assumed that professional vision is an ability that can be learned (Carter et al., 1988) and that the foundation for its development is laid in teacher education. The acquisition of underlying conceptual knowledge that colours the way we see and interpret situations can be considered a key element of teacher training (Cochran-Smith, 2003; Darling-Hammond, 2006), especially among teacher candidates who have not yet gained classroom teaching experience. However, the empirical evidence for this assumption is weak, particularly in the higher education context.

Teachers' Beliefs and Approaches in Teaching and Learning

According to Richardson (1996), beliefs can be defined as understandings or premises that are personally felt to be true. In teacher education research, two underlying beliefs about teaching are often distinguished (Pajares, 1992; Staub & Stern, 2002). University teachers' beliefs about teaching have been found to vary between viewing teaching mainly as transmitting knowledge from the teacher to the students and teaching as facilitating learning that builds knowledge based on one's own understanding to achieve conceptual change if needed (Kember & Kwan, 2000; Prosser et al., 1994; Samuelowicz & Bain, 1992, 2001). According to a more traditional, transmissive view, teachers are expected to simply transmit correct knowledge to students who passively receive this knowledge (Kleickmann et al., 2016; Voss et al., 2013). Typically, teachers with this idea consider their most important task as teachers to offer "the right" information to students. Thus, the teacher focuses on delivering information, producing materials and keeping timetables to ensure that all planned topics are dealt with in a lecture and to cover all that is known about the subject. Therefore, any interruptions, questions, and discussions are often seen as time wasted instead of fruitful learning situations.

In contrast, the constructivist belief implies that students take an active role by individually processing and constructing new knowledge (Staub & Stern, 2002). The latter also includes a conceptual change-oriented belief, that is, the belief that students hold initial preconceptions of phenomena to be studied that are often not consistent with current scientific views. A teacher

with a more constructivist view is also more flexible in adapting to students' needs relating to their prior knowledge in learning-teaching situations and understands that each learning-teaching situation is unique by nature, necessitating that the instructor be able to modify lecture plans on the fly. The teacher with a constructivist view sees the role of the teacher as more of a facilitator for individual learners' development instead of an omniscient knowledge transmitter.

According to previous studies, the cognitive schemas of expert teachers are typically more elaborate, more complex, more interconnected, and more easily accessible than those of novices (Livingston & Borko, 1989). As yet, research examining changes in higher education teachers' beliefs during education is still scarce and ambiguous. While there are results indicating that in-service teachers hold more constructivist and less transmissive beliefs than prospective teachers (Meyer, 2004), Lui and Bonner (2016), who compared in-service and pre-service teachers' beliefs about teaching and learning, found more constructivist than transmissive beliefs in both groups and an even higher score in constructivist beliefs for pre-service teachers compared to in-service teachers. Regardless, teachers' beliefs are assumed to serve as filters for their professional vision, meaning that teachers observe and interpret classroom events based on their existing beliefs, conceptions, and experiences about teaching, subject matter, and students' learning (Borko & Putnam, 1996; Pajares, 1992). Previous research findings have suggested that teachers' classroom video observations and interpretations are very likely to be guided by their beliefs, conceptions, experiences, and understandings of teaching (Brophy, 2004; Schoenfeld, 2011; van Es & Sherin, 2008).

Furthermore, teachers' beliefs about learning and teaching provide the background for teachers' approaches, meaning the sets of practices and strategies that will be implemented in their own teaching (e.g., Entwistle & Walker, 2000). Previous research among higher education teachers distinguishes between two qualitatively different approaches to teaching: the content-focused approach and the learning-focused approach (Postareff & Lindblom-Ylänne, 2008; Trigwell & Prosser, 1996a). In the content-focused approach, the teacher's focus is on transmitting information, whereas a teacher with a learning-focused approach understands learning as an active knowledge-building process based on one's previous knowledge. Teachers who hold a particular instructional belief tend to adopt a corresponding approach to teaching (Kember & Kwan, 2000; Trigwell & Prosser, 1996a). Thereby, teachers who perceive teaching primarily as a process of transmitting knowledge tend to adopt a content-focused approach to teaching. They are also more likely to focus on the whole class and give examples and illustrations from their own experiences. Teachers who conceive

teaching as helping students to construct their own understanding, on the other hand, tend to adopt a learning-focused approach to teaching. They encourage students to discover knowledge on their own through interactions, managing the needs of individual students, for example, by paying attention to possible misconceptions and utilizing the students' prior knowledge and experiences in their teaching. Although some teachers have been shown to describe approaches to teaching that are more content-focused than could be expected from their reported beliefs of teaching, the correspondence between beliefs and approaches has been shown to be around 90% (Kember & Kwan, 2000).

Previous research has shown that there are disciplinary differences in approaches to teaching and beliefs of teaching (e.g., Lindblom-Ylänne et al., 2006; Lueddeke, 2003; Trigwell, 2002). Lindblom-Ylänne et al. (2006) found that university teachers working in hard sciences, such as mathematics or biology, scored significantly lower on the student-centered scale than teachers of soft sciences, such as history or education. These findings are in line with a study of Lueddeke (2003), which indicated a significant difference between discipline and the type of teaching beliefs held by a teacher. However, there are also disparate research results, as Kember and Gow (1994) and Stes et al. (2008) did not find any obvious relationship between disciplines or beliefs of learning and teaching among university teachers. Differences found between the disciplines may thereby originate in the fact that disciplines have their own unique characteristics and challenges related to learning and teaching that may influence adopting certain approaches to teaching and learning. Furthermore, because different disciplines are taught in different departments, variations in teaching might result from variations in departmental culture (Knight, 2002; Knight & Trowler, 2000).

Challenges for University Teaching and the Organization of Pedagogical Training

The instructional challenge at universities also includes that students come to the classroom full of expectations, prior knowledge, and conceptions that, in some cases, significantly contradict the scientific view; often, these preconceptions do not facilitate learning but may rather lead to systematic misinterpretations (Ahopelto et al., 2011; Murtonen et al., 2018; Södervik et al., 2019; Södervik et al., 2020). The quality of students' pre-instructional conceptions plays a critical role in learning (Bransford et al., 2000), and an essential part of teacher expertise is to become aware of them. Teachers should pay attention to students' prior knowledge when designing their teaching and provide opportunities for the students to test and discuss their prior conceptions, which could again support students in

noticing and revising their earlier misconceptions. Thus, prior knowledge, which is a necessary prerequisite for all conceptual learning, may enable learning when it is in unison with the new knowledge to be learned or it may hinder or even prevent learning if there are discrepancies between new knowledge and one's pre-conceptions (diSessa, 2006; Vosniadou, 2013). Understanding this effect on learning is a crucial part of teacher expertise. Hence, the goal of education, teaching for understanding, cannot be achieved without a consideration of students' initial understanding of content knowledge.

In order for teachers to understand their students' learning processes, the teachers need pedagogical knowledge. In many countries, pedagogical training has increasingly been offered but mainly for university staff with teaching duties; although empirical evidence exists that provides early support for new university staff via pedagogical training, opportunities targeted at supporting doctoral students would be remarkably beneficial (Vilppu et al., 2019). The demand for new types of training has led to the development of digital platforms for university staff and doctoral students to study pedagogy. In Finland, a platform called UNIPS has been developed in collaboration with eight universities. The environment is open to all university staff and doctoral students for self-study and includes short, guided modules of one study credit (ECTS) each (Laato et al., 2018).

There is evidence from research that teachers' conceptions of teaching and their approaches to teaching can be developed through pedagogical training. Nevertheless, it seems that profound changes require relatively long-duration courses, such as those extending over one academic year (Postareff et al., 2007; Stes et al., 2010). Shorter pedagogical trainings have also been reported to have positive effects but mostly for teachers with only a few years of teaching experience (Ödalen et al., 2018; Vilppu et al., 2019). More experienced teachers seem to require longer and more difficult processes to change their beliefs and intentions towards a more learning-focused direction (Ertmer, 2005; Lueddeke, 2003; Marsh, 2007; Postareff & Nevgi, 2015; Rienties et al., 2013). Overall, pedagogical training seems to have positive effects (Stes et al., 2012; Trigwell et al., 2012). Although some evidence exists that online courses can support learning if they promote self-regulation skills and facilitate collaborative learning (Teräs, 2016), there is a need for research-based understanding related to developing effective online pedagogical training in order to support university teachers' pedagogical expertise. Thus, in this field of competing views, it is important to know what kind of pedagogical training effectively supports pedagogical competencies of university teachers with different beliefs and conceptions about learning, different

disciplines, and a varying amount of teaching experience.

Aim of the Research and Research Questions

Although the role of prior knowledge in conceptual learning is well known in general, there is still relatively little knowledge about how university teachers understand the role of their students' prior knowledge. Thus, the aim of the current study was to explore university teachers' (current vs. future faculty) professional vision and potential misconceptions from the viewpoint of students' prior knowledge. In addition to professional vision, teachers' misconceptions about prior knowledge were examined. We were also interested in disciplinary differences and whether short online pedagogical trainings can affect participants' professional vision and reduce their misconceptions. Thus, the research questions of the study were as follows:

1. What are the initial levels of teachers' (a) professional vision and misconceptions of prior knowledge measured via a classroom video task, (b) self-reported beliefs in teaching and learning and ability to use student-activating teaching methods, and (c) self-reported approaches for teaching and learning?
 - 1.1. Are there differences in these aspects between current and future faculty?
 - 1.2. Are there differences in these aspects between teachers from soft versus hard sciences?
2. How do teachers' (a) professional vision and misconceptions of prior knowledge and (b) self-reported beliefs in teaching and learning and ability to use student-activating teaching methods develop during a short online pedagogical training?
 - 2.1. Are there differences in changes between current and future faculty?
 - 2.2. Are there differences in changes between teachers from soft versus hard sciences?

Methods

Participants

A total of 53 (women $n = 36$; men $n = 17$) consisting of current ($n = 33$) and future ($n = 20$) higher education teachers from one Finnish university participated in this study in 2017. The future faculty here means doctoral students who had no teaching experience at the university, but who can be involved in teaching duties in the near future. In contrast, the current faculty had teaching duties and/or teaching experience from at least one academic course. The participants represented seven different disciplines, but to guarantee participants' anonymity and to be able to compare the results to those

of previous studies on disciplinary differences (Lueddeke, 2003; Trigwell, 2002), the faculties were grouped into two larger entities: (a) medicine and natural sciences ($n = 27$) and (b) soft sciences ($n = 26$; i.e., economics, law, humanities, educational sciences, and social sciences). A third of the participants ($n = 18$, 33%) had previous education in university pedagogy or instruction. Participants' previous pedagogical education varied from a course worth 1 ECTS to the 60 ECTS of official pedagogical studies.

Ethical Issues of the Study

Participation in the study was voluntary, and informed consent was obtained from the participants. At the university where the study took place, attending pedagogical training was optional, so the participants had enrolled in the courses of their own accord. The study was conducted according to ethical regulations and ethical review statements from the Ethics Committee for Human Sciences of the context university admitted for the UNIPS project.

UNIPS Environment

The UNIPS digital platform has been designed to support university teachers' and doctoral students'

pedagogical development. The materials are open, so teachers can get support for their teaching through self-study whenever they need, or they can participate in small modules of 1 ECTS. Several modules can be offered simultaneously; usually, it takes six weeks to complete a module. During the current study, each participant enrolled in one to three simultaneous UNIPS modules (1 ECTS per module): 17 participants (32%; future faculty teachers $n = 7$) took one module, 14 participants took two modules (26%; future faculty $n = 7$), and 22 participants (42%; future faculty $n = 6$) took all three modules offered simultaneously (see Table 1).

Each course was structured in the same manner. First, there was an independent study phase, in which the participants utilised self-study materials, such as video lectures, journal articles and glossaries, and then wrote an essay reflecting on their own ideas of the themes of the materials. After the independent study phase, the participants were divided into small groups of four to six, where they shared and commented on each other's essays online. The role of the teacher during these courses was merely to read and give feedback on the essays, focusing on the possible misconceptions, dividing the participants into small groups, and monitoring the group work phase (see Vilppu et al., 2019).

Table 1

Frequencies of Teachers from Different Disciplines Completing 1-3 Pedagogical UNIPs Modules

Status	Discipline	Frequencies		
		1 ECTS	2 ECTS	3 ECTS
future faculty ($n = 20$)	humanities/social sciences	6	2	3
	natural science/ medicine	1	5	3
current faculty ($n = 33$)	humanities/social sciences	5	2	8
	natural science/ medicine	5	5	8

Procedure

A pre-test-post-test design was utilized, and the same video interpretation tasks were repeated in the beginning and at the end of the modules (see Table 2). Before starting the university pedagogical courses, the participants answered an online pre-test questionnaire with embedded videos. Answering the questionnaire was included in the course performance, but the respondents could choose not to take part in the research. Participation was stimulated by presenting videos that aligned with students' learning goals.

In the pre-test, the participants answered background questions, accomplished three video clip interpretation tasks, and answered Likert-scale questions. The pre-test was followed by an intervention consisting of one, two, or three parallel six-week courses

about the basics of university pedagogy that were organized fully online. The course titles were "Becoming a Teacher," "How to Plan My Teaching," and "Lecturing and Expertise." Right after the study phase, the participants accomplished the post-test with the same questions as in the pre-test, except the background variable questions and Approaches to Teaching Inventory (Trigwell & Prosser, 1996b).

Measures

A background questionnaire consisted of questions about participants' gender, discipline, previous pedagogical studies, and teaching experience at the university. Measuring professional vision occurred by means of three custom-made videos and two open-ended questions per video: (a) "How would you interpret

Table 2
Study Procedure

Pre-test (open for one week)	Intervention (six weeks)	Post-test (open for one week)
Background variable questionnaire	1–3 parallel independent courses (1 ECTS credit each)	Three video clips and written interpretation tasks measuring (a) professional vision and (b) (mis)conceptions of the role of prior knowledge in learning
Three video clips and written interpretation tasks measuring (a) professional vision and (b) (mis)conceptions of the role of prior knowledge in learning		Likert-scale questionnaires <ul style="list-style-type: none"> • Beliefs about learning and teaching (7 items) • Activating methods in teaching (5 items)
Likert-scale questionnaires <ul style="list-style-type: none"> • Beliefs about learning and teaching (7 items) • Activating methods in teaching (5 items) • Approach to Teaching Inventory (16 items) 		Likert-scale questionnaires <ul style="list-style-type: none"> • Beliefs about learning and teaching (7 items) • Activating methods in teaching (5 items)

this teaching and learning situation?” and (b) “Explain shortly the idea; if you are able to, use pedagogical concepts.” The custom-made videos featured role-playing by actors as teachers and students, representing university teaching-learning situations in which pedagogically interesting situations, called “triggers” (one trigger per video), from the perspective of prior knowledge were included. Video technology was utilised as it offers an opportunity to investigate and support teachers’ learning by capturing the richness and complexity of teaching in a manner that encourages a deliberate examination of classroom practice (Borko et al., 2009).

The video clips presented the following teaching situations. In video one, a teacher activated the student group to consider the answer to a tricky question raised by one student. Video two displayed a teacher ignoring the question raised by the group of students because the particular topic was not part of the original lecture plan. In video three, the teacher took into account the varying backgrounds of the students participating in an introductory course by asking students to discuss their prior knowledge and learning goals at the beginning of the lecture (see Vilppu et al., 2019). The videos were short: the first was 41 seconds, the second was 59 seconds, and the third was 52 seconds in duration. The perceived authenticity of the video material is regarded as highly important (Seidel et al., 2011); therefore, the situations were designed to be interdisciplinary, valid, and plausible. Additionally, the “triggers” in the videos were designed to be domain-general because the participants represented different disciplines.

Three Likert scale questionnaires were used (see Appendix). The Likert scales ranged from 1 (I do not agree) to 5 (I agree). One regarded participants’ beliefs

about teaching and learning (7 items). The other regarded participants’ ideas about activating methods in teaching (5 items), and the third was the well-known Approach to Teaching Inventory (ATI; 16 items; Trigwell & Prosser, 1996b). The ATI was used in the pre-test only; the two other sets of questions were employed in both the pre-test and post-test.

Data Analysis

The data concerning video interpretations were analyzed using a theory-driven approach (Elo & Kyngäs, 2008; Hsieh & Shannon, 2005), in which analysis codes were derived from theory before and during data analysis. Each answer was categorized in light of professional vision of prior knowledge as either scientific, if the participant had recognized the trigger and interpreted it in a pedagogically meaningful way (1), or non-scientific, meaning that the participant had not recognized the “trigger” (0). The scores of the three videos were added together, and each participant received a score of 0–3 related to their professional vision. Additionally, misconceptions about the role of prior knowledge in learning were identified and counted (0–3) from the answers. Examples of the answers, presenting the analysis of the interpretations and how they were coded, are presented in Table 3. Video interpretations in the pre-tests were analyzed and scored by two researchers (the first and the second author). The interrater reliability was 92% for the first video, 93% for the second video and 84 % for the third video. The raters reached consensus by discussing the answers they had classified inconsistently. The quantitative data were analyzed statistically with IBM SPSS Statistics 22 (IBM, Armonk, NY).

Table 3

Examples of Video Clip Answers Categorized as Indicating Either Professional Vision or Misconception Regarding the Role of Prior Knowledge in Learning

Answer Category	Video 1: The teacher activated the student group to consider an answer to a tricky question raised by one student.	Video 2: The teacher ignored a question raised from the group of students because the particular topic was not part of the original lecture plan.	Video 3: The teacher took into account the varying backgrounds of the students by asking them to discuss their prior knowledge and learning goals at the beginning of the lecture.
Professional vision of prior knowledge (PVPK)	“Good that the teacher activates students to answer”	“Problematic that the teacher passes the student’s question”	“Good that the teacher considers students’ preconceptions”
	“The teacher starts by applying learning-focused approach. Also they understand there are students with varying prior knowledge, and tries to encourage the students to get involved in producing knowledge, thus enabling deep approach to learning.”	“It was wrong to ignore student's question. Student's question was actually good and interesting, and it showed that student had interest for the topic and thus should not be "punished" for that.”	“This teaching and learning situation is very good. For the following reasons: 1. The teacher explained the goals of the lecture; 2. Moreover, she tried to bridge the gaps between the students with different background; 3. She gives them the opportunity to understand where they stand and how much they already know.”
	“A student asks the question and teacher turns it into a task that everyone in the lecture could start thinking about. This is a good method.”	“The teacher misses a good opportunity to link previous knowledge to the present themes. This makes the lecture again content focused and leaves the student at a disadvantage in making connections between previously learned and the concepts to be outlined today.”	“The teacher takes into account very well that students have different backgrounds and introduce the goals of the course very clearly and students can affect to what they can learn during the course.”
Misconception of the role of prior knowledge in learning (MPK)	“Problematic that the teacher transmits the question for the students to answer”	“Good that the teacher stays in her original lecture plan”	“Talking about one’s preconceptions with other students is rather useless”
	“This teaching and learning situation is bad. For the following reasons: 1. The teacher started to lecture well; however, the student question from the other lecture/course should not be entertained during this lecture. 2. Moreover, the teacher stopped her lecture and	“This teaching and learning situation seems fine. For the reasons that the teacher gives the student the chance to ask the question during the lecture. However, when question was out of the topic, she limited herself to the topic in hand, it is very good approach.”	“I don’t know if it is essential to discuss about the topics with the neighbour. The lecture has already started. In any case all the student should learn the same things.”

continued on some other lecture after the student interfered”.		
“I would say this is not a problem for the students to answer. Teacher was asked a straight question.”	“This teaching and learning situation is fine. For the following reasons: 1. The teacher let the student ask the question during the lecture; 2. However, she limits herself to the topic in hand.”	“I think the contents student should discuss is not to share only with "neighbour students" but with the teacher.”

First, principal component analyses (PCA) with Varimax rotation were administered to pre-test Likert scale items concerning the participants' beliefs about learning and teaching ($KMO = .706$, Bartlett $\chi^2[21] = 89.597$, $p < .000$), ideas related to using activating methods in one's own teaching ($KMO = .602$, Bartlett $\chi^2[10] = 113.119$, $p < .000$), and items from the ATI ($KMO = .625$, Bartlett $\chi^2[120] = 249.488$, $p < .000$). Two items were omitted because of ambiguous loadings. Two component solutions explained 61%, 81%, and 40% of the variance, respectively. The PCA revealed a scale of (a) “constructive learning,” indicating constructivist beliefs with an acceptable alpha ($\alpha = .795$) and a scale of (b) “learning as remembering,” indicating transmissive beliefs with an acceptable alpha ($\alpha = .643$). The two dimensions related to the use of activating methods were (a) “willing to use activating methods” ($\alpha = .868$) and (b) “No chance to use activating methods due to time restrictions” ($\alpha = .758$; see the factors in the appendix). Two dimensions for approaches to teaching with acceptable alphas included (a) the content-focused approach ($\alpha = .716$) and (b) the learning-focused approach ($\alpha = .745$).

Correlations were calculated between the teachers' beliefs, professional vision scores, misconceptions and approaches to teaching and learning. Additionally, differences between and within groups formed by various background variables (faculty, status, and previous pedagogical education) were tested with non-parametric Mann-Whitney U-tests and Wilcoxon signed-ranks tests. The changes in scores from the pre-test to the post-test within the groups accomplishing one to three parallel UNIPS courses were examined utilizing the split-file condition. Because the Shapiro-Wilks tests as well as skewness and kurtosis statistics showed significant differences from a normal distribution, non-parametric tests were utilised. The fact that the data did not meet the parametric test assumptions may be due to the small sample size.

Results

University Teachers' Professional Vision and Misconceptions of Prior Knowledge Together with Beliefs and Approaches to Teaching and Learning Before the Intervention

At first, in order to guarantee comparability among the participants concerning their previous pedagogical studies, we compared the scores of the participants with previous pedagogical studies with the scores of those without. The results showed that there were no statistical differences in the baseline scores between these groups. Based on the scores of the video interpretations, the participants' ($N = 53$) professional vision of prior knowledge scores were relatively high already in the pre-test ($M = 2.26$; $Md = 2.50$; $SD = 0.84$; $Min = .00$; $Max = 3.00$). The participants had, on average, 0.51 misconceptions related to the role of prior knowledge in learning ($Md = .00$; $SD = 0.72$; $Min = .00$; $Max = 3.00$).

Differences Between Current and Future Faculty Before the Intervention

Before the course, both future and current faculty had more constructivist than transmissive beliefs related to learning, and both groups also had higher scores related to learning-focused than the content-focused approach to teaching (Table 4). Prospective teachers expressed statistically more challenges in terms of using activating methods in their own teaching ($Z = -3.332$, $p = .001$).

Differences Between Teachers from Different Disciplines Before the Course Intervention

The Mann-Whitney U-tests revealed statistical differences in conceptions between the participants from different disciplines (Table 5). Teachers of law, economics, humanities, educational sciences, and

Table 4

Comparison of the Professional Vision of Prior Knowledge (PVPK) Scores, Misconceptions of Prior Knowledge (MPK), Constructivist vs Transmissive Beliefs (CTB) Approaches to Teaching and Scores Related to the Use of Activating Teaching Methods Before the Study Phase Between Future Faculty and Current Faculty

	Future faculty (n = 20)			Current faculty (n = 33)		
	M	Mdn	SD	M	Mdn	SD
PVPK	2.20	2.50	0.95	2.30	2.00	0.77
MPK	0.50	0.00	0.61	0.52	0.00	0.80
Constructivist beliefs	4.39	4.50	0.41	4.52	4.75	0.42
Transmissive beliefs	3.30	3.25	0.50	3.27	3.50	0.64
Learning-focused approach	3.49	3.50	0.61	3.52	3.57	0.63
Content-focused approach	2.57	2.56	0.59	2.51	2.50	0.62
I (will) use activating methods	3.20	3.00	0.82	3.67	4.00	1.07
No chance to activate*	2.95	3.00	0.79	2.09	2.00	0.81

* $p < .05$

Social sciences received higher scores related to constructivist beliefs ($Z = -2.028, p = .043$), and these teachers indicated activating their students more than the teachers in medical faculties and natural sciences ($Z = -2.238, p = .025$). Meanwhile, the participants from medical faculties and natural sciences possessed significantly more transmissive beliefs about learning ($Z = -2.398, p = .016$). However, the latter group had significantly fewer misconceptions related to the role of prior knowledge before the course also ($Z = -2.029; p = .042$).

Change in Professional Vision, Misconceptions, Constructivist vs. Transmissive Beliefs, and Use of Activating Teaching Methods as a Result of Pedagogical Intervention

The Wilcoxon signed-ranks tests showed that the participants' professional vision of prior knowledge increased statistically significantly during the intervention based on the scores of the video interpretation tasks ($Z = -2.736, p = .006$). Participants' misconceptions related to learning and teaching decreased after the intervention ($Z = -3.557, p < .001$). As not all participants took part in all three offered courses, we studied the change in professional vision by comparing the results between the total number of courses taken: those who attended one module (1 ECTS) compared to those who attended two (2 ECTS) or to those who attended two (2 ECTS) or three (3 ECTS) simultaneous modules. The results revealed that only the group that completed all three modules showed statistically significant improvement of the

Table 5

Comparison of the Professional Vision of Prior Knowledge (PVPK) Scores, Misconceptions of Prior Knowledge (MPK), Constructivist vs Transmissive Beliefs (CTB) Approaches to Teaching, and Scores Related to Using Active Teaching Methods Before the Course Between the Teachers from the Natural Sciences (n = 27) and Teachers from the Soft Sciences (n = 26)

	Future faculty (n = 20)			Current faculty (n = 33)		
	M	Mdn	SD	M	Mdn	SD
PVPK	2.26	3.00	.90	2.28	2.00	.79
MPK*	0.37	0.00	.74	0.68	1.00	.69
Constructivist beliefs*	4.31	4.50	.77	4.63	4.75	.36
Transmissive beliefs*	3.50	3.50	.60	3.10	3.00	.43
Learning-focused approach	3.40	3.29	.53	3.63	3.57	.70
Content-focused approach	2.64	2.75	.54	2.44	2.38	.67
I (will) use activating methods*	3.19	3.00	.96	3.77	4.00	.96
No chance to activate	2.50	3.00	.98	2.32	2.50	.84

* $p < .05$

participants' professional vision ($Z = -2.392, p = .017$). This was not the case within the groups who had completed one ($Z = -.791, p = .429$) or two ($Z = -1.732, p = .083$) modules. This means that in order for professional vision scores to improve, completing all three modules was required. In addition, the number of misconceptions decreased in both the group of one course ($Z = -2.236, p = .025$) and in the group of three courses ($Z = -2.810, p = .005$).

Comparison of the Change of Professional Vision, Misconceptions, and Beliefs Related to Learning and Teaching as a Result of Pedagogical Training Between Current and Future Faculty

Current and future faculties were compared in order to investigate whether the short pedagogical intervention had supported these groups differently. The results of the Wilcoxon signed-rank test show that the number of

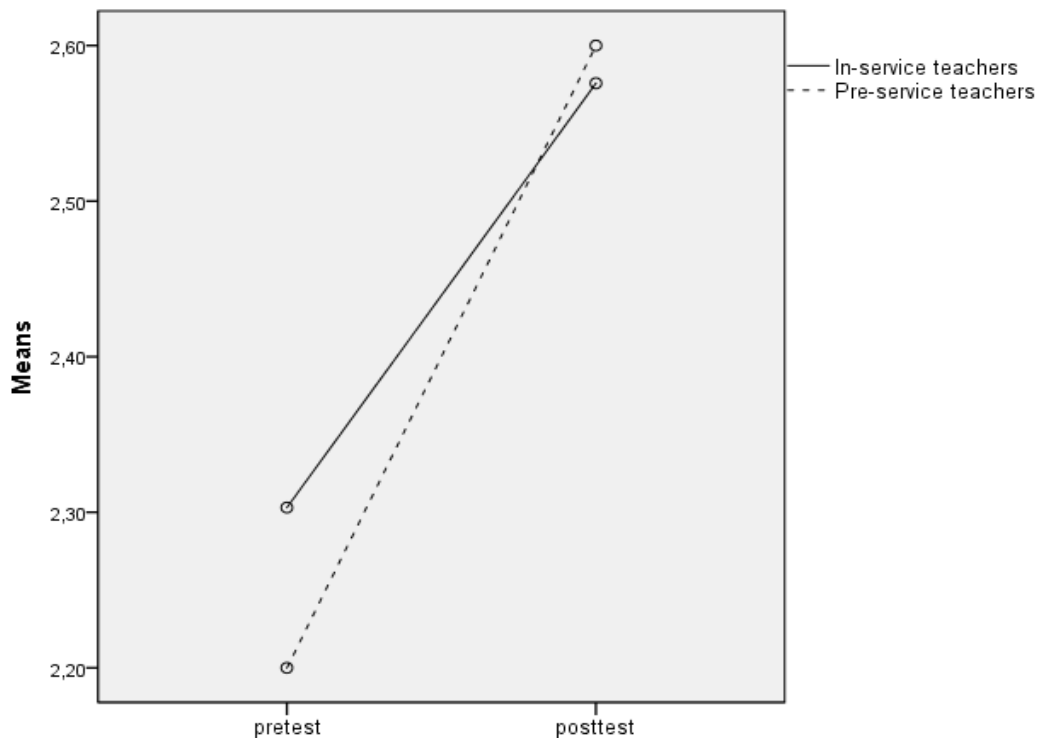
misconceptions decreased significantly in both groups (future faculty: $Z = -2.449, p = .014$; current faculty: $Z = -2.640, p = .008$), and professional vision scores improved. The improvement of professional vision scores was statistically significant among the group of prospective teachers ($Z = -1.994, p = .046$), but differences in the current faculty group did not reach 5% significance ($Z = -1.937, p = .053$; see Figure 1).

Comparison of the Change in Professional Vision Scores and Conceptions Related to Learning and Teaching as a Result of Pedagogical Training Between Teachers from Different Disciplines

We were also interested in whether the short pedagogical intervention supported teachers from different disciplines differently. The results of the Wilcoxon signed-rank test showed that the improvement

Figure 1

Comparison of Teachers' (Current vs Future Faculty) Professional Vision Scores



of professional vision scores was significant in the group of teachers from natural sciences and medicine ($Z = -2.309$, $p = .021$) but not among the teachers from the humanities, social sciences, law, or economics ($Z = -1.748$, $p = .080$). This means that a short pedagogical intervention supported the professional vision of teachers, specifically from natural sciences and medicine, who had a slightly (but not significantly) lower initial level of professional vision. In both groups, the number of misconceptions decreased significantly (teachers from natural sciences/medicine: $Z = -2.121$, $p = .034$; teachers from law/economics/humanities/social sciences: $Z = -2.887$, $p = .004$), and in the post-test, the groups did not differ statistically significantly.

Professional Vision and Misconceptions of Prior Knowledge, Beliefs, and Approaches to Teaching and Learning in Relation to Each Other

When investigating the relationships between professional vision, misconceptions, and beliefs of prior knowledge and approaches to teaching and learning, it became apparent that higher professional vision scores correlated positively with constructivist beliefs about learning ($r = .404$, $p = .003$) and negatively with the content-focused teaching approach ($r = -.300$, $p = .029$; Table 6). The number of misconceptions also correlated negatively with the professional vision scores ($r = -.290$, $p = .035$). Additionally, the sum score of constructivist beliefs about learning correlated positively with the score related to using activating methods in one's own teaching ($r = .425$, $p = .001$) and negatively with the content-focused teaching approach ($r = -.276$, $p = .045$).

Table 6
Correlations of Pre-Test Scores ($N = 53$)

	1	2	3	4	5	6	7	8
1. MPK		.290*	-.074	-.029	-.122	-.021	-.256	.200
2. PVPK			.404**	.021	.195	-.123	-.162	-.300*
3. Constructivist belief				-.064	.425**	-.321*	.074	-.276*
4. Transmissive belief					-.017	-.163	-.153	-.032
5. I (will) use activating methods						-.183	.370**	-.012
6. No time to active							-.093	.213
7. Learning-focused approach								-.041
8. Content-focused approach								

* $p < .05$; ** $p < .01$

Discussion

Although research published from the 1980s has built a solid theoretical foundation concerning the development of teachers' pedagogical expertise, there is a lack of understanding of how these theories can be applied in a higher education context. Thus, the aim of this study was to explore university current and future teachers' professional vision of prior knowledge and their beliefs, (mis)conceptions, and approaches to teaching and learning. The present work sought to answer whether a short, online pedagogical intervention can have an effect on these. Additionally, we were interested if there would be differences among teachers from so-called soft versus hard sciences.

Initial Differences Among and Between Teacher Groups Before the Course Intervention

Contrary to what was expected based on earlier research, the results of our study showed no statistical differences between current and future faculties' level of

professional vision concerning prior knowledge; further, differences were not found at the beginning of the course intervention in misconceptions, beliefs, or approaches for teaching and learning (see Berliner, 2001; Wolff et al., 2015; Wolff et al., 2017). Teachers in both groups received relatively high scores related to professional vision concerning prior knowledge, and all teachers reported more constructive than transmissive beliefs and more learning-centered than teaching-centered approaches for learning and teaching (see also Lui & Bonner, 2016). However, a significant difference between current and future faculty was found before the course intervention related to their conceptualizations about the use of activating teaching methods. Prospective teachers indicated significantly more time-related challenges that might restrict them in using activating methods compared to current faculty.

Furthermore, before the course intervention, discipline seemed to play a larger role than experience when comparing participants' answers. Teachers from soft sciences received higher scores related to constructivist beliefs, and they indicated they activated

their students more than teachers from hard sciences. This result aligns with previous studies reporting that teachers in the social sciences and humanities tend to be more learning-focused, whereas teachers in the natural sciences are typically more content-focused in their teaching (Lindblom-Ylänne et al., 2006; Lueddeke, 2003; Trigwell, 2002). However, although the participants from medical and natural sciences disciplines had significantly more transmissive beliefs about learning, they also had significantly fewer misconceptions related to the role of prior knowledge before the course based on the video interpretations.

Changes Among and Between Teacher Groups as a Result of the Course Intervention

Teachers' professional vision of prior knowledge and their conceptions appeared to have changed towards a learning facilitation direction after completing the pedagogical intervention, although previous research has suggested that longer periods of pedagogical training are often needed for teachers to shift their conceptions towards being more learning-focused (Gibbs & Coffey, 2004; Postareff et al., 2007; Prebble et al., 2004). Our results showed that professional vision scores of prior knowledge improved slightly more among future faculty than among the more experienced current faculty. This may illustrate so-called boundary crossing challenges (Akkerman, 2011). University teachers are experts in their own disciplines, but when it comes to pedagogy, these teachers are more or less novices because most university teachers have only limited knowledge of pedagogical theories and educational sciences (Postareff & Nevgi, 2015). We suggest that for more experienced university teachers, boundaries between their own subject knowledge and pedagogical knowledge might act as obstacles for learning. Future faculty, presumably, do not have automatized or stabilized practices or ways of reasoning regarding their own discipline or regarding pedagogy, which, in this case, may allow them to be more willing to change their conceptions related to pedagogical theories.

However, the theory of "boundary crossing" does not explain how the improvement of professional vision scores found herein was significant in the group of teachers from the hard sciences but not among the teachers from the soft sciences. Despite the greater improvement among hard sciences teachers, they also had more transmissive beliefs and fewer constructive beliefs before the intervention. Thus, the content of the course intervention more drastically contrasted with these teachers' initial beliefs and conceptions, which may explain the greater improvement among that group of teachers. Sometimes, moderate dissonance between one's previous conceptions and the scientific content to

be learned may be helpful to increase metacognitive awareness and facilitate discussions that can lead to deeper understanding and changing of beliefs (Vosniadou et al., 2019).

Last, we compared how teachers' beliefs and conceptions were related to professional vision scores or misconceptions; the results supported the assumption that teachers' conceptions, approaches, and beliefs serve as filters for how teachers observe classroom situations, thereby underlying professional vision because the teachers' self-reported conceptions of learning and teaching were connected to their professional vision scores (Borko & Putnam, 1996; Blömeke et al., 2015; Meschede et al., 2017; Roose et al., 2019; Santagata & Yeh, 2016).

Limitations of the Study

Although the results are encouraging, our study presented some limitations that need to be taken into account when considering the generalization of the results. First, our study was limited in terms of its sample size, which was small and may have been somewhat biased because all the participants of the study can be assumed to be motivated to complete pedagogical courses. In future studies, it would be interesting to study professional vision, (mis)conceptions, and beliefs among university personnel who have teaching duties but who do not seek pedagogical training. In addition, we compared future and current faculties, and it needs to be considered that these groups inevitably have unequal variance in teaching experience; this may explain the lack of statistical difference between the groups in their professional vision scores in the pre-test. The number of years in teaching (or in some other practice) does not automatically correlate with expertise level (Ericsson & Pool, 2016); thereby, to elucidate the transformation of teachers' understanding as a result of the development of pedagogical expertise, it would be fruitful in further studies to compare real expert teachers, defined by their positive impact on student learning, with future faculty before and after training.

Additionally, our data-gathering instruments were constrained to some extent by the ceiling-effect because participants' average scores, particularly related to the measures of "professional vision of prior knowledge" and "constructive learning," were near the upper limit of the scale. This constraint might have reduced the variability found in our data, and further development of the measures are needed in the future. Last, in this study, the professional vision of teachers was investigated with video clips to provide authentic-like input (Meschede et al., 2017). In forthcoming studies, it would be interesting to further investigate, how teachers' professional vision, measured via classroom videos, is related to their actual classroom performance in real situations (e.g., Depaepe

et al., 2020). Additionally, the video task utilised in this study focused on interpreting other teachers' performance in the classroom; in later studies, it would be useful to utilise a reflective approach, where teachers would analyze their own practices because reflection is deemed crucial for fostering teachers' professional growth.

Conclusion

This study investigated changes in university teachers' professional vision of prior knowledge, their beliefs, (mis)conceptions, and approaches to teaching and learning due to a short pedagogical intervention as well as differences between current and future faculty and teachers from hard versus soft sciences. Our research provides more insight into this relatively less investigated research area in a higher education context. Our findings exposed differences among and between teacher groups of different levels of expertise and from different disciplines, which both confirm and update existing theories of teacher expertise.

Generally, our study strengthens the idea that it is valuable to invest in providing opportunities to higher education teachers for improving their pedagogical competence. Moreover, contrary to frequently voiced criticisms, short university pedagogy courses can enhance university teachers' professional vision at least concerning the role of prior knowledge in learning, yet more intense participation can turn out to be more fruitful. Insight into the way teachers' beliefs, approaches and conceptions filter their interpretation of classroom events is vital to support teachers' pedagogical competencies. Thus, recognizing and understanding as well as making teachers aware of their beliefs and conceptions related to pedagogical theories is central to supporting teachers' professional development. To conclude, it may be wise to follow practices of teacher training in other domains and to initiate training before actual teaching duties at the university commence.

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Appendix A

Items and Cronbach α Values of the Sum Scales

Sum scale	Item	Cronbach α
Constructive learning	<ol style="list-style-type: none"> 1. It is important that the teacher is aware of students' previous conceptions concerning the topic. 2. Students' previous knowledge plays hardly any role in their university studies (C). 3. In the learning situation, it is important that the students are able to express their own views about the content. 4. Learning requires connecting the aspects to be learned with one's previous knowledge. 	.795
Learning as remembering	<ol style="list-style-type: none"> 1. Learning means that students adopt course material in detail. 2. If students are able to remember things that the teacher explained, they have learned. 	.643
Willingness to use activating methods	<ol style="list-style-type: none"> 1. In my teaching, I have used teaching approaches in which students are actively involved. 2. I often activate my students to discuss about the topic. 3. In my teaching, I use a lot of time to discuss with the students based on the ideas and questions that they brought up. 	.868
No chance to use activating methods due to time restrictions	<ol style="list-style-type: none"> 1. I would like to dedicate time for discussions or activating teaching methods, but I'm not able to because there is so much content to be taught in the course. 2. My students could have some interesting questions, but usually, we don't have time to go through them. 	.758